



## *2020 State of the VITA Technology Industry*



October 2020

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# State of the VITA Technology Industry October 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](http://www.VITA.com/MarketReports). ([www.VITA.com/MarketReports](http://www.VITA.com/MarketReports))*

## Introduction

COVID-19 is still with us, and now it is the cold and flu season. Schools have been opening for in-person classes and then returning to on-line classes within weeks as campus COVID cases spike. The economy has been improving, but certain segments (airlines, hotels, restaurants, theme parks, cruise lines, retail, etc.) have run out of money and are starting layoffs. Oil prices remain depressed and 36 small oil producers have filed for bankruptcy since January. Amazing technologies are being tested by the U.S. Army and the U.S. Air Force together, while the U.S. Navy seems preoccupied with their recent accidents and internal management problems. On top of all that, it is an election year. So, let us look at what has happened in the last few months and see why it feels like we are living in the "Twilight Zone."

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## Economic Conditions

Q2 2020 was challenging on many fronts: COVID-19, business closures, unemployment, diminished business activity, rioting, and racial unrest. In Q1, U.S. GDP fell by 5%. Q2 declined by 9.5%. These are quarter-over-quarter numbers. Q2 U.S. GDP declined by 32.9% on an annualized basis. You will find articles on the web using both numbers, which is confusing and misleading.<sup>1</sup> That brings-up what Mark Twain said: "There are three kinds of lies: lies, damned lies, and statistics." Just be aware that quarter-over-quarter (QoQ) GDP numbers can understate the situation while year-over-year (YoY) numbers can overstate conditions. Also, consider that the official U.S. GDP numbers are created by 500 people at a government bureaucracy, the Bureau of Economic Analysis (BEA),

<sup>1</sup> Dock David Treece, "How Bad Was Second Quarter GDP, Really?", Forbes, July 31, 2020, <https://www.forbes.com/sites/advisor/2020/07/31/how-bad-was-second-quarter-gdp-really/#7684949a4430>

with a budget of about \$100 million (\$200,000 per employee). BEA makes Amtrak (\$170,000 per employee) and USPS (\$118,500 per employee) look like very efficient organizations. But I digress....

U.S. unemployment at the end of Q1 was 4.4%. It rose to 14.7% in April and declined to 11.1% at the end of Q2 (June).<sup>2</sup> Some analysts say that 25% of the jobs lost in the COVID-19 crisis will not return.<sup>3</sup> Economists state that U.S. unemployment will remain above 10% through 2020, and will not return to 5% until 2022.<sup>4</sup> Other analysts believe that the true unemployment rate is 20% or more, when you include part-time jobs lost and the people who quit looking for employment in the present job market conditions.<sup>5</sup>

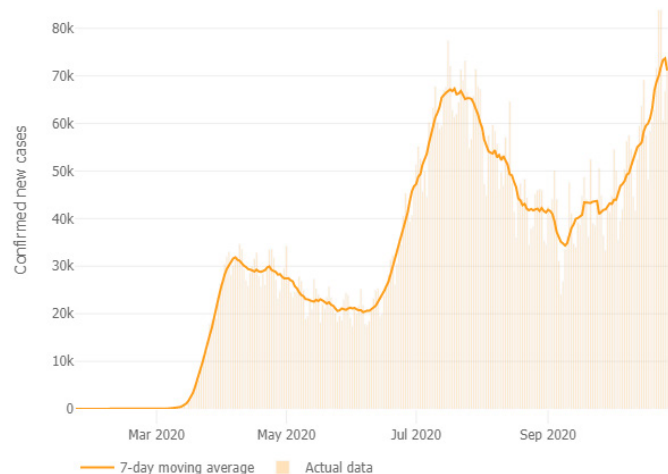
Europe's GDP declined by 12.1% in Q2 (QoQ).<sup>6</sup> Japan's Q2 GDP shrank by 7.8% (QoQ). China's GDP grew 11.5% in Q2, after falling 10% in Q1 (QoQ), but nobody trusts the numbers coming out of China.<sup>7</sup> I constantly wonder about the budget per government employee at the bureaucracies in other countries, that come-up with their GDP numbers. But I digress again....

*"I constantly wonder about the budget per government employee at the bureaucracies in other countries"*

According to the International Monetary Fund (IMF), world GDP will decline by about 5% for all of 2020 (YoY).<sup>8</sup> That makes no sense when you look at the larger developed country GDP declines mentioned previously. It is unreasonable to think that the GDP of Luxembourg, Liechtenstein, Samoa, Trinidad, and Tobago will make-up for the big GDP declines in developed nations. From a purely mathematical perspective, all the major industrial nations would need to experience high positive GDP numbers in the final two quarters of this year for world GDP to decline by only 5% for 2020. But I digress yet again....

The conditions we are experiencing will exhibit five basic phases, and they overlap each other over time. So, let us look at what the future might hold:

**1. Medical Crisis:** Obviously, the virus first created a medical crisis in the world. This has been measured by the number of tests made, the number of positive cases identified, the number of recovered patients, and the number of deaths. The curve for this phase flattened a little in May and June but has started to rise again as bars reopened and colleges resumed in-person classes. Students, who moved into dorms and frat houses in August, have started moving back home as cases increased on campuses and schools transitioned to online classes. Young people hit the bars and partied for two weeks, infecting each other with reckless abandon. The next wave could



