



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

Introduction

Things have been rattling around for the past six months, on the economic, geopolitical, technical, and military fronts. Economic activity has slowed worldwide, China and the U.S. are in a trade war, many governments are being replaced in Europe, the Iranians have become more daring, new memory technologies are coming to market, and it looks like Greenland could become the 51st state if the price is right. Additionally, technology is changing military doctrine and how we fight wars. The future is looking bumpy as we go forward, so tighten your seat belt.

Economic Conditions

Let's start with the U.S. and China trade war. The U.S. has levied tariffs on smartphones, computers, household appliances, apparel, and toys coming from China.¹ China reciprocated by putting tariffs on aluminum, cars, pork, soybeans, fruits, nuts, and steel from the U.S.. China can't win a trade war, so they devalued their currency in August, making their exports cheaper.² The reason for this spat, besides the out-of-whack trade balance between the U.S. and China, is that China is threatening Taiwan again, and they are exerting communist control over democratic Hong Kong. A British colony for 156 years, the Brits gave Hong Kong back to China in 1997. Amazing that China waited 22 years before cracking-down on them.

1 William Mauldin and Vivian Salama, "Trump Threatens New Chinese Tariffs, Rattling Investors Across Markets", The Wall Street Journal, August 1, 2019, <https://www.wsj.com/articles/trump-to-impose-additional-10-tariff-on-chinese-goods-11564681310>

2 William Watts, "Why a falling Chinese yuan crushed the stock market and intensified the trade war", Market Watch, August 10, 2019, https://www.marketwatch.com/story/what-a-falling-chinese-yuan-means-for-the-stock-market-and-the-trade-war-2019-08-05?mod=mw_theo_homepage

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Additionally, certain government groups in China have been hacking into U.S. company and government servers and stealing data. They have been stealing technology from major U.S. companies for decades. They have irritated Japan, claiming sovereignty over some worthless islands. They harass Philippine fishing boats at sea regularly, they claim ownership of some Vietnamese islands, and they also claim ownership of the oil and gas fields off the Vietnam coast. What's really going on between the U.S. and China is a trade war vs a spy war.³ Further proof is the ban of Huawei products in U.S. communications networks.

The trade war has taken a toll on U.S. GDP. In Q1 2019, the U.S. economy grew at 3.1%, but fell to 2% growth in Q2 (second estimate). The Federal Reserve cut interest rates by 0.25% in July and again in September.⁴ China's GDP fell from 6.4% in Q1 to 6.2% in Q2, if you believe their numbers.⁵ Many economists think they overstate their GDP numbers by 2 to 3% regularly.

However, the U.S. and China are in great financial shape compared to the mess in Europe. The European Central Bank cut interest rates to -0.5%, down from -0.4% in September (yes, these are negative interest rates). Germany's economy declined by 0.1% in Q2, after growing 0.4% in Q1.⁶ You have to go back to Q1 2017 to see Germany's economy growing at 1%. Again, Germany's trade imbalance with the U.S. is problematic, so President Trump has threatened tariffs on imported German cars.⁷ Furthermore, Germany's contribution to NATO is abysmal and they constantly interfere with U.S. foreign policy. And, three of their major corporations are in financial difficulty (Volkswagen, Deutsche Bank, and Bayer).⁸

"The U.S. and China are in great financial shape compared to the mess in Europe."

Then, there's France. They grew at a blazing 0.3% in Q2, but Macron has serious political problems. The "Yellow Vests" are rioting over high taxes and the cost of living there. So, Macron pulled-back on tax increases and started economic reforms. He needs money to keep the French welfare state going, but where will he get it? He'll levy a 3% tax (on local revenue, not profits) on all the big U.S. internet companies like Google, Apple, Facebook, Amazon, etc.⁹ President Trump warned that if he did that, the U.S. would slap massive tariffs on French wine and cheese: a glass of French chardonnay, with some brie cheese and crackers, will cost more than a BMW in the U.S..¹⁰ Looking at the bigger picture, the entire EU (28 states) only grew at 0.2% in Q2 2019.¹¹ According to the top economists, who wear ill-fitting European suits and ugly shoes, the U.S.-China trade war has reduced world GDP by about 1% this year.¹²

Let's move on to something more interesting: the political situation in the EU. Ursula von der Leyen will take over as president of the European Commission from Jean-Claude Juncker on October 31. Previously, she was the German

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- 3 Austin Bay, "Trade War a Weapon Against China's Spy War", Townhall, September 11, 2019, <https://townhall.com/columnists/austinbay/2019/09/11/trade-war-a-weapon-against-chinas-spy-war-n2552882>
 - 4 Brian Cheung, "Fed cuts rates again, telegraphs possibility of one more", Yahoo! Finance, September 18, 2019, <https://finance.yahoo.com/news/fed-fomc-decision-september-2019-133503618.html>
 - 5 Huileng Tan, "China posts its lowest quarterly growth in 27 years as the trade war drags on", CNBC Markets, July 14, 2019, <https://www.cnbc.com/2019/07/15/china-economy-beijing-posts-q2-gdp-amid-trade-war-with-us.html>
 - 6 "German economy slips back into negative growth", BBC News, August 14, 2019, <https://www.bbc.com/news/business-49342012>
 - 7 Jana Randow, "Europe Just Reminded Trump Why He's Mad at Them on Trade", Bloomberg, August 16, 2019, <https://www.bloomberg.com/news/articles/2019-08-16/trade-war-latest-trump-eu-tariffs-exports-europe-germany-jze03wnr>
 - 8 Andy Serwer with Max Zahn, "The downfall of 3 iconic German companies is nothing short of stunning", Yahoo! Finance, June 5, 2019, <https://finance.yahoo.com/news/volkswagen-deutsche-bank-bayer-090000658.html>
 - 9 Geert De Clercq and Elizabeth Pineau, "French tax on internet giants could yield 500 million euros per year: Le Maire", Reuters, March 3, 2019, <https://www.reuters.com/article/us-france-tax-internet/french-tax-on-internet-giants-could-yield-500-million-euros-per-year-le-maire-idUSKCN1QK0ET>
 - 10 David Shepardson and Sarah White, "Trump says U.S. could tax French wine in retaliation for digital tax", Reuters, July 26, 2019, <https://www.reuters.com/article/us-usa-trade-france/trump-says-us-could-tax-french-wine-in-retaliation-for-digital-tax-idUSKCN1UL291>
 - 11 "Eurozone and European Union Q2 2019 growth slows to just to 0.2% (QoQ); Quarterly growth slowest in 5 years", This Time It Is Different, July 31, 2019, <https://thistimeitisdifferent.com/eu-q2-2019-gdp>
 - 12 Ann Saphir, "Trade uncertainty to trim \$850 billion global output: Fed paper", Reuters, September 5, 2019, <https://www.reuters.com/article/us-usa-fed-trade/trade-uncertainty-to-trim-850-billion-global-output-fed-paper-idUSKCN1VQ2KH>

