
THE NEXT SPACE RACE

A PATENT LANDSCAPE ANALYSIS OF
TEN COMPANIES SHOOTING FOR THE STARS



Just over 60 years ago on October 4, 1957, the space race between the USA and Russia took off with the launch of Sputnik, driving each country to the limits of science and technology. This was done almost exclusively through governmental agencies and has paved the way to what we can now call the 'second space race', which is filling up with private companies pushing the boundaries further than ever before.

While Boeing, Lockheed Martin, and United Technologies Corporation (UTC) are some of the industry giants (and historically preferred by NASA) in this next generation of space exploration, it is some of the newer and relatively smaller companies that are causing bigger waves. Virgin Galactic, Blue Origin, and SpaceX - to name a few - are all at the top of their game, and are quickly redefining the science, technology, and politics of modern space exploration.

The one often labeled as the world's most high-profile commercial spaceflight company is SpaceX, which has had huge success with its [Falcon 9](#) launch vehicle (with engines 50% more powerful than their predecessors), [Dragon](#) delivery spacecraft, and its groundbreaking launch-and-land technology. It became the first commercial company to dock a spacecraft at the ISS in 2012, and they now do regular shipments of cargo there. None of their flights have been manned as of yet, but they are working on the new mega-rocket codenamed [BFR](#) that can send astronauts to the moon and beyond, with an ultimate goal of setting humans on Mars in 2024.

"We have essentially no patents in SpaceX. Our primary long-term competition is in China—if we published patents, it would be farcical, because the Chinese would just use them as a recipe book."

ELON MUSK • SpaceX CEO

With SpaceX seemingly in the lead, several companies with high ambitions yet approaching from different angles, and technology rolling out across a wide spectrum, how can we understand where this new space race will take us, when we will get there, and who will lead us there?

If we look at the patents, follow the trail of technological advances, and pinpoint the direction that R&D is heading, we should be able to predict the evolution of space exploration 20 years out. But wait, according to hot shot entrepreneur and SpaceX CEO, Elon Musk, this is exactly what they are trying to keep under wraps: *"We have essentially no patents in SpaceX. Our primary long-term competition is China – if we published patents, it would be farcical, because the Chinese would just use them as a recipe book."*¹

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Okay, so SpaceX isn't filing patents, but what about the other top players? The answer is yes and no. Virgin Galactic has next to none, some have just a handful, and others are likely keeping some trade secrets. However, there still are thousands of patents out there that could reveal enough to grasp the overall movement and gain insight on where the industry is heading.

Peering into Space

To run a panoramic view analysis of the space race arena we chose 10 companies active in the field, pulled their 18,514 patent applications from USPTO and WIPO databases from 2002 (the year SpaceX was founded) to 2017, and ran them through our proprietary big data and predictive analytics platform. Starting with a macro-view and keeping it objective, no filters, stop words, or weight adjustments were applied to the dataset.

With the [VALUENEX Radar](#) output, we were able to view the 18,514 patents grouped into 2,663 clusters based on full text semantic similarities precisely plotted on a single map, with the scale of distance representing the difference of technological areas and contour lines carving out levels of document density.

