



2021 State of the VITA Technology Industry



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State of the VITA Technology Industry October 2021

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/Market_Reports). (www.VITA.com/VITA_Technology_Industry)

Introduction

World GDP is recovering from the COVID-19 pandemic lockdowns, except in Europe. There are many new proposed taxes in the developed nations, to find the money to inject into their economies to enhance growth. The COVID-19 Delta variant, inflation, and supply chain disruptions are threatening growth everywhere in the next few quarters. So, things are still uncertain. That's leading to a lot of anxiety, but happiness only occurs in short bursts and is very overrated anyway. That's what we'll explore in this report.

Economic Conditions

In Q2 2021, U.S. GDP rose 6.7% (QoQ), badly missing the economist's crazy estimates of 8.5% growth. Q1 GDP grew at 6.3%.¹ Most of this GDP growth is being driven by pent-up consumer spending, delayed by COVID-19 restrictions. Inflation hit 5.4% in July, driven by all the free money injected into the economy. August inflation was predicted to be about 3.2% but that might be understated considering how bad the economists missed Q2 GDP growth and all the money sloshing around. The unemployment rate for July was 5.2%, with over 10 million job openings for the 8.4 million people receiving unemployment benefits.² About 22 million people were unemployed at the peak of the COVID-19 pandemic, so the recovery has put about 12 million back to work (the

Contents

| | |
|------------------------------------|----|
| Introduction | 1 |
| Economic Conditions | 1 |
| Technology | 4 |
| Military | 7 |
| Mergers and Acquisitions | 9 |
| Summary | 10 |

1 Zachary Halaschak, "Economic growth revised up slightly to 6.7% annual rate in second quarter", Washington Examiner, September 30, 2021, <https://www.washingtonexaminer.com/news/economic-growth-second-quarter-final-revision>

2 Heather Long, Alyssa Fowers and Andrew Van Dam, "Why America has 8.4 million unemployed when there are 10 million job openings", The Washington Post, September 4, 2021, <https://www.yahoo.com/news/why-america-8-4-million-011242636.html>

remainder retired). Wages are up over 8%, and the U.S. government has spent about \$4 trillion on COVID-19 recovery efforts so far, contributing to the inflation pressures.³

EU GDP grew at an anemic 1.9% (QoQ) in Q2, after declining 0.1% in Q1.⁴ Inflation in July was 2.2% and the forecast for Q3 is around 3% as stimulus money starts flowing into their economy. EU unemployment was 7.6% in July. In June, the EU started borrowing about \$950 billion, to divide-up and send to the member countries. They plan to borrow another \$1.3 trillion to finance their COVID-19 recovery. So, their total recovery spending plan is about \$2.2 trillion.⁵ That's an open invitation to higher inflation.

Japan's GDP rose 0.5% in Q2, and China grew at 1.3% (QoQ) or 7.9% (YoY). Both countries growth is being thwarted by export shipping problems: shortages of shipping containers and available ships to carry them. Over 70 ships sit anchored off Long Beach and Los Angeles ports, waiting to be unloaded. And the ports don't have the people to handle the offloading or the truck drivers to take the goods to market.

On the medical front, we were all scanning the internet for vaccination appointments last year. Now, nobody wants them. Before the U.S. got to 50% vaccination rates, we started seeing "vaccination resistance" in the population, especially among young people. With the Delta variant primary today, over 95% of the new COVID-19 cases and deaths are coming from the unvaccinated population. People have been getting conflicting information from government officials, medical experts, and entertainment personalities. The same situation exists about wearing masks. The legal question is.... do the powers of governments and employers stop where your skin starts, or can they mandate vaccinations? The courts are working on the answer. The bottom line is that the surge in new COVID-19 cases could retard GDP growth worldwide in Q3 and Q4.

In further economic news, the U.S. House of Representatives has two spending bills in progress: the \$1.2 trillion infrastructure bill, and the \$3.5 trillion social spending bill. That's another \$4.7 trillion being pushed into the economy if the bills make it through the House and Senate. That would surely inspire inflation to a higher level. The definition of inflation is an abundance of money chasing a scarcity of products.

"The definition of inflation is an abundance of money chasing a scarcity of products."

How will we pay for all this spending? By raising taxes, of course, on corporations and the rich. There are many proposals for higher taxes: (1) raising income taxes on high earners, (2) raising the capital gains tax, (3) eliminating or reducing certain deductions, (4) change carried interest to ordinary income, (5) lower the level of gifts and estates that are exempt from taxes, (6) tax inherited assets as income, and (7) tax inherited businesses at higher rates.⁶

In the infrastructure bill in front of Congress, there's a provision for a per-mile-driven user tax on all cars and trucks. How many miles you drive can be collected and reported to the U.S. Department of Transportation by the electronics in your car, when you renew your tags, or when you have your emissions tested. At some point in the mileage collection cycle, you must pay a tax-per-mile-driven or your car will be impounded or remotely disabled by the DoT (through your car's RF connection). GPS will allow DoT to charge more per mile for driving in cities (a congestion tax) than on miles driven on interstates or rural roads. This idea seems to be aimed at electric vehicle (EV) owners who pay nothing for highway maintenance, since they don't pay any gasoline taxes.⁷ People driving gas-powered cars could be double-taxed.