Defense Minister, and left their military in a shamble.¹³ She has appointed 27 people to handle everything from “Green Initiatives” to “Values and Transparency”. It’s best that you read the list of her appointees and what they do.¹⁴ The scariest person on her list is Magrethe Vestager from Denmark. She is the new VP of “digital issues” for the commission and will remain the EU Competition Commissioner (equivalent to our DoJ anti-trust division). No surprise that she is the one who spearheaded all the huge fines against U.S.-based internet companies in the recent past. So, the problem with digital taxes initiated by France will spill across the entire EU in November. As you have read, the EU economy is declining and they need money badly, so Vestager will search for creative ways to tax U.S. companies.

Next is the UK and Brexit. As predicted, Theresa May lost her job and Boris Johnson is the new PM. He suspended parliament until October 14 (a process called prorogation), and the Queen approved his plan. That date is two weeks before the Brexit deadline of October 31. Parliament ordered Johnson to ask the EU for an extension, and he refused. So, Boris called for snap elections — to oust the anti-Brexiteers. A judge has ruled that the prorogation was illegal, ignoring the Queen’s approval. Parliament is threatening to call for a vote of no confidence and oust Boris. At this point, the situation in the UK is starting to resemble a Monty Python movie. Adding salt to the wound, UK GDP declined by 0.2% in Q2.¹⁵

“At this point, the situation in the UK is starting to resemble a Monty Python movie.”

Italy’s prime minister (Conte) resigned and the government collapsed in August.¹⁶ This government lasted about 14 months. Italy has been through 66 governments since 1945 (that has to be some kind of record).¹⁷ Aside from their political problems, most of Italy’s banks would be insolvent without the multiple European Central Bank bail-outs over the past few years. Nevertheless, Italy’s GDP experienced 0% growth in Q2.¹⁸

Then, there’s Spain. Their government collapsed earlier this year. But, their economy grew at 0.5% in Q2, without a government.¹⁹ In Belgium, they still don’t have a government three months after elections.²⁰ However, they grew at 1.2% in Q2.²¹ We’re starting to see a pattern here: a European country’s GDP grows nicely without a government in place.

Germany sold \$1 billion in government bonds at negative 0.11% interest rates in August.²² Also in August, banks in Denmark were offering 10-year negative 0.5% interest rate mortgages. In mid-September, the European Central Bank lowered EU interest rates by 0.1% and started-up a new round of Quantitative Easing, buying bonds again.²³ There’s about \$16 trillion worth of negative interest rate government bonds in the market today. France, Germany, Sweden, Denmark, and Japan have issued most of them. Why would anyone buy negative interest-rate bonds? It makes no

13 Daniel Depetris, "It's High Time for Germany to Fund, and Fix, Its Military", Defense One, August 14, 2019, <https://www.defenseone.com/ideas/2019/08/its-high-time-germany-fund-and-fix-its-military/159149/?oref=d-river>

14 "New EU Commission team enshrines gender equality", BBC News, September 10, 2019, <https://www.bbc.com/news/world-europe-49646809>

15 Brian Wang, "Germany and UK Will Be in Recession if Third Quarter GDP Growth is Negative", Nextbigfuture, August 10, 2019, <https://www.nextbigfuture.com/2019/08/germany-and-uk-will-be-in-recession-if-third-quarter-gdp-growth-is-negative.html>

16 Steve Goldstein, "Europe stocks drop as Italy's Conte says he will resign", MarketWatch, August 20, 2019, https://www.marketwatch.com/story/europe-stocks-advance-for-third-session-in-a-row-2019-08-20?mod=mw_theo_homepage

17 Ian Bremmer, "Italy's Government Has Collapsed. What Happens Next?", Time, August 23, 2019, <https://time.com/5659693/italy-government-collapse/>

18 Stefanie Moya, "Italian Economy Stalls in Q2", Trading Economics, August 30, 2019, <https://tradingeconomics.com/italy/gdp-growth>

19 Stefanie Moya, "Spain Q2 GDP Growth Weakest in 3 Years", Trading Economics, September 30, 2019, <https://tradingeconomics.com/spain/gdp-growth>

20 Richard Good, "Belgian politics still in limbo, three months after elections", Euronews, August 30, 2019, <https://www.euronews.com/2019/08/29/belgian-politics-still-in-limbo-three-months-after-elections>

21 Trading Economics, <https://tradingeconomics.com/belgium/gdp-growth-annual>

22 Dhara Ranasinghe and Michelle Martin, "Germany sells new 30-year bond with negative yield, a first", Reuters, August 21, 2019, <https://www.reuters.com/article/germany-auction/update-2-germany-sells-new-30-year-bond-with-negative-yield-a-first-idUSL5N25H29G>

23 William Watts, "ECB cuts key rate, relaunches QE to shore up eurozone economy", MarketWatch, September 12, 2019, <https://www.marketwatch.com/story/ecb-cuts-key-rate-restarts-qe-as-it-attempts-to-revive-eurozone-economy-2019-09-12>

sense, but there are certain currency and capital safety reasons that make these bonds a good investment if you're holding Euro.²⁴

Closer to home is the situation in Canada. Trudeau has political and legal problems on several fronts. He's up for election in October and the Canadians are not happy about their cost of living, so he could be voted out. Trudeau needs money to keep the Canadian welfare state going and buy him some votes. So, he is proposing to levy a 1% tax on the value of Canadian homes owned by foreigners. That's a creative way to tax other country's citizens.²⁵ I am sure that Margrethe Vestager took notice of this innovative technique.

There is always risk to investors in any market, particularly the global economy, but there several macro risks that tend to be underexamined by most.²⁶ I touched on a just a few of them earlier. The U.S. trade war with China, the situation in North Korea, Iran's antics, Russia's aggression, and Brexit are all sideshows. The main event for the rest of this year, and into 2020, will be the political turmoil and continuing economic difficulties in the EU. All this information suggests that we look to the East, not the West, as the primary source of economic uncertainty in the months ahead.