Johns Hopkins University & Medicine Coronavirus Resource Center

- 2 "Monthly unemployment rate in the United States", Statista, <https://www.statista.com/statistics/273909/seasonally-adjusted-monthly-unemployment-rate-in-the-us/>
- 3 Ben White, "Political fantasy battles economic reality after tens of millions of jobs lost", Politico, May 8, 2020, <https://www.politico.com/news/2020/05/08/when-will-jobs-return-243925>
- 4 Sylvan Lane, "Bank economists see US unemployment lingering above 10 percent through year's end", The Hill, May 29, 2020, <https://thehill.com/policy/finance/500112-bank-economists-see-us-unemployment-above-10-percent-by-end-of-2020>
- 5 Shahar Ziv, "Don't Be Fooled By Official Unemployment Rate Of 14.7%; The Real Figure Is Even Scarier", Forbes, May 10, 2020, <https://www.forbes.com/sites/shaharziv/2020/05/10/dont-be-fooled-by-official-unemployment-rate-of-147-the-real-figure-is-even-scarier/#245d7c5d55dd>
- 6 Silvia Amaro, "Euro zone GDP plunged by a record 12.1% in the second quarter", CNBC, July 31, 2020, <https://www.cnbc.com/2020/07/31/euro-zone-gdp-q2-2020-as-coronavirus-crisis-hits.html>
- 7 C. Textor, "Quarterly gross domestic product (GDP) growth rate in China Q3 2018-Q3 2020", Statista, October 20, 2020, <https://www.statista.com/statistics/271769/quarterly-gross-domestic-product-gdp-growth-rate-in-china/>
- 8 "World Economic Outlook Update, June 2020", International Monetary Fund, June 2020, <https://www.imf.org/en/Publications/WEO/Issues/2020/06/24/WEOUpdateJune2020>

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come from kids going back to public schools. This phase will continue for many more months, if not a year, until we have an effective vaccine and treatment protocol.

A useful statistic that we don't see from the analysts is the negative effect on GDP per positive COVID test, and the decline in GDP per COVID-related death. After all, locking-down and then reopening businesses is simply a trade-off between higher levels of economic activity and acceptable levels of COVID-related sickness and death in the population. Up to now, there were only two statistical methodologies: Fisherian and Bayesian. Maybe I just created a third: "Economic-Darwinian Statistics".

**2. Economic Crisis:** The medical crisis created an economic crisis as developed economies shutdown. This is macroeconomic and is measured by the rise in unemployment, declines in GDP, and budget deficits in the affected nations. I think declining oil prices fit into this phase, since lower GDP leads to lower energy use. The price of oil dropped to MINUS \$40.32 per barrel in April. In other words, oil companies would give you a barrel of oil AND pay you \$40.32 to take it!<sup>9</sup> Oil prices have now recovered to about \$40 per barrel as demand has increased and many wells were shut down.

**3. Financial Crisis:** The economic crisis is creating a financial crisis. This is microeconomic and is measured by corporate bankruptcies (several retail chains and small airlines have already failed), defaults on loans, defaults on bonds, terminated mergers (Boeing backed out of the purchase of Embraer), and corporate asset fire sales. We will see a blizzard of new bond issues from corporations coming soon: debt (bonds) will replace equity (stocks) as the primary instrument for capitalizing corporations since interest rates are near zero.<sup>10</sup> We will also see a huge number of new bond issues from states, counties, cities, and countries as they scrounge for money.<sup>11</sup> This phase is just beginning now as companies with bad business models and countries with weak finances go under first. Watch the airlines, hotel chains, casinos, restaurants, commercial airplane makers, small colleges, shopping malls, and amusement parks. They are the canaries in the coal mine.

The California legislature is considering a "wealth tax" on their resident's bank and investment accounts to gain more money to keep their bloated government going. And they will continue to tax their resident's financial assets for 10 years, even after they move to another state.<sup>12</sup> In Pennsylvania, the governor is pushing the legalization of recreational marijuana, and taxing it like tobacco and alcohol to get more money to survive.<sup>13</sup>

In New York City, nearly 3,000 small businesses have closed permanently shedding about 520,000 local jobs. Nearly 1,000 bars and restaurants have closed permanently. Over 400,000 wealthy people have moved out of the city during the last few months and took their money with them. Midtown Manhattan to Wall Street looks like a relative ghost town with empty office buildings and they will not fill-up anytime soon.<sup>14</sup> Since the city needs money badly, they are considering a "vacancy tax", to force building owners to rent their empty space at any price.<sup>15</sup> The curve for this phase is getting underway and will destroy a lot of capital before it peaks.

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9 Bill Wang, "US Oil Trades as Low as Negative \$40 a Barrel", Next Big Future, April 20, 2020, <https://www.nextbigfuture.com/2020/04/us-oil-trades-as-low-as-negative-40-a-barrel.html>

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11 Leslie P. Norton and Stephen Kleeg, "Cities and States Are Facing a \$1 Trillion Budget Mess. There Will Be More Trouble Ahead.", Market Watch, August 31, 2020, [https://www.marketwatch.com/articles/cities-and-states-are-facing-horrific-budget-holes-there-will-be-more-trouble-ahead-51598638702?mod=home-page#cx\\_testId=102&cx\\_testVariant=ctrl&cx\\_artPos=5](https://www.marketwatch.com/articles/cities-and-states-are-facing-horrific-budget-holes-there-will-be-more-trouble-ahead-51598638702?mod=home-page#cx_testId=102&cx_testVariant=ctrl&cx_artPos=5)

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15 Nicole Gelinis, "NYC must focus on filling empty buildings again — not profits or tax revenues", New York Post, June 23, 2020, <https://nypost.com/2020/06/23/nyc-must-focus-on-empty-buildings-filled-again-not-prof-its-or-tax-revenues/>

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4. **Political Crisis:** *The financial crisis is creating a political crisis. This phase will be measured in political leadership departures and ruling party changes. Unhappy citizens could remove their local leaders through elections, civil unrest, revolution, civil war, or inter-nation war. We have recently seen a military coup in Mali, the collapse of the government in Lebanon, and riots over the elections in Belarus. In Thailand, demonstrators are demanding the end of the monarchy and a constitutional democracy. Japanese prime minister Abe resigned in late August.*

*We have also seen demonstrations and riots in major U.S. cities, caused by racial tensions. This social unrest, and the underlying economic conditions created by COVID, are motivating many corporations and residents to leave those cities (Minneapolis, Seattle, Louisville, New York City, Chicago, San Francisco, Los Angeles, Philadelphia, Portland) and move elsewhere.<sup>16</sup>*

*This phase is just getting started and could exacerbate the economic and financial decline for those cities, counties, and states.*

