High Altitude Platform Stations

STRATEGIC INTELLIGENCE BRIEFING

Curated with Frontiers

Generated for Marcus Banks-Bey, M.Div on 07 February 2025

Contents

Executive summary

Explore the interactive version online

They are modern airships hovering in the stratosphere, offering up new opportunities for connectivity, coverage, and performance that are unmatched by satellites or terrestrial networks; High-Altitude Platform Stations (HAPS) can fill a crucial niche within communications architecture. They enable rapid, cost-effective deployment in ways that improve disaster relief, environmental monitoring, smart agriculture, and data protection. COVID-19 vividly illustrated a worsening divide between the connected and unconnected worlds that can be bridged with HAPS, by improving access to essential services and fostering greater socio-economic equality - and creating a more sustainable future for everyone.

This briefing was created as part of the World Economic Forum's Top 10 Emerging Technologies Report for 2024, which lists new technologies poised to impact the world in the next three to five years, and was done in cooperation with Frontiers - a publisher of peer-reviewed, open access scientific journals.

The key issues shaping and influencing High Altitude Platform Stations are as follows:

HAPS for Environmental Monitoring
High-Altitude Platform Stations can be invaluable tools to help better protect the planet

Connected Air Transportation
A future full of autonomous flying vehicles will require the connectivity HAPS can provide

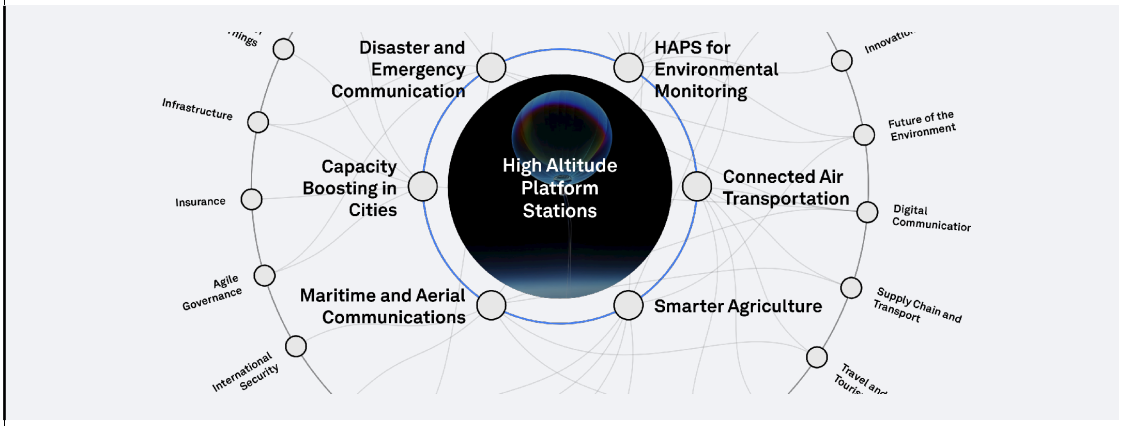
Smarter Agriculture
HAPS can elevate agriculture with precision farming based on data-fueled insights

Maritime and Aerial Communications
HAPS can bridge long-standing gaps in air and sea communications

Capacity Boosting in Cities
HAPS can handle increased data demand in high-population zones

Disaster and Emergency Communication
In emergency situations HAPS can help keep channels open

Below is an excerpt from the transformation map for High Altitude Platform Stations, with key issues shown at the centre and related topics around the perimeter. You can find the full map later in this briefing.



In the following sections, we give a comprehensive summary of the latest **Insights and Trends** shaping the topic, a look at potential **Forecasts and Scenarios** based on current and emerging trends, and an overview of the **Strategic Context**.

1 Insights and trends

A synthesis of the most recent expert analysis.

1.1 Current perspectives

STAT

Q&A: Why low oxygen shows potential as therapy for some chronic diseases

24 January 2025

Low oxygen, known as hypoxia, has shown potential as a therapy for chronic conditions such as mitochondrial diseases, autoimmune disorders, Parkinson's, and aging. Research conducted by Vamsi Mootha and Robert Rogers involved genetic screening and lab experiments in mice, which demonstrated the potential benefits of low oxygen in the setting of mitochondrial dysfunction. Preclinical models of mitochondrial disease have shown significant improvement when placed in low ambient oxygen conditions. Additionally, a natural experiment involving Indian army troops living at high altitudes revealed a lower incidence of cardiovascular disease, stroke, and diabetes.