Military

While North Korea continues to launch missiles into the Sea of Japan, the most pressing threat is coming from Iran in the Strait of Hormuz. They planted mines on two tankers and damaged them. They captured a British tanker and another ship headed toward the UAE. In June they shot down a U.S. drone and in September they allegedly fired missiles at oil production facilities in Saudi Arabia. That attack cut Saudi oil production by about 50%.

Iran's economy is suffering terribly from the sanctions. Unemployment is up to 30% in some age groups (12% overall), inflation is up 37% or more, their currency dropped 60% in value, and food and medicine prices have spiked up 40% to 60%.²⁷ The people of Iran are paying dearly for the terrorist actions and attitudes of their leaders.

Other than their shoot-down of an American drone, Iran has been carefully attacking America's allies Britain and Saudi Arabia. They know that directly attacking any U.S.-flagged cargo, tanker, or military ship in the Gulf would result in an immediate counterattack, especially if lives are lost. After the attacks on Saudi oil facilities, a coalition of countries are now developing the proper response against Iran (economic, political, and military). Further isolation of Iran will cause more pain for their citizens, a further decline in their living conditions, and possibly inspire regime change.

The big news in the military is that U.S. Space Command temporarily opened its doors in Colorado Springs, Colorado in August.²⁸ The permanent location is up for grabs with Colorado, Florida, Alabama, and California all in contention. I am betting on Alabama.

Other issues to be resolved, once Space Command is up and running, are who controls what and who reports to whom. The Air Force Satellite Control Network (AFSCN) is responsible for pre-launch, orbit maneuvering, tracking,



24 Sunny Oh and Joy Wiltermuth, "Here are four reasons why investors might snap up negative-yielding bonds", MarketWatch, August 22, 2019, <https://www.marketwatch.com/story/here-are-four-reasons-why-investors-buy-negative-yielding-bonds-2019-08-21>

25 Kelsey Johnson, "Canada's Trudeau promises to tax foreign speculation in housing market if reelected", Reuters, September 12, 2019, <https://www.reuters.com/article/us-canada-election-housing/canadas-trudeau-promises-to-tax-foreign-speculation-in-housing-market-if-reelected-idUSKCN1VX262>

26 Chris Matthews, "These 10 'grey swan' events could conspire to imperil global economy and markets", MarketWatch, August 17, 2019, https://www.marketwatch.com/story/these-10-grey-swan-events-could-conspire-to-imperil-global-economy-and-markets-2019-08-16?mod=mw_theo_homepage

27 Srinivas Mazumdaru, "How Trump's sanctions are crippling Iran's economy", DW AKADEMIE, June 24, 2019, <https://www.dw.com/en/how-trumps-sanctions-are-crippling-irans-economy/a-49335908>

28 Tom Roeder, "Space Command opens in Colorado, but there's still a long way to go until a Space Force is established", War is Boring, August 29, 2019, <https://warisboring.com/space-command-opens-in-colorado-but-theres-still-a-long-way-to-go-until-a-space-force-is-established/>

and maintenance of satellites. Rocket Lab, NASA, Air Force, and Space X have all launched military satellites in the past. The mission profile and mission data from satellites are controlled by the intelligence agencies. National Security Agency (NSA) controls SIGINT/ELINT satellites. National Reconnaissance Office (NRO) controls all IMINT (imaging) satellites, but the National Geospatial Intelligence Agency (NGIA) does the interpretation. The Army and Navy control their own communications satellites. The Space Development Agency (SDA) designs some of the satellites.²⁹ Now, you can see the political problems surrounding the creation of the Space Force. It looks like they will just protect and defend U.S. military satellites in orbit, but how the intelligence agencies and services will work with them is being hammered-out. Ultimately, Space Command will have satellites with weapons, to fight enemy killer satellites.³⁰ That would make them a combat unit, not a support unit.

Look at the history of military airplanes for a model of what the Space Force might become. Airplanes were first used for reconnaissance on the battlefield. However, in 1911, a pilot dropped grenades on ground troops in the Italian-Turkish war as he was flying around (the first bomber). In 1915, when machine guns were added, a German biplane shot-down a French observation plane (the first interceptor aircraft). During WWI, pilots flew reconnaissance missions with a soldier in the rear seat, who fired his rifle at enemy troops on the ground (the first close air support mission). Also, in 1915, two biplanes with machine guns got into the first aerial dog fight over France (the first fighter planes).

The initial missions for satellites were communications and intelligence (reconnaissance). The next step would be for satellites to drop bombs on enemy positions on the planet, but the Outer Space Treaty (1967) says that's prohibited (the first satellite bomber). However, laser weapons aimed at the planet might find their way onto satellites in the future. Satellites will definitely have on-board weapons, to intercept enemy reconnaissance satellites and shoot them down (intercept satellites). Then, our satellites will engage enemy satellites in dog fights hundreds of miles above the earth (fighter satellites). I don't see an attack role for satellites in close air support for ground troops, unless lasers find their way into that role too. Now you know what the Space Force could be doing in a few short years.

Somehow, we need to bring our allies into our space strategy. How and where does the intelligence and information from their satellites enter into the Space Force? How do the commercial imaging satellite companies (there are about 10 of them) interface with Space Command? The Pentagon buys imaging data from them occasionally. According to some sources, Saddam Hussein bought detailed commercial satellite images of Kuwait before he invaded. Our enemies (Iran, North Korea, Russia, and China) can get all the imaging intelligence they want too. All they have to do is pay the commercial companies with imaging satellites in orbit. There are a lot of unanswered questions here.