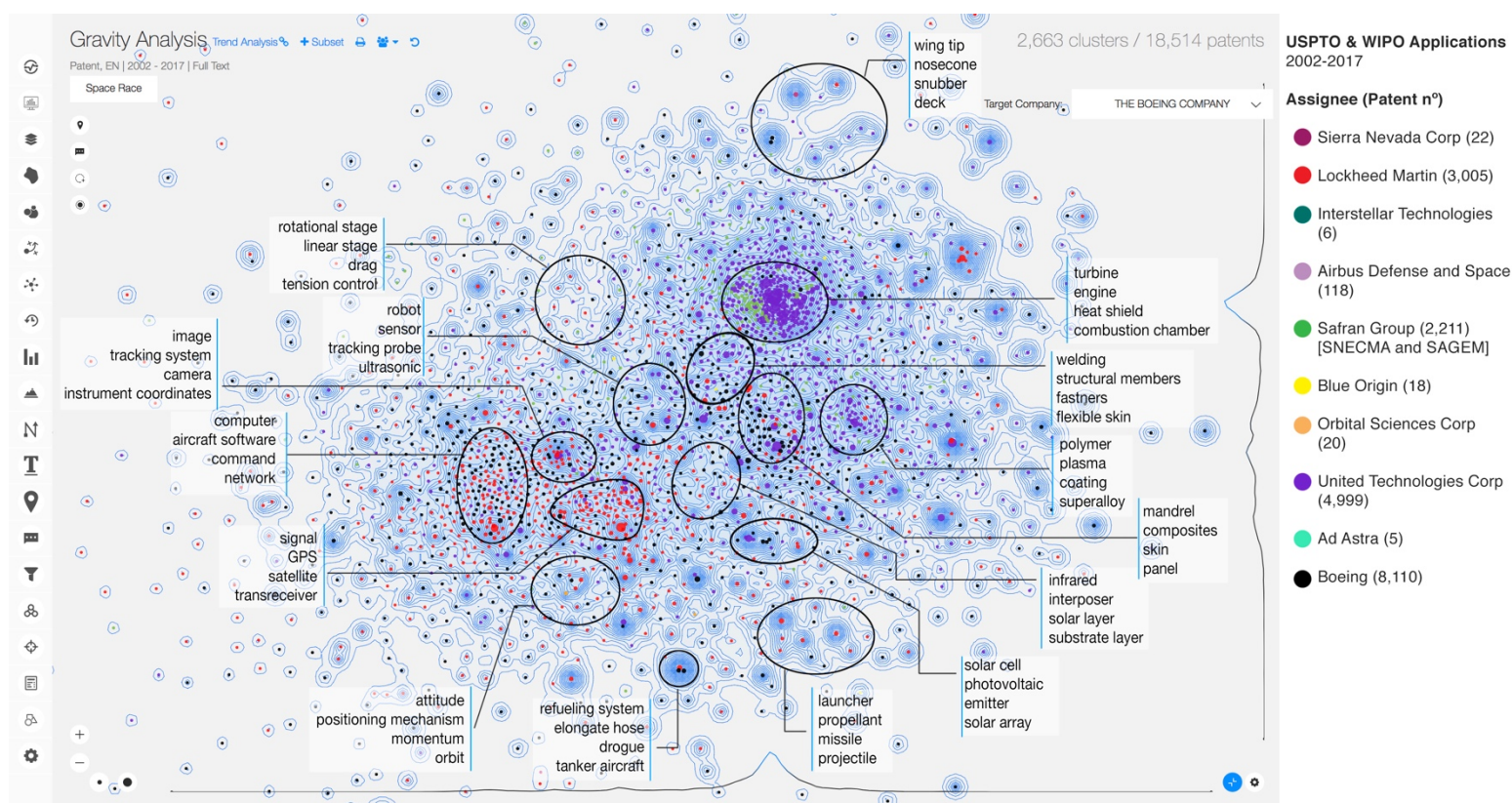
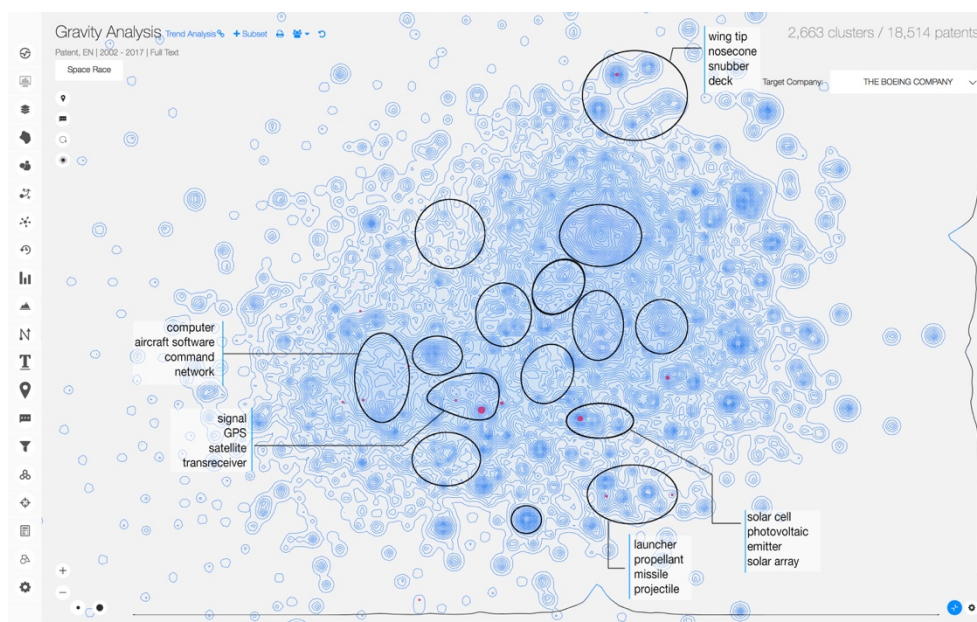


Figure 1 • Panoramic Map with Companies Highlighted

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To quickly grasp where the 10 companies are filing, see the overlap of R&D, find holes in technology portfolios and uncover white spaces we highlighted the clusters containing patents from each individual company (figure 1). A few things are clear: the bigger players are filing heavily in software and engine development, the new entrants are filing broadly across the map and typically outside of high density areas (indicating high levels of innovation), and robotics and manufacturing technology is filling in the the gaps between the well-established regions.