3 "COVID Money Tracker", Committee for a Responsible Federal Budget, <https://www.covidmoneytracker.org>

4 "GDP up by 2.0% in the euro area and by 1.9% in the EU", Eustat, July 30, 2021, <https://ec.europa.eu/eurostat/documents/2995521/11563211/2-30072021-BP-EN.pdf/0567c280-b56c-2734-2a4b-e4af85a55bf5?t=1627630313030>

5 Silvia Amaro and Christine Wang, "EU leaders reach \$2 trillion deal on recovery plan after marathon summit", CNBC, July 21, 2021, <https://www.cnbc.com/2020/07/21/eu-leaders-reach-a-breakthrough-on-the-regions-recovery-fund.html>

6 Ashlea Ebeling, "Capital Gains Tax Hike And More May Come Just After Labor Day", Forbes, September 3, 2021, <https://www.forbes.com/sites/ashleaebeling/2021/09/03/capital-gains-tax-hike-and-more-may-come-just-after-labor-day/?sh=581aec64903c>

7 Zack Friedman, "Infrastructure Package Includes Vehicle Mileage Tax Program", Forbes, August 11, 2021, <https://www.forbes.com/sites/zackfriedman/2021/08/11/infrastructure-package-includes-vehicle-mileage-tax-program/?sh=56bc707a31c6>

Then, there's the "Ultra Millionaire Tax", that taxes the assets of rich people: a 2% annual tax on people with a net worth of \$50 million to \$1 billion, and a 3% annual tax on people with a net worth over \$1 billion.⁸ And, there's the 20-cent-per-pound tax on virgin plastic, to force manufacturers to use recycled plastic.⁹

Additionally, there's the global effort to adopt a 15% minimum tax on the income of all corporations. There are proposals to limit how much money can be put into an IRA, and all IRAs with a value over \$5 million will require mandatory taxable distributions to get those down to the maximum allowed by the new law. Cities and states are foraging for things to tax too. San Francisco is studying charging a \$6.50 per day "congestion tax" on people who drive in the city, that earn over \$100,000 per year. That idea assumes that you must submit your federal tax returns and W-2 when you renew your car tags, so they know how much you make. These new tax proposals are just a sample of new federal/state/county/city taxes being considered.

Let's move on to new business models coming out of the pandemic. Wendy's Restaurants is opening 700 "ghost kitchens" in the U.S., Canada, and the UK. These are mobile kitchens parked in public parking lots owned by Reef, the largest parking lot operator in North America. The food is prepared for take-out and delivery only.¹⁰ They are doing something similar in England.

Private restaurant owners, who lost their fixed locations during the COVID-19 lock-downs, started the "pop-up" restaurant concept.¹¹ They set-up their equipment in a parking lot, on a roof top, or in a public park and cook for people contacted through the internet or their cellphone. Then, they leave and pop-up somewhere else a few days later. Others have invested in food trucks and park them in pedestrian traffic areas. Restaurants are going to the people instead of people going to the restaurants.

Tesla is exploring a distributed cloud computing concept. Their cars contain a lot of computer processing power, and that's going to waste when sitting in the garage or in a parking lot. So, Tesla will pay you to let them use the CPUs in your car when you don't need them. Tesla's control center can download data and applications via the RF connections in the car and run the programs for cloud customers while owners are asleep or at work.¹² They have sold over 2 million cars so they have a lot of processors available, to start-up their distributed cloud services. Another EV maker (Daymak in Canada) has an app that enables their electric vehicle's computers to mine cryptocurrencies when parked.¹³ Daymak claims the cars can make \$5 to \$12 [a day] depending obviously on crypto prices, but don't forget the increased cost of electricity to keep them charged.

Additionally, Tesla is opening a showroom, service, and delivery center on Native American land in New Mexico. That legally avoids NM law, that requires automakers to sell through independent dealerships. Indian reservations are sovereign nations, not subject to state laws. They can avoid collecting state and local sales taxes there too.¹⁴ Watch other automakers follow suit and locate facilities on Indian land in other states.

Forty-eight states have laws prohibiting automakers from selling directly to consumers. Tesla's business model is a perfect example of disintermediation: removing anyone from the value-added chain that contributes more cost and complexity than benefits. Tesla is successfully removing both the dealerships and the state from the value-added

8 Matthew J. Belvedere, "These revelations make me sick' — Cramer suggests a billionaire surtax after ProPublica bombshell", CNBC, June 11, 2021, <https://www.cnbc.com/2021/06/11/cramer-suggests-billionaire-surtax-after-propublica-report-on-tax-avoidance.html>

9 Zachary Halaschak, "Democratic senators eye range of tax hikes to pay for \$3.5 trillion spending package", Washington Examiner, September 3, 2021, <https://www.washingtonexaminer.com/news/democrats-tax-proposal-options-finance-spending-package>

10 Grace Dean, "Wendy's plans to partner with a startup to open 700 delivery-only ghost kitchens by 2025. An exec breaks down why.", Business Insider, August 13, 2021, <https://www.businessinsider.com/wendys-delivery-ghost-kitchens-dark-reef-abigail-pringle-delivery-2021-8>