Let's move on to Europe again, and their defense initiatives. In September, Italy signed-up to be a partner with the UK on the new 6G Tempest fighter plane. Sweden became a partner on this project back in July. On the other side of the fence, we have Germany, France, and Spain partnering on the Future Combat Air System (FCAS) 6G fighter plane. Obviously, the UK was shut-out of the FCAS program because of Brexit. Sweden (who makes the Gripen fighter) and Italy (who makes some small pieces of the Eurofighter Typhoon) were getting the shut-out as well. Germany, France, and Spain will certainly keep all the good jobs and revenue associated with building the FCAS, and hand-out the crumbs (the low-tech parts manufacturing) to other EU countries.³¹

As you would expect, the incoming EU leadership (von Der Leyen) created a new directorate to consolidate the European defense and space industry and get control of the scattered research and development efforts (and the money).³² The leader of this new directorate is Sylvie Goulard, France's defense minister. von Der Leyen was Germany's defense minister, before she took the EU presidency position. The only thing missing now is to put the Spanish defense minister in charge of missile development for the EU. Now you can better understand why Sweden and Italy have joined the UK on the Tempest fighter project. The deck is definitely stacked against them on FCAS. France and

29 Theresa Hitchens, "SDA Will Control Many Sat Buys, But NOT NROs: Tournear", Breaking Defense, September 19, 2019, <https://breakingdefense.com/2019/09/sda-will-control-many-sat-buys-but-not-nros-tournear/>

30 Nathan Strout, "The new head of US Space Command wants to focus here", C4ISRnet, September 9, 2019, <https://www.c4isrnet.com/battlefield-tech/space/2019/09/09/the-new-head-of-us-space-command-wants-to-focus-here/>

31 Jill Aitoro, "A tale of two future fighters", Defense News, September 13, 2019, <https://www.defensenews.com/opinion/editorial/2019/09/13/a-tale-of-two-future-fighters/>

32 Martin Banks, "EU creates top post to herd its fragmented defense industry", Defense News, September 16, 2019, <https://www.defensenews.com/global/2019/09/16/eu-creates-top-post-to-herd-its-fragmented-defense-industry>

Italy have already signed a pact to develop and build the EU's warships in the future.³³ Every country in the EU makes some kind of military ground vehicle, so that segment is scattered across different countries. Expect to see the new EU leadership produce a European Defense Industry white paper that outlines the consolidation plan soon.³⁴

Historically, it takes an average of about 20 years, and billions of Euro, to design and build an advanced fighter plane. Tempest and FCAS are duplicate efforts that could waste a lot of money. Actually, Tempest and FCAS are both political projects, not military projects. One look at the declining GDP and unemployment of some of the involved countries will support that statement. Could the EU wind-up with two different fighter planes in the future? Yes, they have more than that flying now. Another reason for these two different aircraft programs is to avoid buying advanced fighter planes from the U.S..³⁵ When the 6G Tempest or the FCAS actually fly, they will be antiquated: the U.S. will be flying 10G aircraft with anti-gravity engines (flying saucers with death-ray weapons).

How can I make that last statement? Three reasons. First is the Air Force's Next Generation Air Dominance (NGAD) initiative. They plan to build and field a new fighter plane design every 5 years, by learning from each previous generation and making improvements to the platform rapidly, like we did in the past with the "Century Series" fighter planes.³⁶ The Air Force is already adopting this fast-upgrade concept in the Advanced Battle Management System (ABMS).³⁷

Second is the National Defense Industrial Association's "DANCE" program (Data, Algorithms, Networks, Cloud, and Edge computing).³⁸ DANCE is the software version of NGAD, using "Apps". Basically, an NGAD aircraft will be modular. You can add new wings, engines, electronics, weapons, and capabilities incrementally and easily. We will build these planes with hardware "Legos" and software "Apps". Military satellites are also adopting the NGAD and DANCE concepts.³⁹

Third, flying saucers exist. The U.S. Navy recently adopted new procedures for their pilots to report UFOs, and they have released previously classified videos of their pilots chasing them.⁴⁰ Maybe we recovered a crashed UFO and are reverse-engineering it? According to sources on the web, Velcro and WD-40 were first discovered in the debris of crashed alien spaceships. As further evidence of the existence of flying saucers, an insurance company in Florida has sold 6,000 alien abduction insurance policies in the past year.⁴¹



Avro Canada VZ-9AV Avrocar in the Research & Development Gallery at the National Museum of the United States Air Force.

33 "France's Naval Group and Italian Fincantieri sign joint venture deal", The Defense Post, June 14, 2019, <https://thedefensepost.com/2019/06/14/france-naval-group-italy-fincantieri-joint-venture/>

34 Fabrice Pothier, "Why the new European Commission president should launch the first-ever EU defense whitepaper", Defense News, September 20, 2019, <https://www.defensenews.com/opinion/commentary/2019/09/20/why-the-new-european-commission-president-should-launch-the-first-ever-eu-defense-whitepaper/>

35 Robin Emmott, "Poison pills: Pentagon tells EU not to block U.S. companies from defense pact", Reuters, May 14, 2019, <https://www.reuters.com/article/us-usa-eu-defence/poison-pills-pentagon-tells-eu-not-to-block-u-s-companies-from-defense-pact-idUSKCN1SK1V9>

36 Valerie Insinna, "The US Air Force's radical plan for a future fighter could field a jet in 5 years", Defense News, September 16, 2019, <https://www.defensenews.com/digital-show-dailies/2019/09/16/the-us-air-forces-radical-plan-for-a-future-fighter-could-field-a-jet-in-5-years/>

37 Theresa Hitchens, "Air Force To Upgrade ABMS Every 4 Months: Roper", Breaking Defense, September 18, 2019, <https://breakingdefense.com/2019/09/exclusive-air-force-to-upgrade-abms-every-4-months-roper/>

38 Jon Harper, "What to Expect from Sixth-Gen Aircraft", National Defense, September 16, 2019, <https://www.nationaldefensemagazine.org/articles/2019/9/16/what-to-expect-from-sixth-gen-aircraft>

39 Aaron Mehta, "The Air Force wants satellites that grow fast, die young", Defense News, September 16, 2019, <https://www.defensenews.com/digital-show-dailies/air-force-association/2019/09/18/the-air-force-wants-satellites-that-grow-fast-die-young/>

40 Elizabeth Vaughn, "U.S. Navy Official Confirms UFO Videos Released In 2017, 2018 Are Genuine", RedState, September 19, 2019, <https://www.redstate.com/elizabeth-vaughn/2019/09/19/u.s.-navy-official-confirms-ufo-videos-released-2017-2018-genuine>

41 Sarah Taylor, "Company sells nearly 6,000 'alien abduction insurance' policies", The Blaze, July 24, 2019, <https://www.theblaze.com/news/company-sells-nearly-6-000-alien-abduction-insurance-policies>

NGAD and DANCE have much broader implications. They are both concept and implementation ideas that could integrate VPX, SOSA, MOSA, Victory, and the FACE standards into modular military platforms. The concepts from NGAD and DANCE could spread across aircraft, combat ground vehicles, ships, communications systems, intelligence systems, weapons, and satellites in the future. But with politics and inter-service rivalries ongoing, it will take some time for this integration to occur. Along the way, we might see some new standards activities develop, like subsystem interconnect standards. We've all heard the words "system of systems" used when describing next-generation military platforms and weapons. I think that's a misnomer. NGAD and DANCE define a modular "system of subsystems", and that makes much more sense when you think about it.