So now that we have our first glance of the field, let's learn a little more about the 10 companies in the analysis by isolating each one within the data landscape.

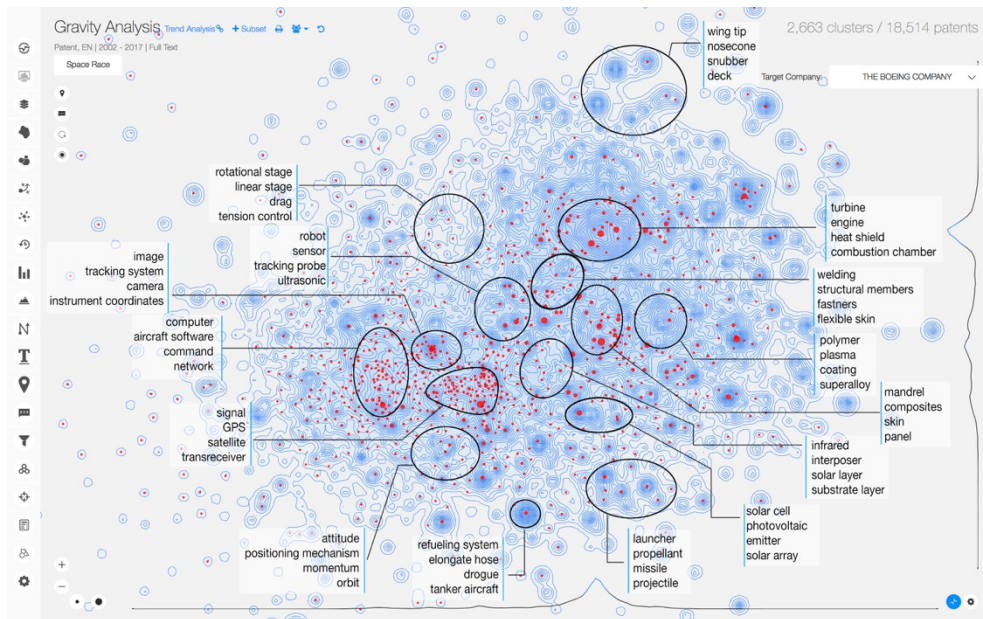


SIERRA NEVADA CORPORATION

Known for its Dream Chaser, a smaller version of the Space Shuttle, able to carry 2-7 astronauts into orbit atop a standard rocket, which can land on commercial runways.

Actively filing in: signal transmissions, GPS measurements, aerodynamic fairing systems, solar array systems

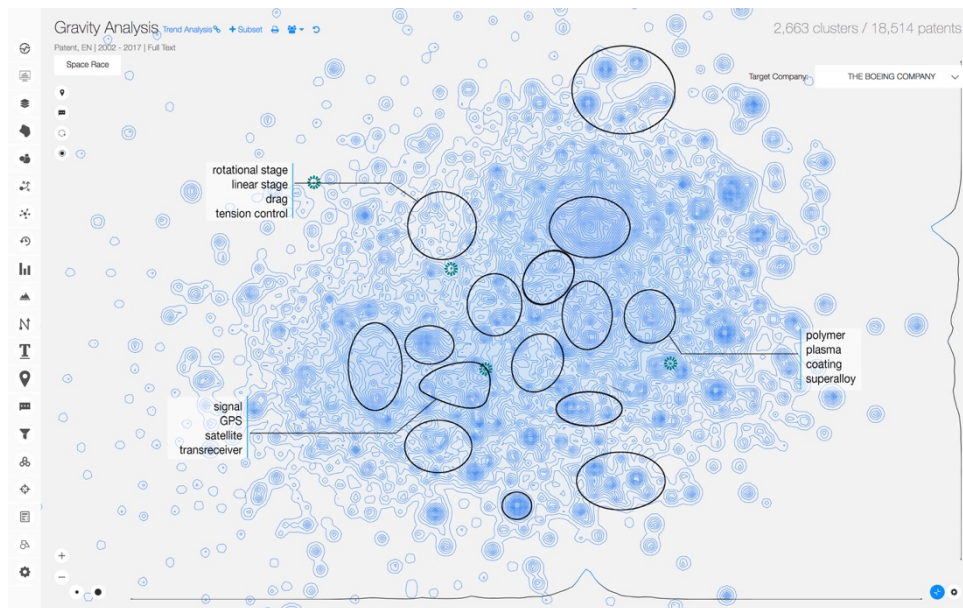
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LOCKHEED MARTIN

Known for building every aeroshell flown by NASA to Mars, and developing the Orion crew capsule for NASA's Space Launch Systems.