5. **International Crisis:** *Deteriorating economic and financial conditions will motivate the leadership of nations to protect their industries and workers through nationalism, isolationism, protectionism, broken treaties, and tariffs on imported goods from other countries. Some of these moves will be overt (like the present situation on imports and exports between the EU countries and the UK), and some will be covert. The EU has been overtly fining U.S. digital technology companies (Apple, Microsoft, Google, Facebook, etc.) for imagined tax infractions for years. Denmark's taxing authority is reviewing Google's accounts now, to find ways to extract more money from them.<sup>17</sup>*

*The EU is now considering a "carbon tax" on imported products from the U.S. and other countries (a covert version of a protectionist tariff).<sup>18</sup> This phase has not yet begun in earnest, but will develop as the economic, financial, and political phases become more severe. We will see increased friction within NATO as EU countries lower their contributions (this treaty has been broken for decades). Most of the steps in this phase, especially from Europe, will be covert and disguised with global warming arguments, national health reasons, or national security concerns. NAFTA has already been replaced with USMCA (U.S., Mexico, and Canada trade agreement), so we will see how that works out. This phase will hamper any efforts to negotiate a trade agreement with China. And it will complicate trade agreements with Europe as they covertly and clandestinely become more protectionist. Additionally, this phase could be the blow that breaks-up the EU, as the financially responsible Northern countries are forced to bail-out the financially irresponsible Southern countries.<sup>19</sup>*

Each of these phases can be broken-down into finer elements, but this is not a thesis for a masters in economics. If you look at the news stories in the future, you should be able to put developing events into one of the five phases and better understand the extended effects of this crisis and where we are on the different curves.

Even if we get effective treatment drugs and vaccines for COVID-19, and the medical crisis phase dissipates, the economic, financial, political, and international phases will continue. This crisis has revealed the downside of globalization and the weaknesses in critical supply chains. In the U.S., we may see products outsourced to other countries brought back, especially in the pharmaceutical area. We may also see the same reaction in automotive (making more car parts in the U.S.) and in electronics (old domestic semiconductor fabs brought back online). Unemployment numbers will also drive the initiative to bring outsourced products back to the U.S. manufacturing base.

*“This crisis has revealed the downside of globalization and the weaknesses in critical supply chains..”*

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16 Jack Kelly, "Cities Will See Citizens Flee, Fearing Continued Riots And The Reemergence Of Covid-19", Forbes, June 2, 2020, <https://www.forbes.com/sites/jackkelly/2020/06/02/cities-will-see-citizens-flee-fearing-continued-riots-and-the-reemergence-of-covid-19/#13a3f529d30d>

17 "Google says Denmark is reviewing its taxes there", Reuters, August 31, 2020, <https://www.reuters.com/article/us-alphabet-tax-denmark/google-says-denmark-is-reviewing-its-taxes-there-idUSKBN25R12H>

18 Kate Abnett, "EU considers tax, emissions trading for carbon border plan", Reuters, July 23, 2020, <https://www.reuters.com/article/us-climate-change-eu-carbon/eu-considers-tax-emissions-trading-for-carbon-border-plan-idUSKCN24O1IM>

19 Spencer Wong, "Is the Coronavirus Ushering in an Era of Eurosceptic Leaders?", The National Interest, April 29, 2020, <https://nationalinterest.org/feature/coronavirus-ushering-era-eurosceptic-leaders-149306>

How long will it take for these five phases to play-out? My guess, from my reading, is about 5 years for all of them to peak, and a total of 10 years to recover. Just consider that some countries, especially Europe and Japan, were barely recovering from the 2008 financial crisis. That is 12 years, so my 10-year recovery estimate is optimistic. We should rebound more quickly than Europe or Asia, as we did from the 2008 financial crisis, but that scenario depends on the slope of the U.S. COVID infection curve.

While the U.S. GDP and unemployment numbers look bad, the U.S. stock market has achieved new record-high valuations. That seems unusual until you consider that the price of stocks is based on anticipated future earnings. So, the stock market is saying that despite all the difficulties we face today, we have a bright future in the U.S.. In fact, U.S.-based technology stocks alone are now worth more than the stocks of all the companies in Europe combined.<sup>20</sup> That's an early predictor of how much faster the U.S. will recover compared to Europe and other nations.

There is no reason to go through all the predictions by economists about what will happen in the rest of this year and into 2021. Just remember what John Kenneth Galbraith said: "The only function of economic forecasting is to make astrology look respectable." We will have to wait and see what the 500 people at the BEA say about the Q-3 GDP numbers. That information might inspire an addendum to this report later this year.

## Technology

Interconnect technologies are taking center stage in computer architectures and many changes are coming to serial connections. Increasing clock frequencies, adding more lanes to a link, and sending more than one bit per clock cycle are all techniques being explored to increase bandwidth.<sup>21</sup> PAM-4 signaling is challenging for backplane-based systems and PAM-8 could be a nightmare.

There's also PAM-12 and PAM-16 in consideration, but the semiconductor people have trouble with the power requirements for these signaling techniques.<sup>22</sup> The next option is Quadrature Amplitude Modulation (QAM) encoding, but that has power and signal integrity issues too. The best option for backplanes is to move signals between boards with twin axial cables and abandon the troublesome copper traces. After that, we must move to optical cables between boards. Either way, cables plugged into the rear of high-performance backplanes are in our future.

*"Cables plugged into the rear of high-performance backplanes are in our future."*

Interconnects have progressed much slower than CPUs, GPUs, and logic blocks over the years. They are a problem at the semiconductor-level all the way through to the systems-level.<sup>23</sup> Two interconnect architectures (CCIX and CXL) have added cache coherency as a partial solution to bandwidth limitations.<sup>24</sup> CCIX is fully symmetric (all chips in the domain are equal) while CXL is asymmetric (one master controls multiple slaves).<sup>25</sup> So, add cache coherency to the interconnect puzzle.