Next, we need to look at why President Trump tried to buy Greenland from Denmark.⁴² Harry Truman tried to buy it in 1946, so this is not a new idea. First, Greenland's economy is primarily based on fishing and tourism, even though they are sitting on top of huge deposits of zinc, iron ore, copper, coal, and rare minerals. Denmark doesn't have the money or the motivation to develop those resources. With the economic decline of the EU, Denmark's prosperity is in question so they might change their mind in a few years.

Second, Baffin Bay is the entrance to the Arctic Ocean, then through the Beaufort Sea to the Chukchi Sea, through the Bering Straits, into the Bering Sea, around Alaska, and then into the Pacific Ocean. As the polar ice cap melts, this route from the Atlantic to the Pacific will significantly cut travel time for cargo ships. They won't need to go through the Panama Canal or around Cape Horn. Greenland will be a major port for fueling and cargo transfers to the Pacific. Alaska will play a similar role for ships going from the Pacific to the Atlantic. It would be nice to control both ends of the new Arctic shipping lanes and guarantee freedom of navigation.

Finally, Greenland is a strategically important piece of real estate for our military. We already have Thule AFB, missile early warning radar systems, and satellite tracking systems located there. Now that you know the reasons, it makes sense to make Denmark an offer. Better yet, maybe we can trade them Puerto Rico for Greenland. The Danes are in desperate need of a warm tropical island for their holidays. The U.S. has Hawaii, the Virgin Islands, American Samoa, Northern Mariana Islands, and Guam, so we can spare a tropical island or two.

If you want a deeper understanding of what I have presented in this report, I highly recommend that you read "The Future of War" by George and Meredith Friedman. The subtitle of the book is "Power, Technology, And American World Dominance in The Twenty-First Century". After you read it, you will have a better understanding of how technology is changing military doctrine.⁴³

Technology

Let's start at the top here, with the world's faster computers. In late 2018, the Summit supercomputer at Oak Ridge hit 148 Petaflops of performance, taking the number one spot. It contains 9,216 Power9 processors, and 27,648 Nvidia V-100 GPUs all connected with NVLink. The second fastest machine is the Sierra supercomputer at Lawrence Livermore Labs, hitting 125 Petaflops. It contains 8,640 Power9 processors and 17,280 Nvidia V-100 GPUs connected with InfiniBand EDR links. Third is the Chinese TaihuLight supercomputer that hit 93 Petaflops. It contains 40,690 Sunway SW26010 64-bit processors connected with a proprietary interconnect.⁴⁴ But these machines are wimpy compared to what is being designed and built today: Exascale supercomputers. One Exaflop is 1,000 Petaflops.

Cray has the orders to build three new Exaflop machines, so it's no surprise that Hewlett Packard Enterprise (HPE) bought them for \$1.3 billion in May.⁴⁵ The first machine on order is "Aurora" for Argonne National Labs, being built in

42 Jordan McDonald, "Here's why Trump wants to buy Greenland", CNBC News, August 22, 2019, <https://www.cnbc.com/2019/08/21/heres-why-trump-wants-to-buy-greenland.html>

43 Bob Scales, "The Future of U.S. Military Doctrine Will Be Decided by Technology", The National Interest, September 17, 2019, <https://nationalinterest.org/feature/future-us-military-doctrine-will-be-decided-technology-81306>

44 Steven Woo, "An Introduction to HPC computing", Rambus, August 8, 2019, <https://www.rambus.com/blogs/an-introduction-to-hpc-computing/>

45 Nick Statt, "Hewlett Packard Enterprise acquires supercomputer maker Cray in the race to 'exascale' performance", The Verge, May 17, 2019, <https://www.theverge.com/2019/5/17/18629716/hpe-cray-acquisition-supercomputers-exascale-performance-deal>

partnership with Intel. It will hit 1 Exaflop using Xeon Xe CPUs and some undecided GPU chips, connected with Cray's "Slingshot" interconnect.

The second one is the Oak Ridge National Lab's "Frontier" supercomputer that will run at 1.5 Exaflops. It will use AMD's EPYC CPUs and Radeon GPUs connected with the Slingshot interconnect. The third one is "El Capitan" for Lawrence Livermore. It will run at 1.5 Exaflops, but they have not decided which CPUs and GPUs to use. And, they will use the Slingshot Interconnect.⁴⁶

China operates 227 supercomputers today, and the U.S. operates 109 of the beasts. Japan has 31, the UK has 20, and the rest of EU has about 72.⁴⁷ All of those machines are below the 100 Petaflop performance level, except for the top two mentioned previously.

In September someone at Google posted a paper online, that claimed that their 54-Qubit "Sycamore" quantum computer created a series of random numbers in 3 minutes that would take the Summit supercomputer 10,000 years to accomplish.⁴⁸ This claim of "quantum supremacy", where a quantum machine exceeds the capabilities of classical computers, was immediately removed from the website.

The biggest threat from quantum computers is their ability to break even the most sophisticated data encryption methods.⁴⁹ While a classical computer would take thousands of years to break complex cyphers, quantum machines can break them in minutes. That makes our intelligence agencies very nervous. NSA has been playing with quantum machines for many years now. In August, Cambridge Quantum Computing claimed that they had broken China and Russia's quantum key distribution system (QKD).⁵⁰

Coming down to the chip level, there's the new Cerebras Wafer Scale Engine (WSE) for artificial intelligence (AI). The chip is about 8.5 inches square (71.64 square inches), made-up of 84 tiles, and containing 1.2 trillion transistors. It has 400,000 computing cores connected together with the 2D-mesh Swarm fabric, that moves data at 100 Petabits/second. It also has 18 Gigabytes of memory on board, and the memory bus has a bandwidth of 9 Petabytes/second.⁵¹ According to other articles, it consumes 15kW of power and obviously must be liquid cooled. For comparison, a commercial-grade high-volume pizza oven consumes about 5kW of power. Cerebras will not sell the chip to OEMs because of the cooling requirements. They are running benchmarks on this chip now, to establish the performance levels.