Actively filing in: ad hoc networks, satellite communication systems, high-performance aircraft manufacturing

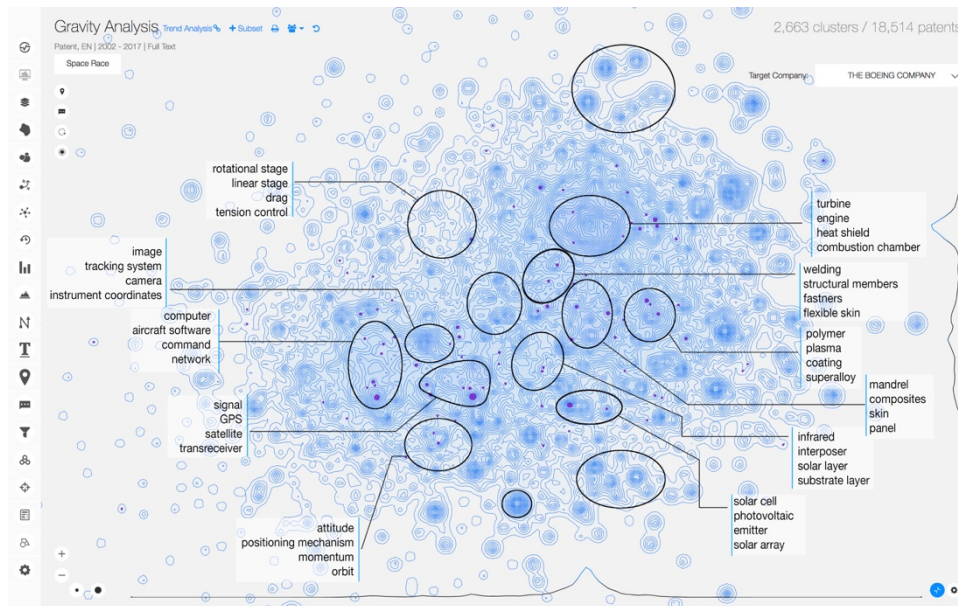


INTERSTELLAR TECHNOLOGIES

Known for being Japan's first private company to attempt a launch into outer space, and developing low cost and customizable rocket systems.

Actively filing in: neutral atoms propulsion systems, energy storage via interacting nanostructures, dispersion force control

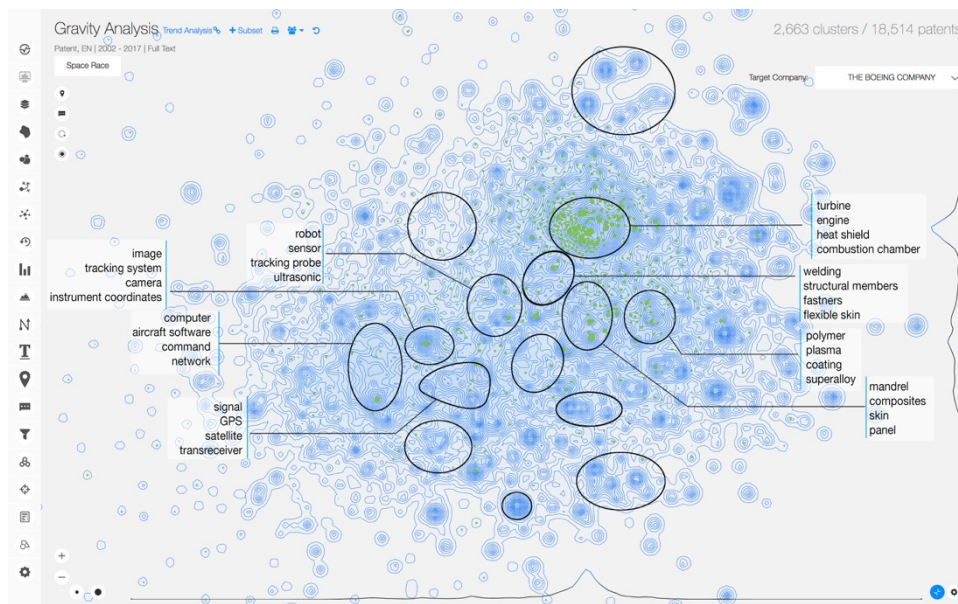
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AIRBUS DEFENSE AND SPACE

Known for space transportation with its Orion Service Module, astronomy missions with Gaia space observatory 3D mapping around 1 billion space objects, and multiple planetary science missions.

