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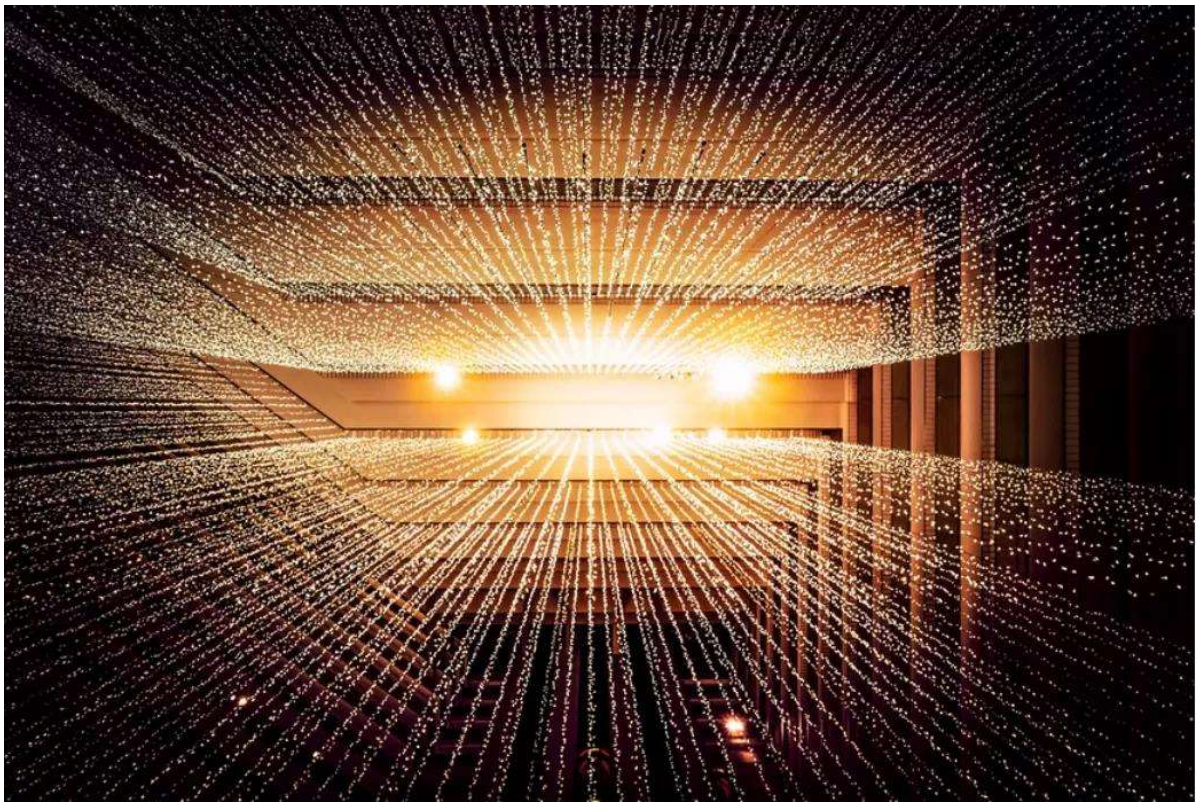
Rosefinch Research | 2022 Series

3060 and Technology Innovation: New Engine for Global Economic Growth



Each year, Rosefinch research teams present their industry view in December Strategic Outlook Conference. This year's meeting took place virtually on Dec 18th, 2021. We will share the key findings in our 2022 Series of publications. The first one is presented by our CIO Mr Huang Zhen 黄振, on the topic of **"3060 and Technological Innovation: new engine for global economic growth."** Below are some highlights and the detailed findings:

- **We focus on three key themes of "3060", intelligentization, and commercial aerospace.**
- **By 2050, hydrogen energy can take up 10% of China's energy mix, with total industry value of over 10 trillion RMB.**
- **We think the "intelligent car" is only the beginning of a broader intelligentization trend.**
- **China may land cosmonauts on the moon by 2030, which similar to US's Apollo program, will provide huge investment opportunities.**

One of Rosefinch's unique characteristics is the industry chain approach to research. By analyzing historical trends, we noted that technological innovation is the new growth engine for global economy.