11 "Pop-Up Restaurants May Stick Around as COVID Sees Resurgence", NewsMax, August 23, 2021, <https://www.newsmax.com/newsfront/business-pop-up-restaurant-covid/2021/08/23/id/1033373/>

12 Brian Wang, "Future Tesla AI Cloud Vs Amazon AWS, Google Cloud, Alibaba", Next Big Future, August 22, 2021 <https://www.nextbigfuture.com/2021/08/future-tesla-ai-cloud-vs-amazon-aws-google-cloud-alibaba.html>

13 Thomas Hum, "This electric vehicle mines crypto in its free time", Yahoo!Finance, October 1, 2021, <https://www.yahoo.com/finance/news/this-electric-vehicle-mines-crypto-in-its-free-time-191748861.html>

14 Grace Dean, "Tesla opens a showroom on Native American land in New Mexico, getting around the state's ban on automakers selling vehicles straight to consumers", Business Insider, September 13, 2021, <https://www.businessinsider.com/tesla-new-mexico-nambe-pueblo-tribal-land-direct-sales-ban-2021-9>

chain, and the states can't do anything about it. For the Indians, this is a perfect extension of their casino and tobacco strategy: state gaming laws do not apply to Indian land, and the Indians don't have to collect and remit state taxes on cigarettes either. Tesla's lawyers found this loophole and are about to exploit it in every state with Indian Reservations.

Ford is transitioning to a build-to-order business model since they can't get the semiconductors to meet the demand for new cars and trucks. It's a waste of those scarce chips to build cars on pure speculation, send them to dealerships, and then bet that a buyer will like the features and the colors. So, customers can design their car online and place their order. Ford will build the car and ship it to a local dealership, who will deliver it to the customer.¹⁵

The build-to-order model is just another step toward eliminating the middlemen (the dealerships) altogether. A recent financial study was done using Z-scores (a formula for the probability of bankruptcy of a company) concerning the auto industry. It predicts that within 2 years, Volkswagen has a 73% chance of going bankrupt. Ford, Daimler, and BMW have a 49% chance of bankruptcy. GM has a 38% chance of going under.¹⁶ Selling direct to consumers over the internet, developing corporate facilities on Indian land, and eliminating the dealerships could forestall the predicted bankruptcies.

Automakers are carrying heavy debt, they were all hit hard during the COVID-19 pandemic, and they are all spending too much money playing with EVs. Considering the latest battery fire-hazard recall on the 142,000 Chevy Bolt EVs on the road, GM has lost between \$17,000 and \$19,000 on each vehicle sold. Bolts are ugly, they look like washing machines with headlights, so GM should just buy them all back from the owners and cut their losses.¹⁷ Hyundai has recalled 82,000 of their Kona EVs for battery replacements too. They all started chasing Tesla by slapping a bunch of third-party parts together, without deep engineering and testing.

Technology

Let's continue with EVs for a moment before we explore other developments. The fastest production car in the quarter mile, using an internal combustion engine (ICE), is the Dodge Demon. With a 6.2-liter V-8 (840HP, 770 pound-feet of torque), it can run the quarter mile in 9.65 seconds (140 mph). However, the Tesla Model-S Plaid with electric motors and batteries (1020HP, 1050 lb-ft) ran the track in 9.272 seconds (152.68 mph), taking the title of the world's fastest production car.¹⁸

In August, the Rimac Nevera, a Croatian-made custom EV, (1914HP, 1741 lb-ft) ran the quarter mile in 8.655 seconds (166.66 mph). If you're thinking about buying one of these, the Dodge Demon costs \$84,995. The Tesla Model-S Plaid costs \$129,990, and the Nevera costs \$2.4 million. What these quarter-mile numbers prove is what we already knew: electric motors create more torque than gasoline engines, acceleration is only limited by the survivability of the human passengers.

If you want to build your own electric hotrod, you can buy Chevy's new electric crate motor (called "eCrate"), with 200HP and 266 lb-ft of torque. It's the motor and drivetrain out of a



Bolt EV electric motor. Photo courtesy Chevrolet.

15 Sebastian Blanco, "Ford Moving toward Build-to-Order, Away from Packed Dealer Lots", Yahoo!, July 31, 2021, <https://autos.yahoo.com/ford-moving-toward-build-order-180000140.html>

16 Brian Wang, "Which Car Companies Will Go Bankrupt First?", Next Big Future, August 25, 2021, <https://www.nextbigfuture.com/2021/08/which-car-companies-will-go-bankrupt-first.html>

17 Brian Wang, "GM EV Clowns", Next Big Future, September 4, 2021, <https://www.nextbigfuture.com/2021/09/gm-ev-clowns.html>

18 Bryan Hood, "Watch: The Rimac Nevera EV Easily Smoked the Tesla Model S Plaid in a Drag Race", Yahoo!Life, August 20, 2021, <https://www.yahoo.com/lifestyle/watch-rimac-nevera-ev-easily-183000077.html>

Chevy Bolt.¹⁹ If you wait a few months, you can buy a used Chevy Bolt at the junkyard for pennies on the dollar and strip-out the motor and controllers you need. Or you can buy Ford's electric crate motor (M-9000-MACHE), with 281HP and 317 lb-ft of torque.²⁰ I'm an old-school gear head who likes the smell of gas, oil, and grease, and the growl of a real engine. I just can't get into electric hotrods. Just think about a restored '55 Chevy with an electric motor instead of an LS engine.