I am sure you remember the idea of embedding optical fibers in a multilayer backplane PCB so that all boards in the rack communicate over optical links without fiber cables.⁵² Well, Intel is working on a patent for plastic RF waveguides on backplane PCBs with all the boards linked together with millimeter-wave RF signals without cables.⁵³

46 Mark Lapedus, "Exascale supercomputers; gold nanosheets; gold glue.", Semiconductor Engineering, August 13, 2019, <https://semiengineering.com/manufacturing-bits-aug-13-2/>

47 James Vincent, "World's fastest supercomputer will be built by AMD and Cray for US government", The Verge, May 7, 2019, <https://www.theverge.com/2019/5/7/18535078/worlds-fastest-exascale-supercomputer-frontier-amd-cray-doe-oak-ridge-national-laboratory>

48 Brian Wang, "Google Quantum Computer Solves Problem 1 Billion Times Faster Than Best Supercomputer Which Might Mean Quantum Supremacy", Nextbigfuture, September 20, 2019, <https://www.nextbigfuture.com/2019/09/google-quantum-computer-solves-problem-1-billion-times-faster-than-best-supercomputer-which-might-mean-quantum-supremacy.html>

49 Christopher Mims, "The Day When Computers Can Break All Encryption Is Coming", The Wall Street Journal, June 4, 2019, <https://www.wsj.com/articles/the-race-to-save-encryption-11559646737>

50 Brian Wang, "China's Quantum Satellite Security Has Been Broken", Nextbigfuture, August 22, 2019, <https://www.nextbigfuture.com/2019/08/chinas-quantum-satellite-security-has-been-broken.html>

51 Andy Patrizio, "Semiconductor startup Cerebras Systems launches massive AI chip", Network World, August 22, 2019, <https://www.networkworld.com/article/3433617/semiconductor-startup-cerebras-systems-launches-massive-ai-chip.html>

52 Mark Schneider and Thomas Kuhner, "Coupling elements for optical printed circuit boards with precision molded alignment structures", Researchgate, June 2008, https://www.researchgate.net/figure/Cross-section-of-optical-printed-circuit-board-with-embedded-glass-fiber_fig1_4344220

53 Rack level pre-installed interconnect for enabling cableless server/storage/networking deployment, U.S. Patent and Trademark Office, August 6, 2019, <http://patentsgazette.uspto.gov/week32/OG/html/1465-1/US10374726-20190806.html>

Optical Internetworking Forum (OIF) has started work on 112Gb/s link standards for die-to-die and chip-to-chip connections. They also have projects for 112Gb/s links over coax cables and copper backplane traces up to 20 inches in length.⁵⁴ This specification will make designing PCIe Gen-6 boards look simple.

While you think about these developments, you need to consider the new memory technologies. All CPUs and GPUs today are memory-bound: the processor can process more data than the memory can deliver. Or if they can provide the data, the power consumption of the memory subsystem is huge (1,024 bit-wide memory buses). There's FeRAM, Nanotube Ram, phase-change memory, ReRAM, MRAM, and stacked 3D SRAM and DRAM in the mix. They are all trading-off density, performance, and power consumption.⁵⁵ We already have HBM (high bandwidth 3D-stacked SDRAM) and 3D Xpoint memory. One way to break the memory bottleneck is to stop moving the data into the CPU registers. That's called "in-memory computing", where the memory devices contain the logic to accomplish some amount of data manipulation.⁵⁶ It will be interesting to see which memory technologies will be used in the new Exascale machines.

Then there's the I/O problem. I/O typically dumps data into memory, so this bottleneck is just an extension of being memory-bound. The new PCIe 6.0 specification is speeding-up the transfer rates, as are the enhancements to Ethernet and optical links. The massive supercomputers mentioned previously are using proprietary link technologies like NVLink or Slingshot, or generally available InfiniBand for now. There's a new link technology coming to market, called Compute Express Link (CXL).⁵⁷ It is a cache-coherent data link based on PCIe. We could see the Cray Slingshot interconnect replaced with CXL in some of the new Exascale machines, if they get the silicon done in time. The PCI-SIG released the PCIe-6.0 spec in June.⁵⁸ Reading that spec is like reading a Stephen King novel: it's very scary if you are a board or backplane designer.

It's clear that some of the memory and I/O technologies being developed for supercomputers will come down to the data centers, along with the high-performance AI and algorithm processors. The question is how much of it will come down to our embedded high-performance computing markets? The precipitous decline of Denard Scaling and Moore's Law are threatening to kill-off the general-purpose CPU in favor of other processors like GPUs and AI engines. If the CPU does survive, it will be relegated to mundane tasks like housekeeping functions and error handling routines. Ultimately a CPU core (like RISC-V) could be buried inside an FPGA, and the CPU chip could go away completely. The old von Neumann architectures just can't handle high-speed data streams coming from the new memory technologies or I/O links.⁵⁹

Some people say that general-purpose CPUs will be around for a long time. Others will say that GPUs and AI engines will replace CPUs rapidly. But both comments are based more on the markets those people are in, rather than the technologies themselves. We have experienced GPUs and FPGAs replacing generic CPUs for many years now. CPUs will be around for a while, until mainstream applications outstrip their capabilities. This transition will happen faster than some believe, but slower than many proclaim. Today, it's the supercomputer and data center markets that are driving technology, not cellphones or the PC. Even the Pentagon is starting to push the technology curves, with initiatives like NGAD and DANCE mentioned in the Military Section. One thing is certain: the CPU, memory, and I/O technologies you are designing with today are rapidly becoming dinosaurs.

Finally, I found this during my research and will pass it along: a way to do fast multiplication of large numbers on classical computers. Back in 1960, mathematician Anatoly Karatsuba came up with a simple way to do this. His method

54 Saman Sadr, "OIF Eyes Expanded Electrical Link Definitions For 112 Gbps", Semiconductor Engineering, August 12, 2019, <https://semiengineering.com/oif-eyes-expanded-electrical-link-definitions-for-112-gbps/>

55 Mark Lapedus, "The Next New Memories", Semiconductor Engineering, August 15, 2019, <https://semiengineering.com/the-next-new-memories/>

56 Ed Sperling, "In-Memory Computing", Semiconductor Engineering, August 8, 2019, <https://semiengineering.com/in-memory-computing/>

57 Ian Cutress, "CXL Specification 1.0 Released: New Industry High-Speed Interconnect From Intel", AnandTech, March 11, 2019, <https://www.anandtech.com/show/14068/cxl-specification-1-released-new-industry-high-speed-interconnect-from-intel>