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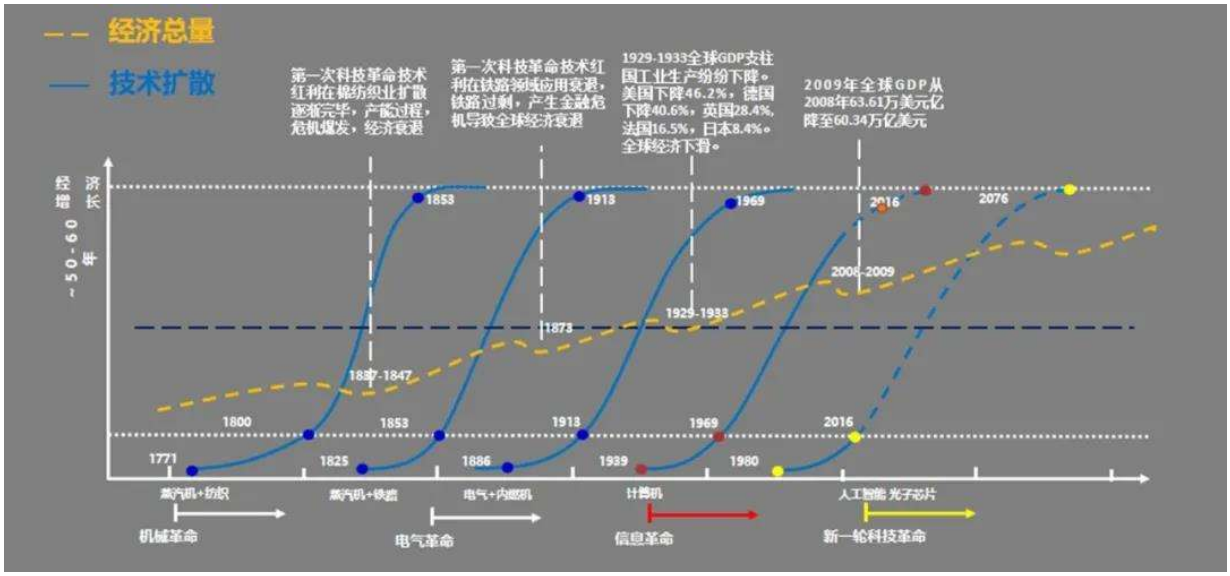
Each major innovation brought structural changes to various industries, and eventually reflected through capital market asset price changes. The below chart showed how mechanical revolution, electricity revolution, data revolution, and the new technological revolution affected the economic structures.



Mechanical revolution started with steam engine; electricity revolution started with electricity and internal combustion engine; data revolution started with computers; and the new technological revolution started with artificial intelligence and photonic integrated circuits.

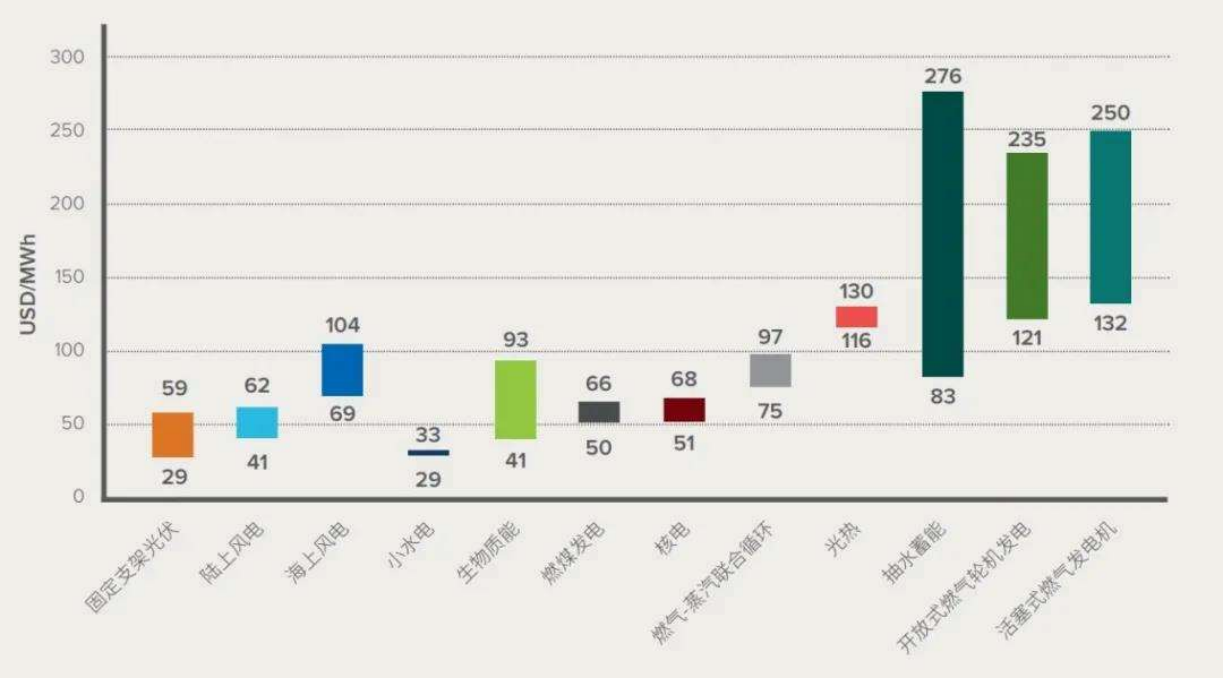
We analyzed the evolution of US's richest person from 1850 to 2021. During these 170 years, the first one in 1850 was Cornelius Vanderbilt who made his fortune in shipping and railroad; he's followed by oil magnet John Rockefeller and steel tycoon Andrew Carnegie. By 1940's, the richest person was Henry Ford who made the best-selling cars. Sam Walton took the honor in the 80's as he built Walmart into the retail giant. The 90s saw the data and internet revolution with Bill Gates and Jeff Bezos taking the crowns. And in 2021, the US and the world's richest person is Elon Musk, whose business included photovoltaic, electric vehicle, and commercial aerospace. We can see from the history that each major structural change in industries is reflected in the capital market. **Therefore if we want to capture the future investment opportunities, we will want to study how the industry structure changes.** Following our detailed and in-depth analysis, we believe the key themes to focus on will be: 3060, intelligentization, and commercial aerospace.