"I'm an old-school gear head who likes the smell of gas, oil, and grease, and the growl of a real engine."

With the shortage of chips plaguing the electronics and automotive industries, there's been a flurry of announcements coming from the semiconductor industry. IBM made their first 2nm chip back in May of this year.²¹ TSMC and Samsung are making 5nm chips, pushing their processes down to 3nm. Intel is stuck at 10nm, moving to 7nm.

In May, TSMC announced plans to build 6 new fabs in Phoenix, about 7 or 8 miles from my home. You won't believe how much my house increased in value right after that announcement.²² Intel announced in March that they will build two new fabs in Chandler, AZ.²³ Looks like Phoenix is rapidly becoming Silicon Valley Southwest.

Samsung has announced that they will build a new U.S. fab. Candidate locations are Texas, New York, and Phoenix. In July, Intel announced that they will build 2 new fabs in Europe.²⁴ Candidate locations are Germany, Netherlands, Belgium, or Italy, depending on which country gives them the most money and tax breaks to build in their country.²⁵ They also announced expansions to their existing Ireland fab. The amount of chip-making capacity coming online in the next few years is phenomenal.



Chevy LS Engine

Before we leave the semiconductor industry, let's look at the cost to design a chip at each geometry. For 28nm devices, it's \$40 million. At 10nm, it's \$150 million. At 7nm, it's \$217 million. At 5nm, it jumps up to \$416 million, and at 3nm it's \$590 million.²⁶ The new TSMC fab under construction in Phoenix will cost about \$12 billion, when you include all the lithography, wafer handling, and water-treatment equipment. TSMC, Samsung, and Intel are the only companies that have the money, and the talent, to play this game.

According to the latest reports on the Exascale supercomputers under construction, over 60% of their power consumption is used just to move the data around. Obviously, that's more than the power used to process the data. The new El Capitan machine, for Lawrence Livermore Labs, will produce 2 Exaflops of computing power from 30 megawatts

19 Stef Scharader, "The Chevrolet Performance eCrate Is Here to Make Electric Drivetrain Swaps Easier Than Ever", The Drive, October 29, 2020, <https://www.thedrive.com/news/37354/the-chevrolet-performance-ecrate-is-here-to-make-electric-drivetrain-swaps-easier-than-ever>

20 Dan Mihalascu, "Ford Performance Electric Crate Motor Makes 281 HP, 317 Lb-Ft", Inside EVs, August 27, 2021, <https://insideevs.com/news/529286/ford-eluminator-crate-motor-specs/>

21 Brian Wang, "IBM Made First Chip with 2 Nanometer Nanosheet Technology", Next Big Future, May 6, 2021, <https://www.nextbigfuture.com/2021/05/ibm-made-first-chip-with-2-nanometer-nanosheet-technology.html>

22 Brandon Hill, "TSMC May Build Up To Six Chip Fabs In Arizona To Satisfy Voracious Customer Demand", Hot Hardware, May 4, 2021, <https://hothardware.com/news/tsmc-may-build-up-to-six-new-chip-fabs-in-arizona-to-meet-voracious-customer-demand>

23 Kif Leswing, "Intel is spending \$20 billion to build two new chip plants in Arizona", CNBC, March 24, 2021, <https://www.cnbc.com/2021/03/23/intel-is-spending-20-billion-to-build-two-new-chip-plants-in-arizona.html>

24 Joel Hruska, "Intel May Build Chip Facilities Across Europe as Part of \$20B Foundry Plan", ExtremeTech, July 13, 2021, <https://www.extremetech.com/computing/324610-intel-may-build-chip-facilities-across-europe-as-part-of-20b-foundry-plan>

25 Douglas Busvine, "Intel seeks \$10 billion in subsidies for European chip plant", Yahoo!Finance, April 30, 2021, <https://finance.yahoo.com/news/intel-seeks-8-billion-euros-113115892.html>

26 Mark Lapedus, "Piecing Together Chiplets", Semiconductor Engineering, July 22, 2021, <https://semiengineering.com/piecing-together-chiplets/?cmid=291477a6-f062-4738-b59f-1ec44fd21e39>