58 "PCI-SIG® Announces Upcoming PCI Express® 6.0 Specification to Reach 64 GT/s", Business Wire, June 18, 2019, <https://www.businesswire.com/news/home/20190618005945/en/PCI-SIG-Announces-Upcoming-PCI-Express-6.0-Specification>

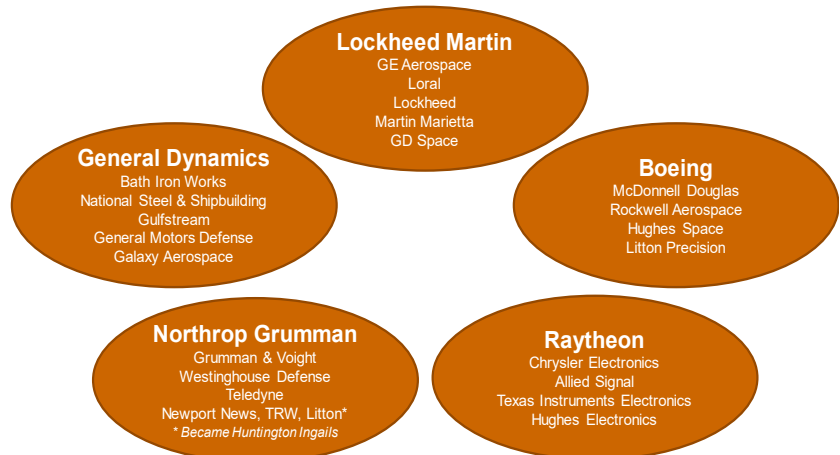
59 Brian Bailey, "Semiconductor's Dinosaurs", Semiconductor Engineering, July 25, 2019, <https://semiengineering.com/semiconductors-dinosaurs/>

involves splitting long numbers into shorter numbers. It takes substantially fewer CPU cycles and you'll be amazed at how it works.⁶⁰ Give the link to your software folks.

Mergers and Acquisitions

In the semiconductor segment, Intel tried to buy Mellanox early in 2019 but lost the bidding to Nvidia. So, they bought Barefoot Networks in June.⁶¹ Maybe this will help them in their Compute Express Link (CXL) silicon design efforts for fabrics in supercomputers. In June, Infineon bought Cypress Semiconductor.⁶²

In the military segment, United Technologies (UTC) turned down a buy-out offer from Honeywell in 2016 but then they agreed to merge with Raytheon in June 2019.⁶³ UTC bought Rockwell Collins (avionics) in 2018 and owns the Pratt & Whitney jet engine business too. The diagram "Should Investors Worry About Defense-Industry Consolidation?" summarizes some of the history of M&A in the defense contractor industry. Read the complete article to refresh your memory.⁶⁴



"Should Investors Worry About Defense-Industry Consolidation?"
Lou Whiteman, The Motley Fool

In July, Advent International Group (a private equity company in Boston) bought Cobham, a UK defense and aerospace company.⁶⁵ M&A activity in the EU may pick up soon, depending on the dictates from the new leadership taking office in Brussels in October. There are about 50 military contractors in the EU. Depending on which way the political winds and the contracts blow on the EU's upcoming military projects, many of those companies may be looking to merge or possibly buy someone in that segment. Only a few of them have the technology and the ability to take on major programs.

We will definitely see more M&A occurring in the military segment. Here are the predictions that were made by Wall Street back in July.⁶⁶ They predict that Northrop Grumman, L3Harris Technologies, and Huntington Ingalls could be bought by either Honeywell, Boeing, or General Dynamics. The reason for these mergers is the Pentagon's demand that primes spend much more money on R&D for advanced military platforms and electronic systems in the future. Some of this pressure is coming from programs like NGAD and DANCE, mentioned in the Military section. The drive for

60 Kevin Hartnett, "A New Approach to Multiplication Opens the Door to Better Quantum Computer", Quanta Magazine, April 24, 2019, <https://www.quantamagazine.org/a-new-approach-to-multiplication-opens-the-door-to-better-quantum-computers-20190424/>

61 Larry Dignan, "Intel acquires Barefoot Networks, plans to bolster networking, interconnect silicon", ZDNet, June 11, 2019, <https://www.zdnet.com/article/intel-acquires-barefoot-networks-plans-to-bolster-networking-interconnect-silicon/>

62 Arno Schuetze and Douglas Busvine, "Infineon revs up auto business with \$10 billion Cypress deal", Reuters, June 3, 2019, <https://www.reuters.com/article/us-cypress-semicond-m-a-infineon/infineon-revs-up-auto-business-with-10-billion-cypress-deal-idUSKCN1T40Jl>

63 Harry Brumpton, and Kate Duguid, "United Technologies, Raytheon to create \$120 billion aerospace and defense giant", Reuters, June 9, 2019, <https://www.reuters.com/article/us-utc-m-a-raytheon/united-technologies-raytheon-to-create-120-billion-aerospace-and-defense-giant-idUSKCN1TA0S6>

64 Lou Whiteman, "Should Investors Worry About Defense-Industry Consolidation?", The Motley Fool, June 16, 2019, <https://www.fool.com/investing/2019/06/16/should-investors-worry-about-defense-industry-cons.aspx>

65 Guy Anderson, "Private equity firm bids GBP4 billion for Cobham", Jane's 360, July 24, 2019, <https://www.janes.com/article/90066/private-equity-firm-bids-gbp4-billion-for-cobham>

66 Al Root, "Defense Companies Need to Merge or Die. 3 Companies That Could Get Bought.", Barron's, July 11, 2019, <https://www.barrons.com/articles/defense-companies-need-mergers-raytheon-united-technologies-deal-51562786347?siteid=yhoof2&ypr=yahoo>

hypersonic missiles, directed energy weapons (lasers), and constellations of small military satellites requires a lot of research and up-front investment too.

In April, Mercury Systems bought Athena Group (cryptographic and countermeasures products) and Syntonic Microwave (SIGINT components).⁶⁷ In September, Mercury Systems bought American Panel, the maker of display screens used in the cockpits of the Apache helicopter, F-35, and F/A-18.⁶⁸ William Conley, director of electronic warfare systems at the Pentagon, joined Mercury Systems as their new CTO in September.⁶⁹

I missed this one last year, so I'll include it here now. Reliance Industries (India) bought RadiSys in 2018 for \$70 million.⁷⁰ RadiSys sales were \$133 million in 2017, so that's an exit multiple of about 0.53 times sales. In July, Smart Global bought Artesyn Embedded Technologies (previously Motorola Computer Group) for \$80 million.⁷¹

According to the history of M&A in our industry, telecom board and systems companies change hands multiple times, and the price goes down for each subsequent sale.