1. The five investable opportunities under "3060" theme:

Let's first look at the 3060 investment opportunities. Since 2020, the global economies have a common development direction: the green economy. On Sep 22nd, 2020, China's leader Xi made important announcement that China will reach Carbon-Peak by 2030, and Carbon-Neutral by 2060. He further specified that by 2030, China's wind and solar generation capacity will exceed 1500 GW. Europe also announced their Green Deal in 2020, with a target EU carbon-reduction of 55% by 2030. How to achieve that? EU plans to implement carbon-tariff by 2023, which means all EU imports will be subject

to tax based on its carbon-footprint. Take electric car as an example: we may think the environmentally friendly electric vehicle has no carbon-footprint. But if you take the entire industry chain into account, such as carbon-footprint during the aluminum or rubber tire productions, the carbon-footprint may be around 20 to 30 tons per electric vehicle. If we use the carbon-credit price of 70 EUR per ton, this will translate into an additional high cost of 2000 EUR per car. The US Biden government also announced clean energy targets for 2035, with photovoltaic contribution of 45%. We can therefore see that vast majority of global countries and regions are shifting their energy requirements from the natural resources of carbon-complex to advanced manufacturing capacities in batteries and electricity networks. We believe China will deploy both policy support and technological innovation to achieve its "3060" goals.

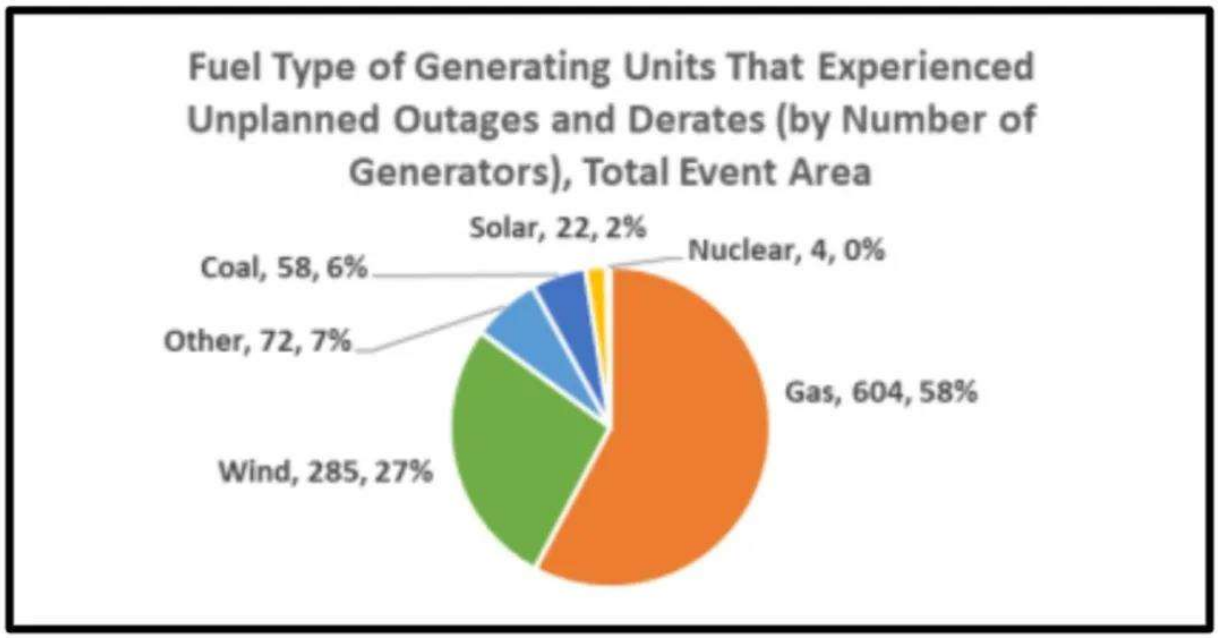
When we look at "3060", the first thing is to develop low-carbon, clean energy source. **The most important source of clean energy is solar energy, which is our first investment opportunity.** Below is the table of per-unit generation costs for China's solar energy vs other energy methods:



Source: Rosefinch. Starting from left: photovoltaic, land wind, ocean wind, small hydropower, biomass, thermal coal, nuclear, gas-powered, CSP, water-pumped storage, open gas turbine, piston gas turbine.