Actively filing in: solar arrays for spacecraft, propulsion unit for reusable launch vehicles

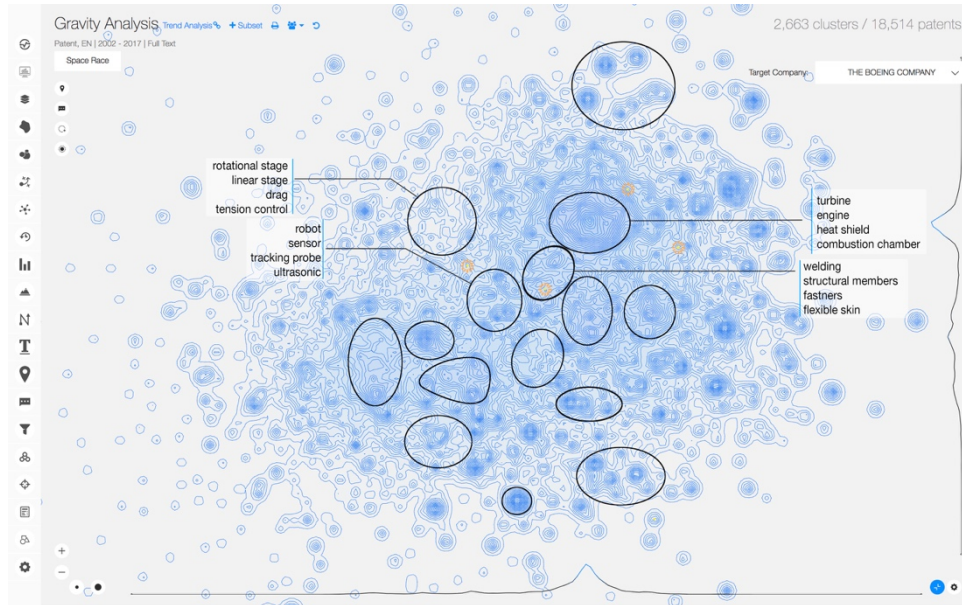


SAFRAN GROUP (SNECMA AND SAGEM)

Known for its advanced liquid propulsion systems for space launchers.

Actively filing in: turbo jets, heat shields, ferromagnetic particles, precision manufacturing

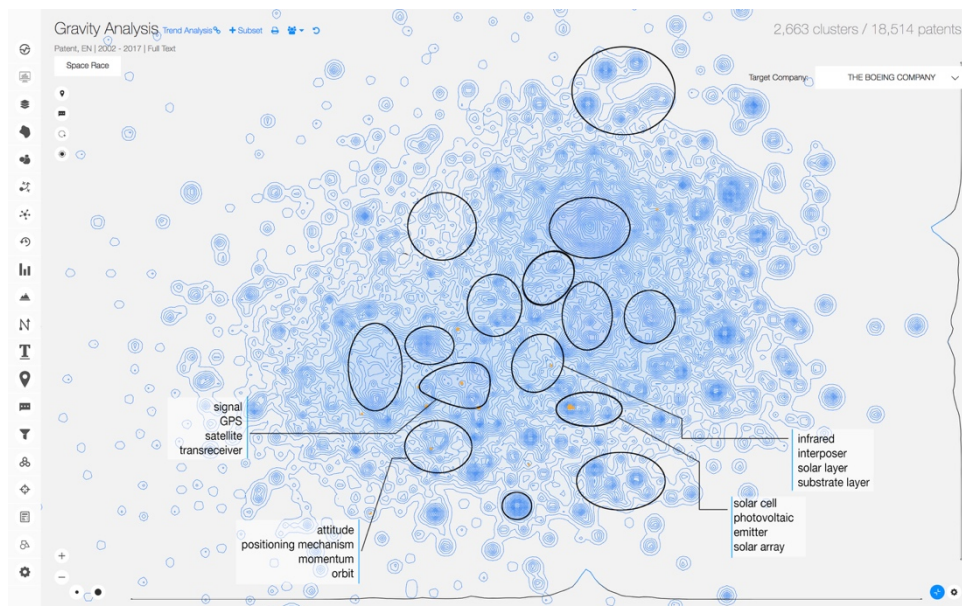
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BLUE ORIGIN

Known for being the first to achieve vertical takeoff and landing of a reusable rocket, a low-cost provider of rockets, and founded by Amazon founder Jeff Bezos.