The semiconductor industry has been consolidating for many years, with too many transactions to mention here.<sup>26</sup> Semiconductor demand has been concentrating in several end markets: cellphones, servers, communications,

<sup>20</sup> Jesse Pound, "U.S. tech stocks are now worth more than the entire European stock market", CNBC, August 28, 2020, <https://www.cnbc.com/2020/08/28/us-tech-stocks-are-now-worth-more-than-the-entire-european-stock-market.html>

<sup>21</sup> Bryon Moyer, "High-Speed Signaling Drill-Down", Semiconductor Engineering, June 17, 2020, <https://semiengineering.com/high-speed-signaling-drill-down/>

<sup>22</sup> Bryon Moyer, "What's After PAM-4?", Semiconductor Engineering, June 23, 2020, <https://semiengineering.com/whats-after-pam-4/>

<sup>23</sup> Brian Bailey, "Interconnect Challenges Grow, Tools Lag", Semiconductor Engineering, June 15, 2020, <https://semiengineering.com/interconnect-challenges-grow-tools-lag/>

<sup>24</sup> Ed Sperling, "Which Chip Interconnect Protocol Is Better?", Semiconductor Engineering, May 11, 2020, <https://semiengineering.com/which-chip-interconnect-protocol-is-better/>

<sup>25</sup> Ed Sperling, "Choosing Between CCIX And CXL", Semiconductor Engineering, May 19, 2020, <https://semiengineering.com/choosing-the-appropriate-interconnect-protocol/>

<sup>26</sup> Ed Sperling, "Deals That Change The Chip Industry", Semiconductor Engineering, September 28, 2020, <https://semiengineering.com/deals-that-change-the-chip-industry/>

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automotive, and networking. The cost of a new fab is now around \$5 billion and not many companies can afford that entry fee. There have been several start-ups, mostly designing IP (intellectual property), and they have their chips made by foundries like TSMC. With low interest rates, and further demand consolidation in a just few end markets, expect to see more semiconductor consolidation in the future.

You may know about the 27 different types of convolutional neural networks (CNNs).<sup>27</sup> Obviously, combinations can be stitched together into application-specific networks that can solve certain problems. That process is labor-intensive and unforeseen combinations could be more efficient and productive. Quoc Le, a Google research scientist, and others at Google, created AutoML-Zero, an artificial intelligence program that can define, write, test, and compare different algorithms in seconds without human involvement. AI (artificial intelligence) programmers could be next in line at the unemployment office, right behind fighter pilots, when AutoML-Zero writes the algorithms for autonomous fighter jets that can dogfight enemy fighters without a human in the cockpit. There is more news about AI algorithm developments in the Military Section.

*“AI programmers could be next in line at the unemployment office, right behind fighter pilots.”*

In previous reports, I outlined the top three supercomputers in the world. Number one, at 148 petaFLOPS, was the Summit Supercomputer at Oak Ridge. It contains 36,864 CPUs and GPUs and uses about 13 megawatts of energy. In June, Japan announced that their Fugaku Supercomputer hit 415.5 petaFLOPS, taking the crown as the most powerful computer in the world.<sup>28</sup> It uses 158,978 48-core A64FX ARM-based CPU chips made by Fujitsu (7.3 million cores) and draws about 28.33 megawatts of power. Fugaku could hold the title until one of the three Exaflop supercomputers (1,000 petaFLOPS) are completed in the U.S.. Those machines are Aurora, Frontier, and El Capitan.

In May, Microsoft announced they had built a supercomputer for AI in its Azure cloud, the ND A100 v4 VM series.<sup>29</sup> It can scale up to 285,000 CPU cores and 10,000 GPU chips using AMD CPUs and NVIDIA GPUs. They claim it has the performance to be in the top five supercomputers in the world, but that was before the Fugaku machine took over the top spot.

Not to be left out, NVIDIA built and ran (in 3.5 weeks) the seventh fastest supercomputer in August: Selene.<sup>30</sup> It usually takes a year or more to build a supercomputer. Selene hit 27 petaFLOPS in normal computing, and 1 Exaflop in AI algorithm processing. NVIDIA used a “pods” concept to build this new machine. A DGX chassis contains eight A100 GPUs and two AMD Epyx 64-core 7742 CPUs for 5 AI petaFLOPS. Put four of those in a rack and you have a pod with 20 AI petaFLOPS. Strap five pods together and you have a superpod with 100 AI petaFLOPS. Strap seven superpods together, and you have Selene. It took 6 years and about \$1 billion to design and build the Fugaku supercomputer. Selene was built in 3.5 weeks for a cost of about \$56 million.

In previous reports, I mentioned that the automotive industry has the worst business model since the invention of the wheel (with the possible exception of the airline industry). The new CEO at Ford is trying to change that as the company moves into commercial electric trucks. They want to sell fleet management services to companies.<sup>31</sup> Ford will collect data from the customer’s trucks in operation, do analysis, and sell them management

*“The automotive industry has the worst business model since the invention of the wheel.”*

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27 Ann Stefforna Mutschler, "Using CNNs To Speed Up Systems", Semiconductor Engineering, August 10, 2017, <https://semiengineering.com/using-cnns-to-speed-up-systems/>

28 Tiffany Trader, "Japan's Fugaku Tops Global Supercomputing Rankings", HPC Wire, June 22, 2020, <https://www.hpcwire.com/2020/06/22/japans-fugaku-tops-supercomputing-list-415-petaflops/>

29 Doug Black, "Microsoft's Massive AI Supercomputer on Azure: 285k CPU Cores, 10k GPUs", HPC Wire, May 20, 2020, <https://www.hpcwire.com/2020/05/20/microsofts-ai-supercomputer-on-azure-combinations-of-perceptual-domains/>

30 Karl Freund, "NVIDIA Provides More Details On Selene Supercomputer", Forbes, August 17, 2020, <https://www.forbes.com/sites/moorinsights/2020/08/17/nvidia-provides-more-details-on-selene-supercomputer/#6b987244e9e5>

31 Ben Klayman, "Ford's incoming CEO wants the U.S. automaker to run like a Deere", Reuters, September 8, 2020, <https://www.reuters.com/article/us-ford-motor-commercial-vehicles-insigh/fords-incoming-ceo-wants-the-u-s-automaker-to-run-like-a-deere-idUSKBN25Z2JH>

services to make the fleet more efficient. In essence, Ford is trying to turn the one-time sale of a truck into an annuity. John Deere already does that for farmers who buy their tractors and harvesters.