As we look at cost of solar energy in US, Germany, and India, we note that solar energy per-unit cost is fast becoming the cheapest alternative for most regions. Looking ahead, the photovoltaic efficiency still has room to improve, thus we may see further unit cost reduction in solar energy. And in terms of market size, we estimate that by 2050, the global electricity consumption will be about 60 trillion kilowatt hours with 45% provided by photovoltaic cells. This means on average we'll add 1140 GW each year. To put things in perspective, the current installed industrial-scaled photovoltaic capacity is only 170 GW. Even though the photovoltaic industry has grown tremendously in recent years, there's still much more room for its future growth.

As photovoltaic and wind energy contribute greater percentages of energy generation, their inherent instability or inconsistent generation will cause frequent and sizeable interruptions to the electricity grid. This will force substantial upgrade of existing electricity grid system, with more intelligent management, UHW power transmission, and flexible transmissions. **Our second investment opportunity under the "3060" theme will therefore come from the electricity grid upgrade demands from integration of renewable energy sources.** We remember in Feb 2021, US Texas experienced severe cold front which dramatically downgraded the local electricity and heating supplies. Below are the different generating units that had outages:



Source: Rosefinch.

During that time, gas and wind generating units experienced the most outages, while the photovoltaic units only made up of 2% of the total outages. We believe that photovoltaic cells can be a very important energy source, especially if it combines with energy storage capacity to provide more stable transmission over time. **We believe energy storage is the 3rd investment opportunity under "3060" theme.** Bloomberg NEF estimated that by 2030, the global energy storage capacity will be 1028 GW, or roughly 20 times current capacity.

As we deepened our research into "3060", we realized that it's very hard to achieve such target based solely on wind and solar energies. There are many industries like airlines, oceanic shipping, or steel smelting that will be hard to de-carbonize. One way to resolve this issue is through hydrogen energy, because hydrogen has the unique benefits of not containing carbon, producing water as byproduct, and three times the energy output as gasoline. Currently, most hydrogen is produced via electrolysis of water. Thus with wind and solar power taking up more electricity generation roles, we may have a more

"green" production of hydrogen. According to various industry estimates, by 2050, hydrogen energy can reach 10% of China's energy consumption, with industry value of over 10 trillion RMB. **Hydrogen energy will therefore be our 4th investment opportunity under "3060".**

In the current energy sources, about 60-70% come from traditional carbon complex, so if we want to achieve carbon-neutral, we will need to work on carbon's capture, storage, and reuse. Based on International Energy Agency's forecasts, if we achieve global carbon-neutrality by 2070, Carbon-capture technology must be deployed on over 15% of global carbon releases. **Therefore our 5th investment opportunity will be on carbon capture, storage, and reuse companies.**

2. The intelligent car is the start of Intelligentization-Of-Things

When we look at technological innovation, the first key link is intelligentization. The current focal point on the intelligentization is of course the "intelligent car" with Tesla market capitalization over 1 trillion USD this year, and various PE investments pouring into "intelligent car" companies. Can the car be truly intelligent? The jury is still out on this question. From our perspective, for the car to be truly intelligent, it must mimic the human during the driving decision processes. It may utilize camera or radar as its ears or eyes to monitor the environment, and then use its AI chips to process the information, plan responses, and use mechanical wiring to mimic human control. The path to an intelligent car is therefore very clear. But there remain some major obstacles along the way:

First obstacle is the sensory processing in a complex and changing environment. The driving environment is highly open and complex. We must differentiate and identify various objects including people, cars, buildings, signposts, and animals. How do we process accurately in such complex environment can indeed be challenging.