Actively filing in: bidirectional control services, multi-use rocket engines, tail down landings

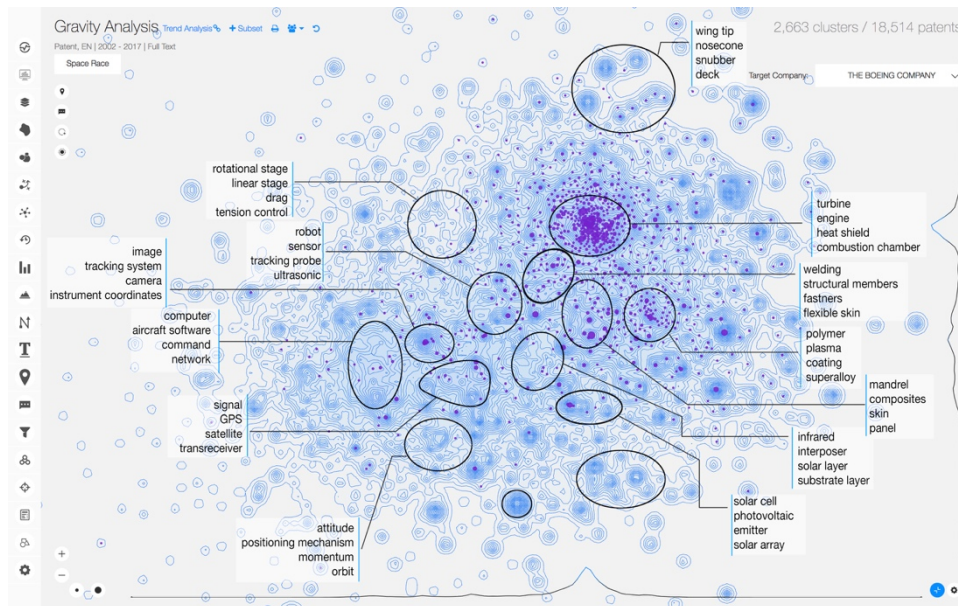


ORBITAL ATK

Known for designing, manufacturing, and launching space and rocket systems for commercial and military use.

Actively filing in: hybrid cycle liquid propellant rocket engines, satellite maneuvering control, payload communications

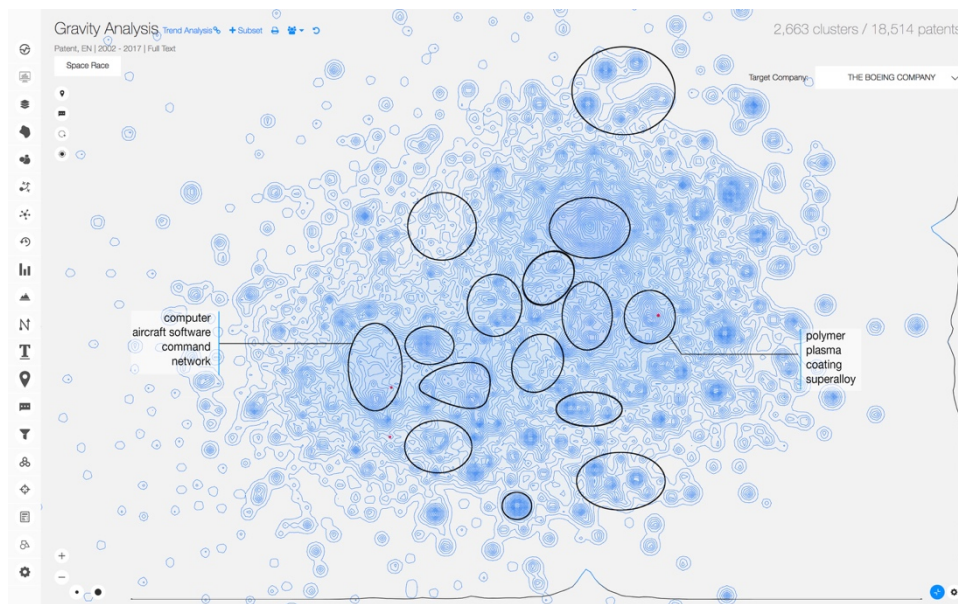
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UNITED TECHNOLOGIES CORPORATION

Known for being a major supplier for international space programs and designing and manufacturing aerospace systems for commercial and military aircraft.