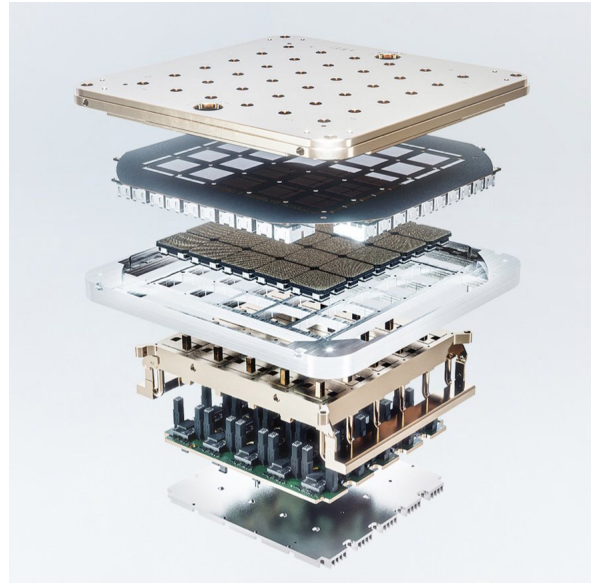
of power consumption.²⁷ The Frontier supercomputer, for Oak Ridge Labs, will produce 1.5 Exaflops from about 29 megawatts of power. The Aurora supercomputer, for Argonne National Labs, will produce about 1 Exaflop of processing power. All I could find was that it will consume something less than 60 megawatts of power. When you look at the CPUs used in this machine, you'll understand why power consumption is so high.

The fastest supercomputer today (Fugaku in Japan) produces 442 Petaflops of processing power from 158,976 low-power ARM-based CPU chips. The machine consumes 28.3 megawatts of power.²⁸ Additionally, Tesla engineers have developed a supercomputer optimized for AI learning applications, so they could break into the top 500 soon.²⁹

Speaking of data movement, some smart people at MIT, Raytheon, and Intel have created a cable-base data link that moves 105 Gb/s without all the crosstalk, insertion loss, and collapsing eye-diagram problems we are enduring. No, it's not copper wire, and it's not optical either. It's a hollow plastic-polymer flexible tube (a conduit) about the diameter of a human hair. Yes, it's a waveguide.³⁰ Silicon-based chips send RF signals down the waveguide without using as much power as copper and optical cables. You can bundle the conduits together (X2, X4, X8, X16, etc.) and reach terabit data transfer speeds. This concept could reduce the data-movement power consumption problems seen in Exascale supercomputers, and in HPEC (high-performance embedded computers).

With the great advances in processor performance over the past few years, all computers are I/O-bound: the processors can handle more data than the memory and I/O devices can deliver. This dilemma is driving the CPU makers crazy, so there's a huge amount of research being done on higher-performance interconnects (die-to-die, chip-to-chip, box-to-box).³¹ But, you don't see much talk about board-to-board interconnects. That's because chip-to-chip interconnects, or network links (like Ethernet), can often be used board-to-board when the connectors and backplane traces are adapted to their electrical layers. We did that in the past with PCI, PCI Express, Ethernet, InfiniBand, and RapidIO. So, whatever those semiconductor engineers come up with for chip-to-chip interconnect, will probably come down to us in the embedded markets when those chips go into volume. Meanwhile, PCIe will be around for a while, and CXL looks too heavy for board-to-board interconnects at this point. CXL is cache-coherence from CCIX sitting on top of PCIe 5.0 and 6.0.

I thought the Kandou bus technology looked promising, but the polymer conduit (waveguide) concept looks even better. Copper is running out of headroom for data transfers, so we need another solution to solve the bandwidth limitations we are experiencing in the embedded markets.



Tesla DOJO AI Supercomputer Chip

27 Brian Wang, "AMD Leading Exascale Supercomputers with 2 Exaflop El Capitan Supercomputer in 2023", Next Big Future, August 31, 2021, <https://www.nextbigfuture.com/2021/08/amd-leading-exascale-supercomputers-with-2-exaflop-el-capitan-supercomputer-in-2023.html>

28 "Fugaku Holds Top Spot, Exascale Remains Elusive", Top 500, June 28, 2021, <https://www.top500.org/news/fugaku-holds-top-spot-exascale-remains-elusive/>

29 Brian Wang, "Tesla Dojo, Supercomputers and AI", Next Big Future, September 17, 2021, <https://www.nextbigfuture.com/2021/09/tesla-dojo-supercomputers-and-ai.html>

30 Daniel Ackerman, "Data transfer system connects silicon chips with a hair's-width cable", MIT News, February 24, 2021, <https://news.mit.edu/2021/data-transfer-system-silicon-0224>

31 Ann Steffora Mutschler, "Data Tsunami Pushes Boundaries Of IC Interconnects", Semiconductor Engineering, September 22, 2021, <https://semiengineering.com/data-explosion-pushes-boundaries-of-ic-interconnects/?cmid=ce2fe984-fcff-44ef-8164-dade141e80bf>

Military

The U.S. Air Force designed and built a 6G fighter plane in one year and flew it last September. The Air Force won't talk about that plane or release any pictures. Look at the leaked photo of a new advanced aircraft design heading to radar cross-section testing in California in late September.³² It's sitting upside-down on the two support columns on the trailer, so the cockpit is on the bottom left and the tail is on the bottom right. Lockheed won't talk about that one either.

With anemic GDP growth in the EU, and trillions of Euros for COVID-19 recovery spending planned, there's not much money left for their advanced military platform programs. I think the pandemic will put them 3 to 5 years behind schedule on their 6G fighter, their warship building, and their tank and combat ground vehicle programs.