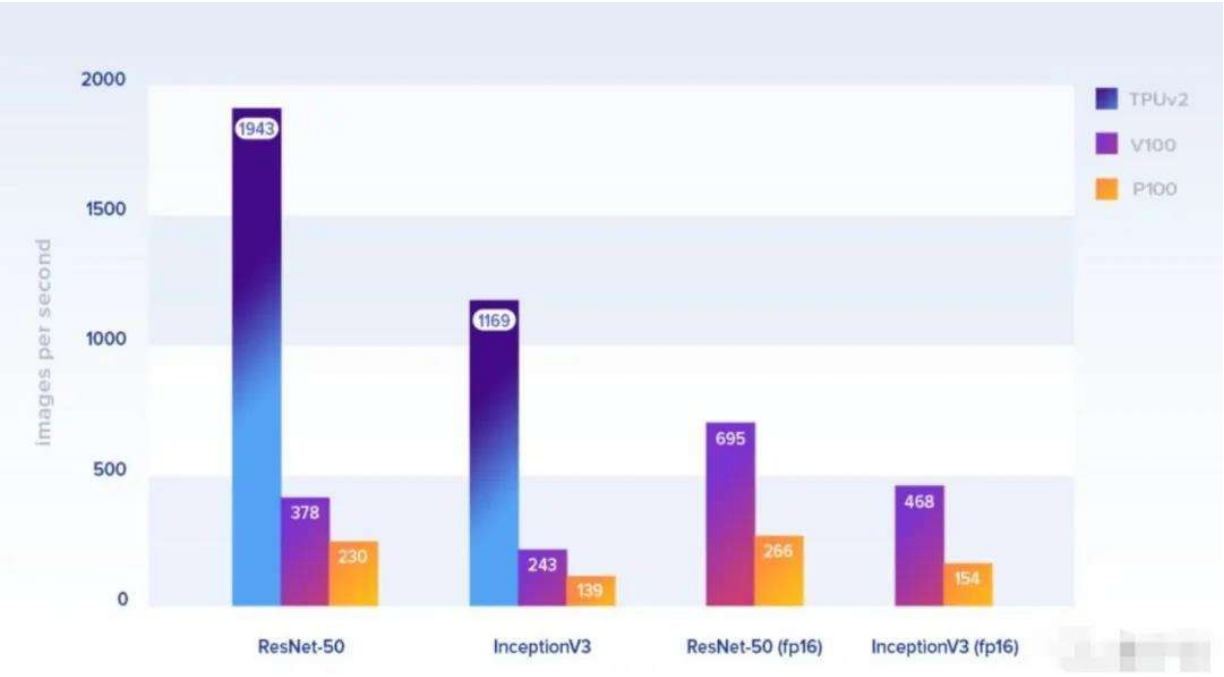
The second obstacle is the timeliness of the data-analyzing and decision process. When we are driving in high speed, the decisions may be made and executed within milliseconds. The car's computing power must complete the info-gathering, analyzing, decision, and implementation in that short period.

The third obstacle is the "tail problem" of different driving scenarios. Because in different countries or regions, the driving habits or local architectures will be different. How to address different background across the world is another challenge.

Overall, we believe the car industry has largely transformed the question of whether we CAN make the intelligent car into the question of WHEN we can make the intelligent car. We're at the stage to systematically overcome various engineering issues by achieving the right combination of computing framework, processing power, and data. The computing framework needs to use upgraded models to improve the environmental awareness; the processing power needs to use more powerful chips; and we

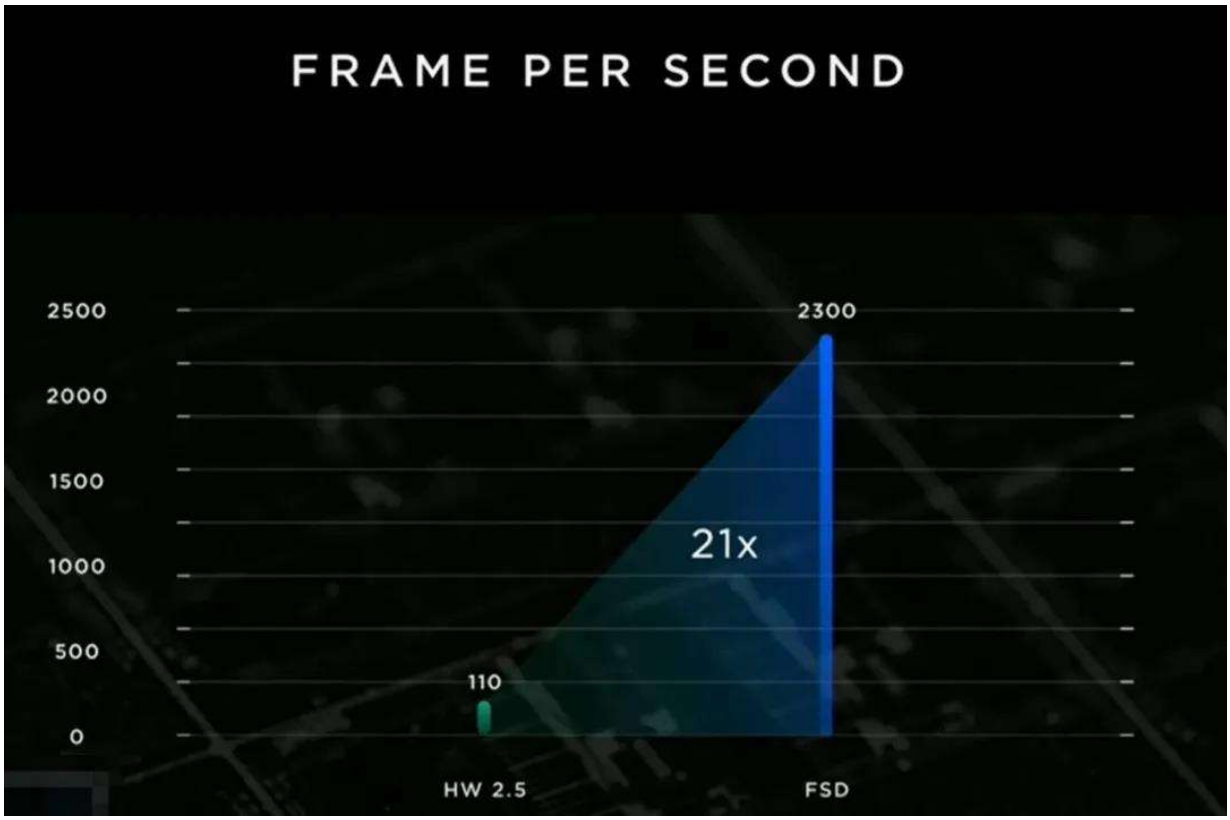
must continuously gather high quality data to support the decision process. Let's look at the computer framework first: there must be a mathematical model to take in various sensory inputs such as camera or radar to create the environmental awareness. The results should differentiate various objects such as people or vehicles, and once identified, track the speed and distances of these objects. As we have more results, we can update our 3D model of the environment in real time. As the computing framework upgrades are combined with hardware advancements, we believe the car's environmental awareness may catch up and even exceed humans. For example, humans exchange information typically through words or pictures. In the past, we may think it's tough to translate across different languages through computers. Today, the Google Translate is over 95% accurate. We believe similar improvement will happen over time in the area of environmental awareness.