Actively filing in: temperature-resistant airfoil assembly, solar tracking, thermal energy solar cell systems

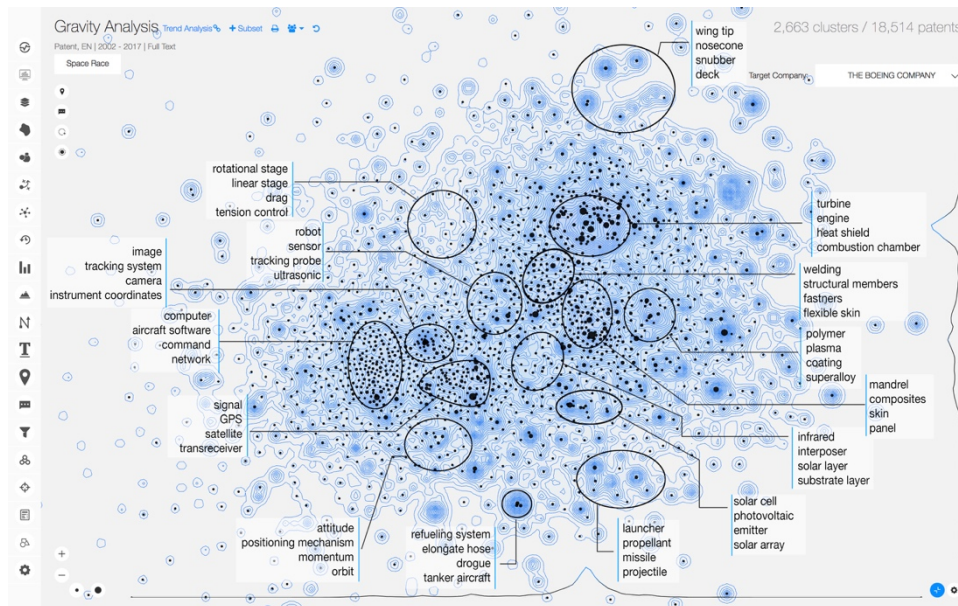


AD ASTRA ROCKET COMPANY

Known for developing a versatile form of electric propulsion from plasma for use in many in-space applications.

Actively filing in: space-time calibration systems, celestial transmissions, plasma sources, mobile terminal viewing

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BOEING

Known for its development of NASA's Space Launch System's core stage, providing its heavy lift capability.

Actively filing in: dynamic routing, array antennas, imaging resonators, vertical lift aircraft, carbon nanotube and metallic composites, electromagnetic forces

Having mapped the sparseness of some of the newer entrants such as Blue Origin, Sierra Nevada Corp, and Interstellar Technologies and knowing that they are, like SpaceX, pushing the boundaries of launch and space technology, there absolutely must be a trove of trade secrets behind their office walls. One might even begin to wonder if they are filing select patents to keep others from sniffing out their true R&D trails.

Shifting to some of the bigger filers and taking a look at the centers of gravity (defined after calculating the entire scope of their portfolios), the breadth of Lockheed Martin and Boeing's partnership in United Launch Alliance is clear (figure 2). Since its formation in 2006, the 50-50 joint venture has had a 100% success rate on 600+ launches of its [Atlas](#) vehicles, and remains one of the most experienced and successful launch teams in the U.S. But what is more interesting is if we look at their trend lines as individual entities, we can see that they are essentially heading in exact opposite directions. After mapping the movement of their R&D patterns of the last 19 years, we can see that Boeing has shifted its heading towards United Technology and Safran's core area of engine and high-temperature resistant materials, while Lockheed has turned towards satellite and communication technologies. While no one expects ULA to slow down anytime soon, it does seem that Boeing and Lockheed's long term visions are quite different.

“We should not over-focus on one competitor. Competition will come not only from California”

STEPHANE ISRAEL • Arianespace

If we put Safran and UTC in the mix (figure 2), we can see a tight overlap of their centers of gravity, and their trend lines show they are moving in the same pinpointed direction. However, going back to UTC's position in the beginning of the time range, we can see that they were in a much different area, and in the mid 2000s began to rapidly move towards Safran's already well-established territory. As UTC is an M&A focused organization, could this be because they had to play catchup after missing out on an opportunity to join with SNECMA before they merged with SAGEM in 2005 forming Safran Group, the propulsion and aerospace equipment powerhouse? It could be, but it is a fact that they are direct competitors now, and with Safran's €8.7B acquisition of Zodiac Aerospace expected to be finalized in 2018, it will bump up their expected sales to €21B, just under UTC's #1 spot with €25.4B.