The U.S. pulled all troops out of Afghanistan in August and only about 2,500 soldiers remain in Iraq. There is a big shift in U.S. military focus from the Middle East to the Pacific, the "Asian Pivot" in military and political circles. China has been building and militarizing island chains in the South China Sea (their A2/AD strategy). They claim ownership of islands previously claimed by Japan, Taiwan, Malaysia, Vietnam, and the Philippines (the Senkaku Islands, the Paracel Islands, and the Spratly Islands). They claim ownership of the South China Sea and harass fishing boats from other countries in those waters, driving them out.

Further validation of the Asian Pivot came in mid-September, when the Australian Navy cancelled a \$40 billion order for new diesel submarines from Naval Group (France) and announced they would buy nuclear submarines from the U.S. and the UK. Additionally, they announced a security pact between Australia, the UK, and the U.S. (called AUKUS). France was livid, since they lost a lot of jobs, tax revenue, and withdrew their ambassadors from the U.S. and UK (they sent them back a few days later). And France's status in the Pacific was severely diminished since they were not asked to be a part of AUKUS.

Besides AUKUS, there are two other agreements in the Pacific. The first is called the "5 Eyes", a formal alliance that shares military signals intelligence (intercepted enemy communications) between the U.S., Australia, New Zealand, the UK, and Canada. In early September, Congress drafted a bill to study including South Korea, Japan, India, and Germany in the Five Eyes alliance.³³

The second is the "Quad", an informal alliance between the U.S., Japan, Australia, and India on economic, health, and other social issues. It's starting to look like AUKUS, Five Eyes, and the Quad might see some level of integration in the future. Bringing Japan, India, and South Korea into a military and intelligence alliance in the Pacific makes sense, including France and Germany does not. They do not contribute much to NATO, so what can they contribute to an Asian defense agreement? To counter China's aggression, we need allies with large local navies, and we need deep-water bases around the South China Sea to dock, resupply, and refuel our fleets.

The U.S. Navy was stretched thin during the wars in the Middle East, keeping carrier battle groups on station during the conflicts there. At the same time, they were conducting FONOPS (Freedom of Navigation Operations) in the Pacific. After four years, and eight Navy Secretaries, they still don't have a future fleet plan. That probably won't come until 2023.³⁴

The big program, to connect all the weapons and ISR systems together across all the services into the Kill Web, is the Pentagon's JADC2 (Joint All Domain Command and Control) effort. Under that, the Army plan is called Integrated Battle Command System (IBCS), the Air Force's plan is called Advanced Battle Management System (ABMS), and

32 Joseph Trevithick, "Skunk Works Boss Says He Can't Comment On Video Of Mysterious Stealth Shape At Radar Test Range", The Drive, September 29, 2021, <https://www.thedrive.com/the-war-zone/42568/skunk-works-boss-says-he-cant-comment-on-video-of-mysterious-stealth-shape-at-radar-test-range>

33 "Germany, India, Japan and S.Korea Could Join 'Five Eyes' Intelligence Sharing Program", Defense World, September 2, 2021, https://www.defenseworld.net/news/30346/Germany__India__Japan_and_S_Korea_Could_Join___Five_Eyes___Intelligence_Sharing_Program#.YVPdTi-cbOQ

34 Bradley Peniston, "US Navy's Latest Plan for Its Future May Not Come Until 2023, Says Top Admiral", Defense One, September 24, 2021, <https://www.defenseone.com/policy/2021/09/us-navys-latest-plan-its-future-may-not-come-until-2023-says-top-admiral/185613/>

the Navy's plan is called Cooperative Engagement Capability (CEC). The Pentagon is about to release their JADC2 implementation plan in the next few weeks.

Since 2020, the Army and Air Force have been actively working together, connecting their platforms in experiments under "Project Convergence". But the Navy has just started their integration under "Project Overmatch", connecting their weapons and ISR platforms together. Back in April, they used air, undersea, and surface drones to find a surface target and pass that targeting information to a destroyer many miles away. During the UxS IBP 21 exercise, the destroyer launched a missile and hit the target without seeing it with their own sensors.

In early September, the Navy fired a missile from USV (unmanned surface vessel) Ranger and hit a target identified by remote sensors.³⁵ In early September, the Navy initiated Task Force 59, to link their manned and unmanned ISR and weapons systems together for testing and evaluation in the Middle East. These experiments will involve UAV's (unmanned aerial vehicles), UUVs (unmanned underwater vehicles), USVs and manned surface ships.³⁶

Meanwhile, the Army fired bullets, grenades, and missiles remotely from UGVs (unmanned ground vehicles) in late September.³⁷ They have also implemented new radios to connect their combat divisions together through HF and satellite channels.

The Air Force is also busy. Since the F-35 and the F-22 COMM systems were never designed to talk to each other, they put a "black box" on a KC-46 tanker plane and now they can send targeting information to each other.³⁸ The new Secretary of the Air Force approved installation of operational AI-based target recognition systems in some of their armed aircraft. So, part of the kill web is now live and functioning.³⁹

The Pentagon dropped their JEDI cloud services contract with Microsoft in July after a bunch of complaints and legal wrangling. The new program is called JWCC (joint warfighter cloud capability).⁴⁰ This will be a multi-vendor indefinite-delivery indefinite-quantity set of contracts. JWCC will be the foundation for JADC2, that connects all ISR and weapons systems together from each of the services, all over the world, in real-time. Each of the services operate at different tempos in war: fast for the Air Force, medium for the Army, and slow for the Navy. So, it looks like each of the services will have their own cloud, and each of their clouds connect into a JADC2 cloud. That says you can expect to see contracts issued to at least 4 cloud vendors. The Pentagon and the services already have 600 cloud contracts, but they are mostly for administrative and data base functions.