Summary

We covered a lot of ground in this report by looking at several technical, economic, and political elements. Each of these perspectives will help determine where we are going and how we will get there. Technically, we are seeing tremendous investment in new computer architectures for AI and machine learning, new memory technologies, and faster I/O links to move data around. Those basic ideas are coming from the supercomputer and data center markets and will filter down to some degree, to our high-performance embedded computer markets.

Economically, the U.S. is in the best position to take advantage of these technological transitions. While the U.S. and China have growing economies, Europe's taxation and political policies have created stagnation and according to forecasts, their economies will continue to decline through 2024.⁷² EU innovation has been lagging for a decade or more. The horrible productivity of both capital (negative interest rates) and labor (perpetuation of industrial-era manufacturing jobs) is killing the EU. New commercial technologies are a primary contributor to the economic growth of developed nations, and Europe has more things dragging them down than driving them forward.⁷³ EU GDP will barely grow at 1% in the coming years while some of their member countries could go into recession.

China's policies create innovation problems too, which is why they copy or steal technology from the U.S. and Russia. China's J-15 carrier-based fighter plane is a copy of the Russian SU-33, first built in 1987.⁷⁴ Their aircraft carriers are a copy of the Russian Admiral Kuznetsov class, first built in 1982.

Europe's initiative to design and build their new 6G fighter plane domestically is further dividing the union: the UK, Sweden, and Italy (the Tempest project) are going up against Germany, France, and Spain (the FCAS project). Other

67 "Mercury Systems Announces Acquisitions of The Athena Group and Syntonic Microwave", Mercury Systems" April 18, 2019, <https://ir.mrcy.com/news-releases/news-release-details/mercury-systems-announces-acquisitions-athena-group-and-syntonic>

68 "Mercury Systems Completes Acquisition of American Panel Corporation", Mercury Systems, September 23, 2019, <https://insidedefense.com/insider/mercury-systems-acquire-american-panel>

69 Mark Pomerleau, "Pentagon's electronic warfare leader heads to industry", C4ISRnet, September 23, 2019, <https://www.c4isrnet.com/electronic-warfare/2019/09/23/pentagons-electronic-warfare-leader-heads-to-industry/>

70 Ray Le Maistre, "India's Reliance Industries Snaps Up Radisys", Light Reading, July 2, 2018, <https://www.lightreading.com/nfv/nfv-strategies/indias-reliance-industries-snaps-up-radisys-/d/d-id/744372>

71 "SMART Global Holdings Announces Entry into Embedded Computing Market Through Acquisitions of Artesyn Embedded Computing and Inforce Computing", SMART Global Holdings, July 9, 2019, <http://ir.smartm.com/news-releases/news-release-details/smart-global-holdings-announces-entry-embedded-computing-market>

72 "Growth of the real gross domestic product (GDP) in the European Union and the Euro area from 2014 to 2024", Statista, <https://www.statista.com/statistics/267898/gross-domestic-product-gdp-growth-in-eu-and-euro-area/>

73 Mohamed El-Erian, "Christine Lagarde must jump-start change in Europe's economy", The Guardian, September 30 2019, <https://www.theguardian.com/business/2019/sep/30/christine-lagarde-europ-economy-ecb>

74 Michael Peck, "Russia Is Angry That China Stole and Copied Its Jet Fighter Design", The National Interest, September 13, 2019, <https://nationalinterest.org/blog/buzz/russia-angry-china-stole-and-copied-its-jet-fighter-designs-80351>

EU countries will join one or the other of the projects over time. The UK has a mock-up of their new plane – it looks a lot like the F-35.⁷⁵ Dassault (France) released a mock-up of the FCAS in June (it looks similar to the experimental YF-23 built by Northrop/McDonnell-Douglas back in 1990, but with a longer nose).⁷⁶ The Tempest is planned for service in 2035 (15 years). The FCAS is planned for 2040 (20 years). Look at these two proposed planes. Imagine what the semiconductor chips in the avionics, mission computers, sensors, radar, electronic warfare, fire control systems, and the engines will look like in 15-20 years.

This is where NGAD and DANCE start making sense. They can't imagine what the airframes, engines, and electronic systems will look like in 15-20 years either. Or, what they will cost. So, these initiatives propose a 5-year innovation and upgrade cycle for jet fighters. Our European friends should remember the words of Norman Augustine, when he was Chairman of Martin-Marietta. He said "...in the year 2054, the entire [U.S.] defense budget will purchase just one tactical aircraft. This aircraft will have to be shared by the Air Force and Navy, three and one-half days per week, except for leap year, when it will be made available to the Marines for the extra day." The cost of an F-35 has just come down below \$100 million each and that's with production volumes of about 130 planes per year. The research, development, test, and evaluation cost for the F-35 was about \$55.1 billion. It took about 24 years to design the F-35 and put it into production, so the 15-20-year plans for the Tempest and FCAS are overly optimistic.

Obviously, the Europeans will need to spend more than \$55 billion on both the Tempest and the FCAS projects, and they want that money to flow through their GDP instead of buying American-made fighter planes and contributing to our GDP. They need the jobs and the income tax revenue from the manufacturers and the workers to support their government social programs. But there's a big-time gap before that money will start to flow.

To fill that gap, they must figure-out how-to tax U.S. technology companies like Google, Facebook, Apple, and Amazon. If they don't make some difficult political and economic policy decisions in the next few years, most of the innovation coming from Europe will be in tax law, not technology.

75 Kyle Mizokami, "U.K. Introduces New Fighter Jet: The Tempest", Popular Mechanics, July 16, 2019, <https://www.popularmechanics.com/military/research/a22168844/uk-new-fighter-jet-tempest/>

76 Stefano D'Urso, "Dassault and Airbus FCAS 6th generation Fighter Mockup Unveiled At The Paris Air Show", The Aviationist, June 18, 2019, <https://theaviationist.com/2019/06/18/dassault-and-airbus-fcas-6th-generation-fighter-mockup-unveiled-at-the-paris-air-show/>



The Next Generation Fighter mockup.
(Photo: Dassault)



Tempest, TOLGA AKMEN, GETTY IMAGES

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