Connect all the dots and you can see that massive amounts of data will be created in many market segments. To move that data around, we need faster and more efficient interconnects. To make sense of all that data, we need efficient AI algorithms. And those algorithms need to run on fast inexpensive supercomputers.

## Military

To everyone's surprise, the U.S. Air Force flew their first prototype of a 6G fighter plane in September, as part of the Next Generation Air Dominance (NGAD) program.<sup>32</sup> It probably flew at Area-51, where secret flight tests for the U-2, F-117, and SR-71 were conducted. Dr. Will Roper, Assistant Secretary of the Air Force, said the new prototype broke several records but gave no details about the aircraft or who built it.

Only three U.S.-based companies can build military fighter aircraft today: Boeing, Lockheed, and Northrop Grumman. With digital manufacturing techniques, Walmart could probably build this new fighter plane so we may be in for another surprise in the near future. This new 6G fighter development concept should quell the rumors that the DoD might need to nationalize these three companies to fortify our defense manufacturing capabilities.<sup>33</sup> By comparison, the DoD has identified 13 companies than can build the Skyborg unmanned fighter plane in the future.<sup>34</sup>



An animation from Roper's presentation shows digital Airmen preparing to switch nose cone sections on a notional modular unmanned aircraft. USAF

Roper did say that the new aircraft was designed and built using digital design and manufacturing techniques, agile software development, and open system architectures. This plane had operational electronics and software onboard to connect to drones, satellites, and ground stations when it flew. He said it took one year to design and build the new plane. That means they used engines and some other components from existing fighters (F-35, F-18). It took about 10 years to develop the F-22 and about the same for the F-35.

There is no designation for this new aircraft yet, but it could be the replacement for the aging F-22. The software in the F-22 is a mess of spaghetti code running on old processors, and it took forever to integrate the new AIM-120 missile onboard. The Air Force has been talking about changing the way they design and build fighters with the "Digital Century Series" concept, to overcome the problems. In the 1950's and 1960's, the Air Force and contractors designed, built, and deployed six new fighter planes in rapid succession (F-100 to F-106), so they are resurrecting that plan. They do not want to be locked-in to one aircraft design like the F-35, buy that plane for 20 years, and live through all the harrowing, expensive, and time-consuming upgrade cycles.

*"The software in the F-22 is a mess of spaghetti code running on old processors"*

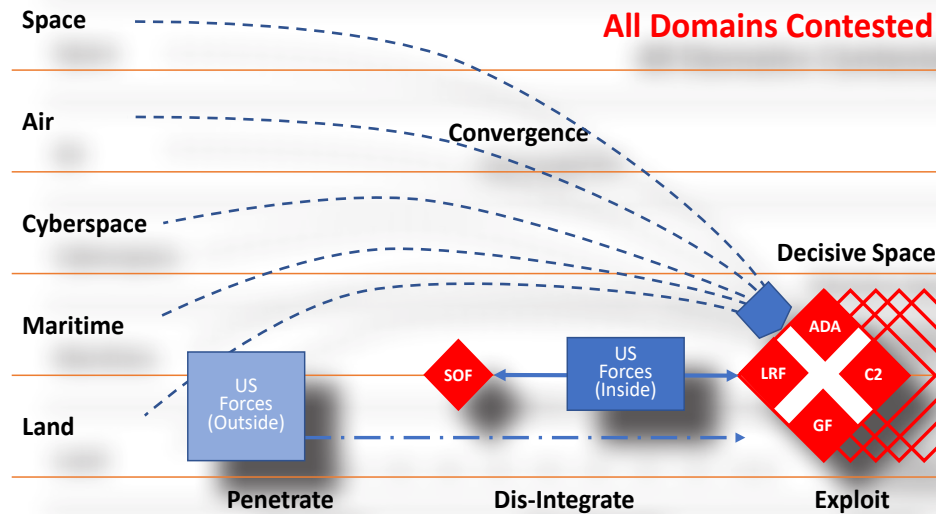
32 Valerie Insinna, "The US Air Force has built and flown a mysterious full-scale prototype of its future fighter jet", Defense News, September 15, 2020, <https://www.defensenews.com/breaking-news/2020/09/15/the-us-air-force-has-built-and-flown-a-mysterious-full-scale-prototype-of-its-future-fighter-jet/>

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34 Valerie Insinna, "US Air Force adds vendors to list of companies that could make autonomous Skyborg drone", Defense News, September 30, 2020, <https://www.defensenews.com/air/2020/09/30/the-air-force-adds-more-vendors-to-the-list-of-companies-that-could-make-its-autonomous-skyborg-done/>



## JOINT FORCES CAPABILITIES



## Multi-Layered Stand-off

### Competition

- Create political separation
- Diplomatic means
  - Economic levers
  - Unconventional warfare
  - Information operators
  - Conventional forces

### Armed Conflict

- Separate the Joint Force in time, space and function
- Long-range fires
  - Unconventional warfare
  - Ground-based air defense systems
  - Electronic warfare, space, and cyber

Source: Army Multi-Domain Operations Concept, December 2018

USAF Chief of Staff, General Charles Brown is making big changes in the Air Force and he said something remarkably interesting at the Air, Space, and Cyber Conference in mid-September. He said, "Leadership without risk is called management." Basically, he said that the Air Force needs more leaders, not more managers.<sup>35</sup>

In 2019, the U.S. Navy released classified videos of UFO encounters with their fighter planes ("Go Fast", "Gimble", and "FLIR1"). In August, SECDEF Esper formed the Unidentified Aerial Phenomena Task Force (UAPTF), to officially catalog and track them in the future. In September, the Japanese Self Defense Force announced standing orders for their troops to report any UFOs back to their brass.<sup>36</sup> Maybe the Navy pilots in the videos saw what the Iranians saw a few years ago?

Back in 2012, Iran reported that their fighter planes intercepted strange aircraft over their nuclear facilities.<sup>37</sup> These unidentified aircraft could hover and then fly away at MACH 10, leaving a faint green glow. Iran claims that these UFOs were advanced spy planes flown by the CIA. Read my recent article "[UFOs and the kill web](#)" on UFOs for a better understanding. The Air Force could be flying something more advanced than their new 6G fighter prototype.