The second obstacle is about the timeliness of decision making. The main route to increasing decision speed is by improved chips of onboard computers, which is subject to Moore's Law. While the overall Moore's Law effect seems to be slowing, the AI-specific ASIC chips' computer power is still increasing rapidly. The below chart shows the relative performance of ASIC chip vs generic GPU chips. Using Google's cloud computing TPU chips as an example, it's performance is about 6 times of the generic GPU chips.



Source: Rosefinch.

The next chart shows the picture processing power of Tesla's FSD chips vs the generic GPU chips. When processing the picture-recognition FPS mode, FSD chips is 21 times more efficient than the GPU chips. We believe as AI developments continue, the specialized ASIC chips will be able to address and resolve the timeliness issue.



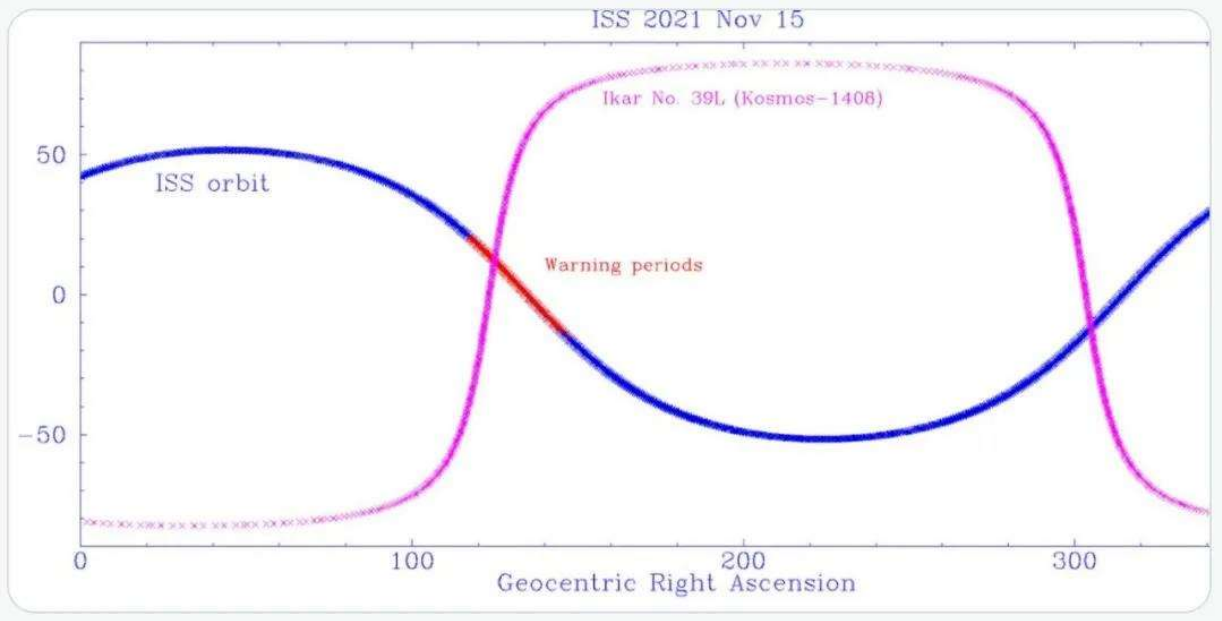
When we look at computation framework, processing power, and data, we know data is the foundation of all computational processes and is therefore the key to solving more complex problems. A few years ago, the program AlphaGo swept the human Go-masters. There were many reasons for its triumph, but a main reason was that it analyzed huge number of human games and categorized them into over 30 million samples. This big-data collection and analysis was a key reason for the AlphaGo's final victory. And when it comes to driving scenarios, we believe the solution lies with collection of large amounts of data through car fleets across different areas, and use such data to train onboard computers to better dealing with "tail problems." This year during Tesla AI-day, there was a demo video of 10 police cars making left turns to chase one red sedan. While the video itself was edited, it is through videos in general that we can provide more training for AI to resolve potential "tail problems." We believe overall, the intelligent car has a straight road ahead to its goal. And more importantly, we believe it's just a start of the Intelligentization-Of-Things. For example, in this year's Tesla AI-day, the biggest crowd-pleaser was the prototype service robot: Tesla-Bot. When you look at the core components of Tesla Bot, you will see the same camera, chip, battery and motor parts that are in Model 3 or Model Y. This means Tesla can extend its industry chain beyond cars and into other hardware such as delivery robots, storage robots, service robots, etc. We may find that one day, it'll be the cleaning robot that knows best where things are in the house.