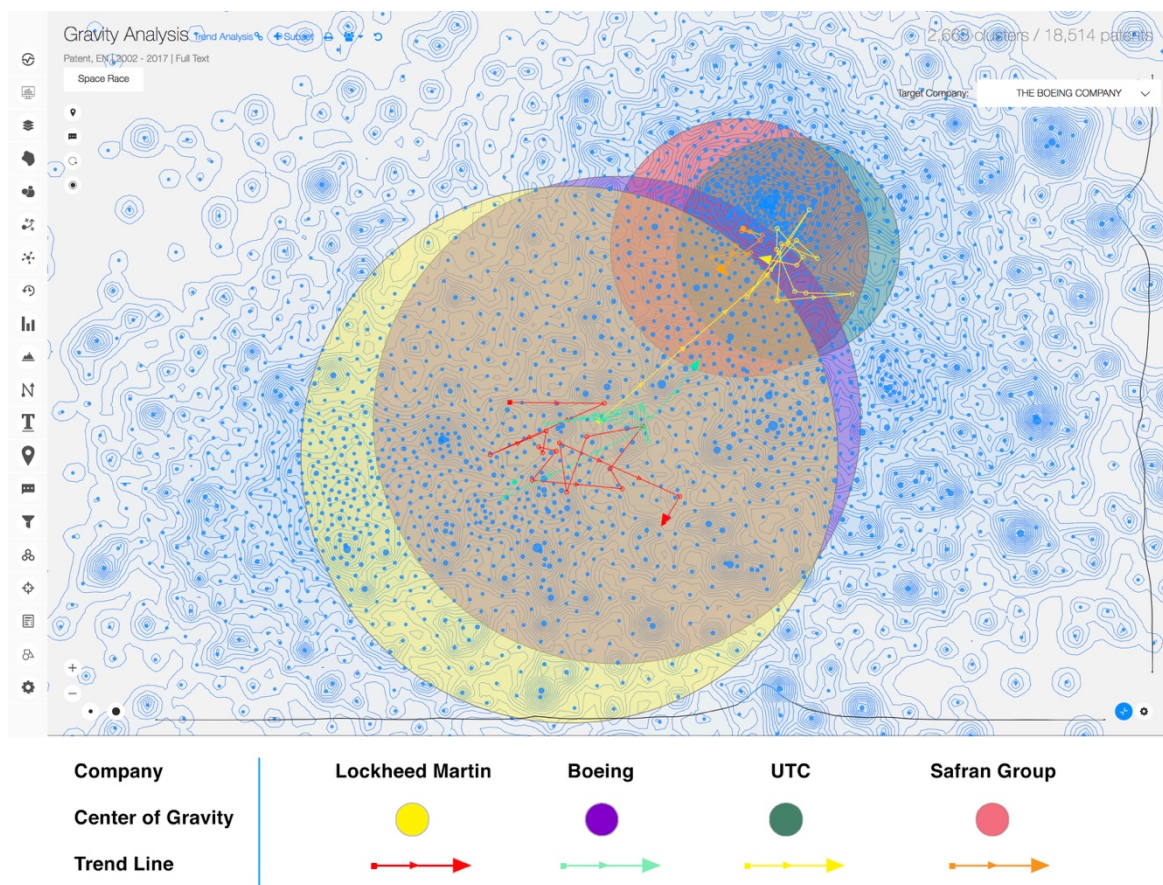


Figure 2 • Centers of Gravity and Trend Graphs of four big filers

In the end

We have gained some insight on the industry and grasped the levels of activity taking place, identified technological overlaps in portfolios, mapped the outliers filing patterns, and detected divergence of technologies, but we are still left with the original questions: where are we headed, when will we get there, and who will lead us there?

To go even deeper in the conquest for these answers we could pull in more patent portfolios and jurisdictions, incorporate non-patent literature such as press releases and scientific reports (and possibly SpaceX's employee's published research papers), add grant data in the mix and analyze them together to try to reveal even more of the inner workings of the companies in the field. Maybe then we could even uncover Elon Musk's strategy, but remember that Arianespace's CEO, Stephane Israel, was right when he said: *"We should not over-focus on one competitor. Competition will come not only from California"* ².

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UPDATED RELEASE: AUGUST 2018
FIRST RELEASE: JANUARY 2018