You may be familiar with Space X's Starship reusable hypersonic space plane concept. It has a range of 8,000 miles, a speed of MACH 15 to MACH 30, can carry 100 tons of cargo, and be reused for multiple flights. The Air Force is looking at that platform as a potential hypersonic bomber aircraft for the future. It can deliver 100 tons of ordinance on a battlefield anywhere in the world faster and cheaper than firing a barrage of expensive ballistic missiles.<sup>38</sup>

While there are amazing advancements in weapons systems, the U.S. intelligence community is experiencing another revolution in the collection and processing of data about our enemies. Autonomous vehicles and AI are at the center of

35 Theresa Hitchens, "CSAF Brown Mulls Streamlining Of Air Force Commands; Barrett Announces 'e' Aircraft", Breaking defense, September 14, 2020, <https://breakingdefense.com/2020/09/secaf-brown-mulls-streamlining-of-air-force-commands-barrett-announces-e-aircraft/>

36 Alex Hollings, "Japan Follows US Navy Lead, Establishes UFO Reporting Procedures", Sandboxx, September 14, 2020, <https://www.sandboxx.us/blog/japan-follows-us-navy-lead-establishes-ufo-reporting-procedures/>

37 David Axe, "What Were the Mach 10 UFOs That Iran's Jets Encountered?", The National Interest, September 18, 2019, <https://nationalinterest.org/blog/buzz/what-were-mach-10-ufos-irans-jets-encountered-81366>

38 Brian Wang, "SpaceX Starship Hypersonic Bomber Will Give US Decades of Air Dominance", Next Big Future, September 15, 2020, <https://www.nextbigfuture.com/2020/09/spacex-starship-hypersonic-bomber-will-give-us-decades-of-air-dominance.html>

this revolution.<sup>39</sup> We will see significant demand for compact HPEC (high performance embedded computer) systems as this market segment grows in the near future.

There are three independent programs ongoing, to integrate ISR, C2, and weapons systems in a tactical mesh network. The Air Force has Advanced Battle Management System (ABMS), the Army has the Integrated Battle Command System (IBCS), and the Navy has Cooperative Engagement Capability (CEC). Those are now being integrated into the Pentagon's Joint All Domain Command and Control (JADC2) system.<sup>40</sup> The services have always had rivalries and animosities with each other. As an example, AF General Curtis LeMay was asked who he favored in the upcoming Army-Navy football game by one of his staff. He chomped on his cigar and said, "I hope they both lose". But those days are over. In early September, the Air Force and Army signed an agreement to work together and change the name JADC2 to Combined Joint All Domain Command and Control (CJADC2).<sup>41</sup>



*An Extended Range / Multipurpose (ER/MP) Unmanned Aircraft System (UAS), returns from functional testing during Project Convergence 20, at Yuma Proving Ground, Arizona, September 15, 2020.*

In an ABMS test in December 2019, a simulated cruise missile attack on the U.S. was detected, targeting information was sent to Air Force F-22's, Air Force and Navy F-35's, a Navy destroyer in the Gulf of Mexico, and an Army ground-based missile unit. In September, a second ABMS test simulated a cyber-attack on U.S. satellites and another missile attack against the U.S. (using a BQM-167 missile drone). Targeting data was shared among platforms, and the drone was intercepted by a hypervelocity smart projectile launched by an Army M-109 Paladin 155mm artillery cannon.<sup>42</sup>

In early October, the third ABMS exercise, Valiant Shield, was conducted in the Pacific area involving Army, Navy, Marine, and Air Force platforms. At this event, a new piece of software, C2IMERA (pronounced chimera), combined data from many sensors and updated the Common Operational Picture (COP) sent to both headquarters' units and forward operating bases.<sup>43</sup>

In mid-September, the U.S. Army conducted Project Convergence, where satellites, airplanes, drones, and ground troops shared targeting information and automatically tasked the best weapon to fire at the threat.<sup>44</sup> Marine F-35B fighter planes and Air Force F-35A fighters were included in the data sharing experiment. Imaging data from satellites was sent to computers at Ft Lewis, WA, along with imaging from drones flying over Yuma, AZ. Using Prometheus AI (target ID) software, an enemy tank was identified and coordinates sent to the Firestorm AI (weapons fire control) in Yuma, which chose the appropriate weapon, took control of that cannon, automatically aimed the barrel, and gave the order for a soldier to pull the trigger.<sup>45</sup> It took 20 seconds from satellite detection, through target identification with

39 Anthony Vinci, "The Coming Revolution in Intelligence Affairs", Foreign Affairs, August 31, 2020,

<https://www.foreignaffairs.com/articles/north-america/2020-08-31/coming-revolution-intelligence-affairs>

40 Kris Osborn, "Air Force, Navy & Army Merge Attack Tactics -Joint All Domain Command & Control", Warrior Maven, August 28, 2020

<https://defensemaven.io/warriormaven/air/air-force-navy-army-merge-attack-tactics-joint-all-domain-command-control-0cRmmweT6UC7kbVVa5-2BQ>

41 Andrew Eversden, "US Army, Air Force sign agreement to develop joint all-domain concept", C4ISRnet, October 5, 2020,

<https://www.c4isrnet.com/battlefield-tech/it-networks/2020/10/05/us-army-air-force-sign-agreement-to-develop-joint-all-domain-concept/>

42 Brian W. Everstine, "'Smart' Bullet Downs Cruise Missile in 2nd ABMS Test", Air Force Magazine, September 4, 2020,

<https://www.airforcemag.com/smart-bullet-downs-cruise-missile-in-2nd-abms-test/>

43 Theresa Hitchens, "First Joint Exercise To Test All-Domain Capabilities: Valiant Shield 2020", Breaking Defense, October 7, 2020,

<https://breakingdefense.com/2020/10/first-joint-exercise-to-test-all-domain-capabilities-valiant-shield/>

44 Jen Judson, "Inside Project Convergence: How the US Army is preparing for war in the next decade", Defense News, September 10, 2020,

<https://www.defensenews.com/smr/defense-news-conference/2020/09/10/army-conducting-digital-louisiana-maneuvers-in-arizona-desert/>

45 Kris Osborn, "How the U.S. Army and Air Force Want To Link Their Weapons of War", The National Interest, October 1, 2020,

<https://nationalinterest.org/blog/buzz/how-us-army-and-air-force-want-link-their-weapons-war-169918>

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UAV imaging, through firing the artillery shell and destroying an enemy tank.<sup>46</sup> With another two lines of code and a trigger actuator-solenoid, Firestorm AI could have fired the weapon autonomously.