The picture below is from New Yorker magazine from 2017 that illustrate potential future scenario. The cover showed that once robots become intelligent, they'll rule the world. We believe that once intelligentization goes beyond the complex intelligent car, the future growth will be tremendous. The intelligent car is therefore only the beginning of the Intelligentization-Of-Things.

3. Similar to US's Apollo program, China's Moon-landing Program will create huge investment opportunities

Let's turn our attention now to another technological innovation area: commercial aerospace. We believe commercial aerospace has already evolved from the government-sponsored stage of 1950-60s to the market-driven stage today. In the aerospace industry, there were two recent events that warrants our close attention. First on Nov 15th, Russia deployed anti-satellite ASAT weapon and destroyed satellite #1408. Below is a screen capture of a simulation video that showed the path of satellite 1408 in blue, and the ASAT missile in white. Once the satellite is destroyed, it created over 1500 broken pieces where some of them worryingly overlapped orbit of the International Space Station.

The chart below shows the ISS's orbit curve in blue and the satellite #1408 in red. Because the two orbits have clear overlap, the ISS astronauts had to enter into spaceships under emergency protocol.

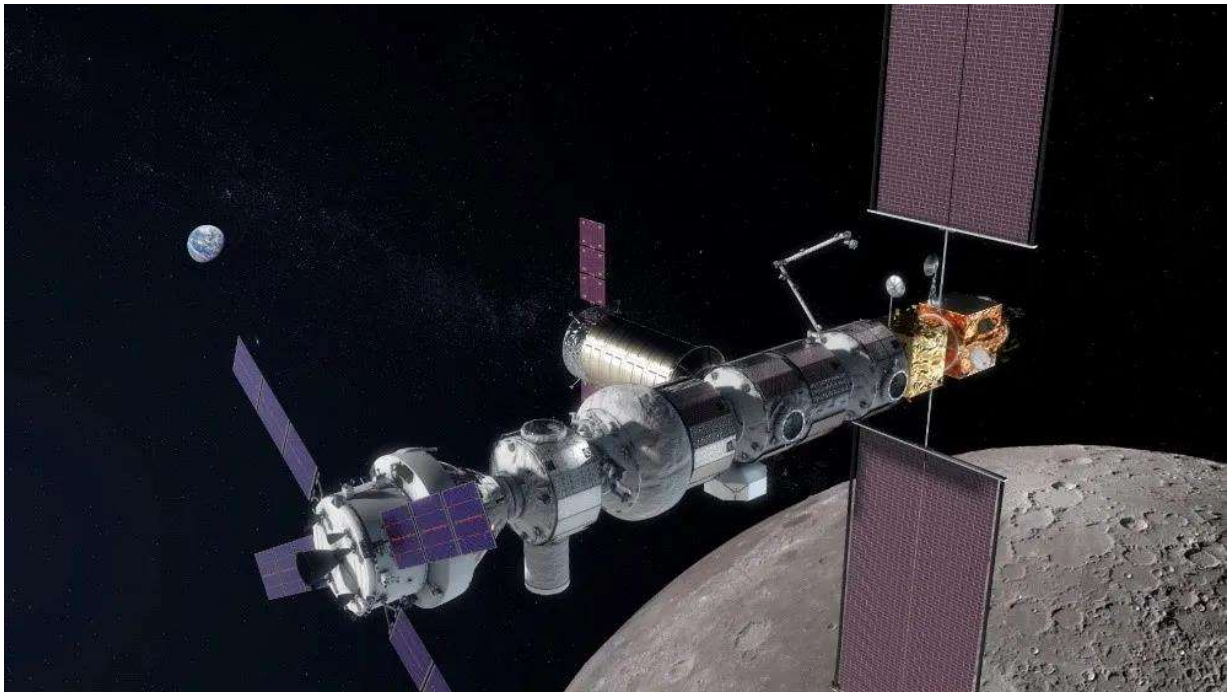


Source: Rosefinch.