If you want to see what happens when all ISR and weapons systems are connected, through cloud computers into a kill web in a war, there are three recent techno-novels you need to read. Start with "Ghost Fleet" by P. W. Singer and August Cole (2015). Then read "Burn-In", also by Singer and Cole (2020). Finally, read "2034" by Elliot Ackerman and Admiral James Stavridis (2021). You'll see how the kill web works and how it fails in some instances.

SIPRI (Stockholm International Peace Research Institute) released their worldwide military spending report back in April.⁴¹ When you read it, you'll see military spending falling in countries around the Middle East and rising in the Pacific nations, another sign of the Asian Pivot.

35 Tyler Rogoway, "This 'Ghost Fleet' Ship Firing An SM-6 Missile From A Modular Launcher Is A Glimpse Of The Future", The Drive, September 3, 2021, <https://www.thedrive.com/the-war-zone/42254/video-of-ghost-fleet-ship-firing-an-sm-6-missile-from-a-modular-launcher-is-a-glimpse-of-the-future>

36 Joseph Trevithick, "New Navy Task Force Will Be All About Bringing Unmanned Capabilities To The Middle East", The Drive, September 6, 2021, <https://www.thedrive.com/the-war-zone/42302/new-navy-task-force-will-be-all-about-bringing-unmanned-capabilities-to-the-middle-east>

37 Kris Osborn, "U.S. Army Robots Fire Machine Guns, Grenade Launchers and Anti-Tank Missiles", Warrior Maven, September 28, 2021, <https://warriormaven.com/land/army-robots-fire-machine-guns-grenade-launchers-and-anti-tank-missiles>

38 Valerie Insinna, "US Air Force's newest refueling tanker to get gear allowing F-35 and F-22 to share data", Defense News, May 21, 2021, <https://www.defensenews.com/air/2021/05/21/the-air-forces-newest-refueling-tanker-to-get-gear-that-will-finally-allow-the-f-35-and-f-22-to-share-data/>

39 Amanda Miller, "AI Algorithms Deployed in Kill Chain Target Recognition", Air Force Magazine, September 21, 2021, <https://www.airforcemag.com/ai-algorithms-deployed-in-kill-chain-target-recognition/>

40 Meredith Roaten, "Death of the JEDI: Pentagon Learning from Terminated Cloud Initiative", National Defense, August 27, 2021, <https://www.nationaldefensemagazine.org/articles/2021/8/27/pentagon-learning-from-terminated-cloud-initiative>

41 Aaron Mehta, "The world spent almost \$2 trillion on defense in 2020", Defense News, April 26, 2021, <https://www.defensenews.com/global/2021/04/26/the-world-spent-almost-2-trillion-on-defense-in-2020/>

Here's something else worth reading, the latest report on where the DoD spends their money by state. Over 75% of defense spending occurs in just 15 states.⁴² California's share keeps declining while Texas' share keeps rising. Alabama's share is rising while Colorado's is declining.

The National Defense Authorization Act for Fiscal Year 2022 is still stuck in Congress. It looks like the top line will be about \$750 billion, but we won't know how that's allocated until the bill passes. Based on predictions, the Navy gets the most money, followed by the Air Force. The Army budget will shrink since we pulled out of Afghanistan and Iraq. Lots of technology experiments are ongoing under JADC2 (Pentagon), IBMS (Army), ABMS (Air Force), and CEC (Navy) programs but I don't have the space to include those here. I'll try to get all the projects and programs organized under each one and include it in a future white paper.

Mergers and Acquisitions

Overall, merger and acquisition activity slowed during the pandemic, caused primarily by economic uncertainty. Mergers and acquisitions that were underway were delayed and new deals were put on hold. In April, Leonardo bought a 25% stake in Hendsholt's sensor division, to get a foothold in future military platforms.⁴³ Huntington-Ingalls bought Alion Science and Technology in July.⁴⁴ Alion makes ISR systems and data analytics products. In the last year or so, Huntington bought Hydroid and Spatial Integrated Systems' autonomy business, and made investments in Kongsberg Maritime and Sea Machines Robotics. They are betting on the Navy building a lot of autonomous unmanned underwater and surface vehicles in the near future. The Navy released their shipbuilding plan in June, but Congress may not be very happy with it.⁴⁵

In our part of the universe, Mercury bought Pentek in May.⁴⁶ Everyone in our industry has been speculating on who would buy them. I was betting that it would be DRS Signal (a division of Finmeccanica, who is now Leonardo), but I was wrong. Additionally, Mercury bought Avalex Technologies in late September.⁴⁷ They make mission-critical avionics computers.