Last year, the DoD bought a 6 petaFLOPS supercomputer in a cargo container, built by IBM.<sup>47</sup> It could be a platform to run the Prometheus AI and Firestorm AI software in a war zone. Sending satellite and UAV images from a distant battlefield to Ft Lewis, to do target ID and weapons tasking, would be slow and problematic. So, maybe this containerized supercomputer will be put in England, or Poland, or Guam for the next "Project Convergence" test?

The U.S. Navy is lagging the Air Force and the Army in next-generation multi-domain warfare concepts, technologies, and testing. They have endured ship collisions (USS Fitzgerald and USS John S. McCain incidents), removing admirals and other high-level officers for bribery (the "Fat Leonard" scandal), removing fleet commanders and ship captains for infractions, experiencing fires on the USS Bonhomme Richard (actually, 4 navy ships have caught fire lately), and suffering the departure of five Navy Secretaries over the past few years. Additionally, the Zumwalt-class stealth destroyer program has been terminated, the Littoral Combat Ship (LCS) program is a great disappointment, and the catapults and elevators on the new Gerald R. Ford class carrier do not work properly.

Navy leadership has not submitted a realistic "future force assessment" report since the Obama administration, so SECDEF Esper took that responsibility away from them and gave it to a Pentagon committee.<sup>48</sup> Esper also asked the Hudson Institute to study the Navy and submit a report on future requirements. They came back and said the Navy needs 581 ships by 2045, and about one third of those should be unmanned autonomous vessels.<sup>49</sup> With the report from the Pentagon committee, Navy officials can soon start their planning. Maybe that is why the Navy has not been heavily involved in the ABMS testing and Project Convergence activities.

Finally, the Joint Enterprise Defense Infrastructure (JEDI) cloud computing contract was awarded to Microsoft in October 2019, but Amazon protested that President Trump influenced the decision. Google dropped out of the bidding early on. The DoD handled the protest, re-awarded the contract to Microsoft in September, and Amazon protested again. The Pentagon already has over 500 active cloud computing contracts in force and cannot wait for all the legal issues with JEDI to be resolved. The Air Force has created Cloud One, the Army has created cARMY, and the Navy created GovCloud using a mix of Google, Microsoft, Amazon Web Services, and some other providers.<sup>50</sup> When the JEDI legal morass is untangled, the services will start moving their data and code to the JEDI cloud and we'll have more fun. Some employees at Google, Microsoft, and Amazon have protested and resigned over their company's technologies being used for military purposes.

For those of you who need to track military spending worldwide, the Stockholm International Peace Research Institute (SIPRI) has published their report for 2019.<sup>51</sup> This is an excellent report that covers each country's military spending in some detail.

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46 Sydney J. Freedberg Jr., "Improvise Mode: The Army Network Evolves In Project Convergence", Breaking Defense, September 21, 2020, <https://breakingdefense.com/2020/09/improvise-mode-the-army-network-evolves-in-project-convergence/>

47 "HPCMP to Welcome a Mobile, Containerized Supercomputer to Support Artificial Intelligence, Machine Learning, and Data Analytics in 2019", Department of Defense, <https://www.hpc.mil/2013-08-29-16-06-21/featured-stories/featured-story-6-12-19>

48 John R. Kroger, "The US Navy Has Drifted Badly Off Course", Defense One, September 21, 2020, <https://www.defenseone.com/ideas/2020/09/navy-has-drifted-badly-course/168632/>

49 Paul McLeary, "DoD Ponders 581-Ship Fleet, As Navy Shipyard Problems Persist", Breaking Defense, September 30, 2020, <https://breakingdefense.com/2020/09/dod-ponders-581-ship-fleet-as-navy-shipyard-problems-persist/>

50 Sydney J. Freedberg Jr., "JEDI Delay Doesn't Derail DoD Cloud: Pentagon CIO", Breaking Defense, September 30, 2020, <https://breakingdefense.com/2020/09/jedi-delay-doesnt-derail-dod-cloud-pentagon-cio/>

51 "Global military expenditure sees largest annual increase in a decade—says SIPRI—reaching \$1917 billion in 2019", Stockholm International Peace Research Institute, April 27, 2020, <https://www.sipri.org/media/press-release/2020/global-military-expenditure-sees-largest-annual-increase-decade-says-sipri-reaching-1917-billion>

## Mergers and Acquisitions

The big news in mergers and acquisitions is the purchase of ARM by NVIDIA.<sup>52</sup> Not only will this give NVIDIA a premier position in the edge computing market, with low-power CPUs and GPUs, but in the data center and supercomputing markets. Intel and AMD are both working on edge processors and target the data center and supercomputing markets too, so expect them to object to the NVIDIA-ARM deal. ARM management crossed their hearts and promised not to share any of their customer information with NVIDIA management if the deal is approved.<sup>53</sup> Meanwhile, many ARM customers are nervous, downloading and evaluating the RISC-V open source core.<sup>54</sup>

The second most interesting news is AMD's acquisition of Xilinx.<sup>55</sup> This development is sure to rattle management cages at Intel, since Intel bought Altera back in 2015.

In July, BAE Systems bought Raytheon's military GPS business, but that divestiture was dictated by the U.S. DOJ to approve the Raytheon-United Technologies merger, so no surprise here. Raytheon still needs to dump their space-based optical systems and military airborne radio businesses to meet DOJ requirements.<sup>56</sup>

In our corner of the world, Curtiss-Wright bought Pacific Star Communications in September.<sup>57</sup> Pacstar makes tactical and enterprise network equipment. This acquisition makes a lot of sense after reading about the integration of the service's networks under CJADC2 discussed in the Military section of this report, .