The second event took place on Nov 24th when NASA launched DART spacecraft as part of the first global anti-asteroid defense program. We know the dinosaurs went extinct because of a large asteroid impact. We also know there are over 25,000 sizable asteroids in the solar system, so how do we avoid another large extinction event? NASA's plan is to shift asteroid's path by impacting it with spacecraft. In a simulation video, DART will impact an asteroid on Sep 26th, 2022 at a speed of 6.6 km/s. NASA will collect data on its effectiveness, and the whole world will be watching this anti-asteroid defense test.

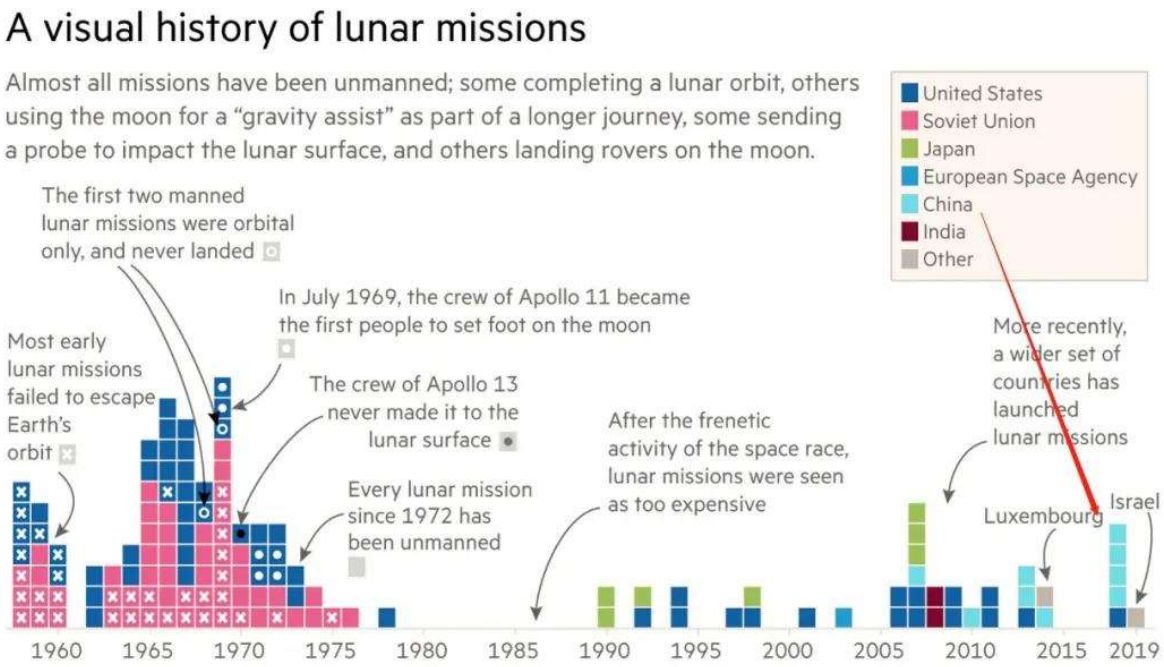
When we talk about commercial aerospace industry, we must talk about the moon. NASA had announced the Artemis plan to return manned flight to the moon. Its total budget is over 50 billion USD, with a target of establishing a permanent base on the moon. The four pictures below are the four major component of the Artemis project. The top two are the main SLS booster and the Orion vehicle. The bottom two pictures are the human landing system and the lunar terrain vehicle.

Because NASA's Artemis project calls for a permanent living quarters on moon, it must sustainably send people and material to the moon base. Due to current technological constraints, it needs a waystation that's similar to the current ISS. Below is the picture of such a station: Gateway.



Once NASA establishes a permanent base on another extraterrestrial body, its next target will be on Mars. The Gateway may therefore become the launching point of the Mars-bound vehicle. We believe Artemis may be the first step of human's march towards the stars, with huge future room for development. The Artemis project may impact US economy and technology in a similar way as the Apollo program. Within 10 years, the Apollo program saw investments of over 150 billion USD, with over 8 times the economic outputs across strategic areas such as liquid boosters, radar, remote operations, radio communications new material, and integrated circuits. Take integrated circuit as an example, it was still in nascent stage of development without much commercial applications. NASA's Apollo program took over about 2/3 of the US integrated circuit capacity, effectively supported the whole industry development, and accelerated development of high-tech companies like Boeing, Lockheed Martin, IBM, Motorola, etc. In addition to companies, the Apollo program's success sparked the era of technological innovation, with many students inspired to take up STEM concentrations in advanced studies.

When we look at the following picture that tracks major lunar explorations from 1960 to 2019, most of the early explorations come from US (blue) and USSR (red), while recently it's China since 2015.



China's lunar explorations started in 2004. With the return of lunar rock samples in Chang-e vehicle on Dec 17th 2020, China has successfully completed its goals to circle, land, and return from the moon. The next major goal is to create a permanent base. According to official forecasts, China may attempt human-landing of the moon after 2030. Just like the US's Apollo program, we believe China's moon-landing program will also present huge opportunities for the entire industry.