Once we see the details of the 2022 defense budget and the funded programs and platforms, we might see more M&A activity in our segment. Meanwhile, the EU is forming alliances between defense contractors in each country, to gain economies of scale in making their future platforms. There are proposals for EU shipbuilders to consolidate through M&A, but that's fraught with political objections.⁴⁸ Their 6G fighter programs are already split between the UK, Sweden, and Italy (Tempest), and France, Germany, and Spain (Future Combat Air System or FCAS). So far, all they have shown is that they can build plastic and sheet-metal models that look pretty.

42 Doug Berenson, "The Evolving Geography of the U.S. Defense Industrial Base", War on the Rocks, September 1, 2021, <https://warontherocks.com/2021/09/the-evolving-geography-of-the-u-s-defense-industrial-base/>

43 Tom Kington, "Leonardo to buy stake in German sensor specialist Hensoldt", Defense News, April 26, 2021, <https://www.defensenews.com/global/europe/2021/04/26/leonardo-to-buy-stake-in-german-sensor-specialist-hensoldt/>

44 Joe Gould, "Huntington Ingalls to buy Alion Science and Technology for \$1.65 billion", Defense News, July 6, 2021, <https://www.defensenews.com/congress/2021/07/06/huntington-ingalls-to-buy-alion-science-and-technology-for-165b/>

45 Megan Eckstein, "Navy releases long-range shipbuilding plan that drops emphasis on 355 ships, lays out fleet design priorities", Defense News, June 17, 2021, <https://www.defensenews.com/naval/2021/06/17/navy-releases-long-range-shipbuilding-plan-that-drops-emphasis-on-355-ships-lays-out-fleet-design-priorities/>

46 John Mchale, "Mercury Systems buys radar and SIGINT subsystem provider Pentek for \$65 million", Military Embedded Systems, May 27, 2021, <https://militaryembedded.com/radar-ew/signal-processing/mercury-systems-buys-pentek-for-65-million>

47 Lisa Daigle, "Mercury Systems agrees to acquire Avalex Technologies", Military Embedded Systems, September 27, 2021, <https://militaryembedded.com/avionics/computers/mercury-systems-agrees-to-acquire-avalex-technologies>

48 "Military naval industry: the urgent need for European consolidation", Robert Schuman Foundation, March 23, 2020, <https://www.robert-schuman.eu/en/european-interviews/0099-military-naval-industry-the-urgent-need-for-european-consolidation>

Summary

The COVID-19 Delta variant, inflation, supply chain disruptions, energy shortages, food shortages, increased taxes, and government debt-driven recovery spending are certainly threats to growth in the coming quarters. Add-in the political elements, and you have a recipe for anxiety and uncertainty.⁴⁹ Trillions of dollars are being thrown into the world economy, some of it borrowed and much of it just printed (created out of thin air) by governments.

We are seeing new business models from companies trying to stay alive. How they will fare is unknown. A second serious dip in economic activity could sink a lot of companies and governments living on borrowed money. Stock sales, bond sales, government grants (PPP money), and loans from the bank have created a lot of “zombie” companies. Supply chain disruptions and labor shortages are now chocking-off their oxygen.

Politics has invaded businesses, economics, the legal system, education, medicine, law enforcement, and news sources, more than ever before. That is forcing the signal-to-noise ratio down to very low levels. That, in turn, has destroyed the credibility of many famous people and trusted institutions. The rule of law has been suspended in many places too. Just remember what Gideon John Tucker (1826-1899) said: “No man’s life, liberty, or property is safe while Congress is in session.” Mark Twain is also credited with saying that.

Winston Churchill said: “Democracy is the worst form of government...except for all the others that have been tried.” By extension, “Capitalism is the worst form of economic system...except for the others that have been tried,” (I said that). Millions of people are trying to get into this country, despite the economic, health, and political uncertainty we are experiencing. To them, the situation in the US is much more appealing than the country they left. Their perspective is relative.

“Capitalism is the worst form of economic system... except for the others that have been tried.”

Every major crisis inspires government intervention to “fix it”. But they usually make the situation worse. Their involvement always results in more power given to the government, and the people always see a corresponding loss of rights and freedom. All I can suggest is that you go back and reread Aldous Huxley’s “Brave New World” (1932), and George Orwell’s “1984” (published in 1949). That will make our present situation relative and make you feel better.

But don’t get so happy once you read those old books about dystopian societies and realize how lucky we are. Just remember what Phil Knight (founder of Nike) said recently: “Happiness is dangerous. It dulls the senses.” He’s saying that happiness is an abnormal condition for humans. It comes in little spurts and makes us vulnerable to attack if it’s prolonged. So, control how much happiness you have in your life and be hyper-aware of what’s going on around you as we get through all the crises mentioned in this paper. In other words, happiness is very overrated so don’t spend a lot of time looking for it, especially in our present circumstances.

“Happiness is very overrated so don’t spend a lot of time looking for it, especially in our present circumstances.”

⁴⁹ Dominic Rushe, Helen Davidson, Kate Connolly, Andrew Roth, Phillip Inman and Martin Farrer, “How the supply chain crisis is affecting six big economies”, The Guardian, October 2, 2021, <https://www.theguardian.com/business/2021/oct/02/how-the-supply-chain-crisis-is-affecting-six-big-economies>

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