I have been tracking and recording the M&A in the board industry for decades. For years the transactions were primarily board companies buying other board companies, a horizontal acquisition strategy, purely to gain market share. Starting with Mercury Systems acquisition of Microsemi, we have seen the larger board and systems companies doing vertical acquisitions, buying advanced-technology component suppliers.

There are not many board makers with significant market share left to buy these days, so expect horizontal M&A activity in our industry to be slow. We are more likely to see the larger board and systems companies acquiring more high-tech component suppliers, to gain technology advantages and differentiation for their product offerings.

For those of you who are involved in M&A, read a recent excellent article, "[Good Vs. Bad Acquisitions](#)" by Ed Sperling, Semiconductor Engineering, who reviews why some acquisitions work and others fail. It is informative and enlightening.

## Summary

As you can see from reading the Technology and Military sections of this paper, new technology is advancing, maturing, and being implemented at an astonishing rate in both the military and commercial markets. What can we expect in the future?

In my "[UFOs and the kill web](#)" article, I speculated about 50-foot soldiers on the battlefield, devastating and destroying everything in their path with impunity. That prediction was surely met with skepticism since Galileo's square-cube law

52 Ed Sperling, "[Nvidia To Buy Arm For \\$40B](#)", Semiconductor Engineering, September 13, 2020, <https://semiengineering.com/nvidia-to-buy-arm-for-40b/>

53 Stephen Nellis, "[Arm exec says 'firewalls' will protect customer info after Nvidia deal](#)", Reuters, October 7, 2020, <https://www.reuters.com/article/us-nvidia-arm/arm-exec-says-firewalls-will-protect-customer-info-after-nvidia-deal-idUSKBN26S3A1>

54 Stephen Nellis, Josh Horwitz, Hyunjoo Jin, "[Nvidia's Arm deal sparks quick backlash in chip industry](#)", Reuters, September 14, 2020, <https://www.reuters.com/article/us-arm-holdings-m-a-nvidia-industry-anal/nvidias-arm-deal-sparks-quick-backlash-in-chip-industry-idUSKBN2650GT>

55 "[AMD to Acquire Xilinx, Creating the Industry's High Performance Computing Leader](#)", AMD, October 27, 2020, <https://ir.amd.com/news-events/press-releases/detail/977/amd-to-acquire-xilinx-creating-the-industrys-high>

56 Nathon Strout, "[BAE Systems completes \\$1.9 billion acquisition of Raytheon's military GPS business](#)", C4ISRnet, July 31, 2020, <https://www.c4isrnet.com/industry/2020/07/31/bae-systems-completes-19-billion-acquisition-of-raytheons-military-gps-business/>

57 Lisa Daigle, "[Curtiss-Wright Defense Solutions to acquire PacStar, provider of battlefield network operations solutions](#)", Military Embedded Systems, September 24, 2020, <https://militaryembedded.com/comms/curtiss-wright-defense-solutions-to-acquire-pacstar-provider-of-battlefield-network-ops-solutions>

says that no human over 9 feet tall can survive on this planet. The tallest man ever recorded (other than Goliath in the Bible, at 9' 9") was Robert Wadlow at 8'11". He had to use steel braces on his legs to move around and died at age 22.

My prediction was vindicated in September, and Galileo's square-cube law avoided, when Japanese engineers built Gundam, a 59-foot tall robot that weighs 25 tons. Gundam can walk and kneel, but that is all it can do for now. His appearance is not very intimidating since he is modeled after a character in a popular cartoon series.<sup>58</sup>

Check out the Youtube video on what the 6 foot, 200 pound **Boston Dynamics** robot can do: jumps, spins, backflips, and somersaults. Atlas looks a bit more intimidating, but not the menacing and scary appearance we need to confront our enemies. Integrate Atlas with Gundam, and we have the foundation for a 50-foot robotic combat soldier. We will call him "Joe", since all the old WWII movies always had a soldier named Joe. Form some rubber skin to make Joe look like the Yautja creature in the "Predator" movies, mount some Hellfire missile racks on his shoulders and some machine guns on his forearms, and we'll have the 50-foot robotic soldier I predicted. The MQ-9 Reaper drone is only 36 feet long, and it can carry 8 Hellfire missiles, so arming-up Joe is certainly possible.<sup>59</sup>



If the Air Force can design and build a 6G fighter plane in one year with digital design, digital manufacturing, agile software development, and open systems architectures, we can easily design and build Joe in a year or less. And Joe may never need to fire his weapons. Imagine 200 Joes that look like the Yautja, invading an enemy city. That would cause a sewer-system overload and the enemy would immediately surrender. Joe could end the dangers of "urban combat" we experienced in Mogadishu, Baghdad, Ramadi, Fallujah, Kabul, and Kandahar.

Supercomputers, using the new concept of "pods" from NVIDIA, can be built faster and cheaper than traditional methods. AI algorithms like Google's AutoML-Zero will soon be able to write, enhance, and debug new algorithms without a human programmer involved. 3D printers and plasma cutters can make the needed parts. These technologies will be at the center of new design and manufacturing techniques. Design algorithms can create, evaluate, optimize, and refine thousands of possible product iterations in minutes. Then, they can push the final designs into manufacturing and build the product in hours, days, or weeks. We are on the cusp of a revolution in engineering and manufacturing, both in commercial markets and in the military. To defeat our economic and military foes in the future, we will soon have the tools and a promising methodology. The COVID pandemic has motivated companies, as well as the military, to lessen their dependence on people and invest more in intelligent machines. Read Klaus Schwab's book, "*The Fourth Industrial Revolution*", to gain more insight.

58 Justin McCurry, "*Big in Japan: giant Gundam robot makes its first moves in Yokohama*", The Guardian, September 23, 2020, <https://www.theguardian.com/world/2020/sep/23/giant-gundam-robot-japan-makes-its-first-moves-in-yokohama>

59 Stephen Losey, "*Double the firepower: MQ-9 tests flying with eight Hellfire missiles*", Air Force Times, October 1, 2020, <https://www.airforcetimes.com/news/your-air-force/2020/10/01/double-the-firepower-mq-9-tests-flying-with-eight-hellfire-missiles/>

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