Al Monitor

Watching the sun rise over a new Damascus

27 December 2024

After the fall of Bashar al-Assad, people in Damascus are finally able to climb Mount Qasyun again and admire the view of their capital. During the years of the civil war, access to the mountain was restricted due to snipers and military activity. Now, people can relax, take selfies, and enjoy firework displays on the mountaintop. The reopening of the mountain represents a new sense of freedom for the people of Damascus, who were previously restricted by government control.

SpringerOpen

Multiband in-band full-duplexing using fractal concentric circular antenna arrays

21 December 2024

Researchers have presented an innovative approach to improve multiband communication systems using fractal concentric circular antenna arrays. This approach enables antenna subsystems to simultaneously transmit and receive across multiple independent in-band full-duplex (IBFD) channels. The method utilizes hexagonal star array (HSA) geometry, providing a unique self-interference cancellation (SIC) capability across multiple bands. Simulation results demonstrate significantly enhanced SIC bandwidth for signals near 5 GHz, with the integration of subbands achieving a bandwidth of 1.4 GHz. The authors also validated the multiband functionality with pilot signals at 2.68 and 5.2 GHz. This research shows promise in optimizing radio resources in multiband communication systems.

YiCai Global

China's First Low-Altitude Economy Auction Wasn't for Airspace, Official Clarifies

02 December 2024

Shandong Jinyu General Aviation has won the franchise rights for the low-altitude economy in China's Pingyin county with a bid of CNY924m ($127m), according to a notice on the website of the Jinan Public Resource Trading Center. The auction was held to establish a state-owned platform for the low-altitude economy, not for airspace. Jinyu Aviation will use the funds to finance and participate in low altitude projects, improve local airports' facilities, and carry out drone test flights, flight training, and small aircraft sales.

Pingyin is actively promoting the development of drone logistics, aviation tourism, and flight training.

Wired

Is Apple's iPhone 16 Pro Good for Games?

04 November 2024

The iPhone 16 Pro has been touted as a powerful gaming device, allowing users to play AAA games anywhere. However, playing these high-end games on the iPhone comes with limitations. Users have to download large amounts of data before playing, often resulting in a lack of touchscreen optimization and the need for an external controller. The visual quality and performance of these games also fall short compared to consoles and PCs. Additionally, there are associated costs and practical issues such as battery drainage and limited device storage. While the experience can be enjoyable, it is not on par with dedicated gaming platforms.

Smithsonian Magazine

Ten Isolated, Gravity-Defying Monasteries You Can Visit Around the World

31 January 2025

Monasteries around the world have been built in isolated and gravity-defying locations. These spiritual sites, such as the Meteora Monasteries in Greece and the Hanging Temple in China, are often located on steep cliffs or on top of massive monoliths. Some monasteries, like the Bobbio Abbey in Italy, were renowned for their libraries and contribution to medieval Christian practices. Despite their challenging locations, these monasteries have attracted visitors from around the world and continue to be places of tranquility and contemplation.

Max Planck Society

Erste Sonnenaufnahmen von Sunrise III

17 December 2024

Das ballongetragene Sonnenobservatorium Sunrise III hat erstmals Bilder der Sonnenoberfläche veröffentlicht. Die Aufnahmen zeigen kleinste Strukturen mit einer Größe von nur 50 Kilometern und ermöglichen eine detaillierte Beobachtung der Prozesse auf der Sonne. Der Datensatz umfasst etwa 200 Terabyte an Informationen und wurde während eines sechseinhalbtägigen Fluges im Stratosphäre gesammelt. Das Observatorium konnte dabei auch Sonnenflecken und zwei Strahlungsausbrüche erleben. Die Daten müssen noch weiter aufbereitet werden, um ihr volles Potential auszuschöpfen.

Try translating with Google

Frontiers

Deep reinforcement learning for time-critical wilderness search and rescue using drones

03 February 2025

This article presents a novel algorithm that uses deep reinforcement learning to create efficient search paths for drones in wilderness search and rescue (WiSAR) operations. The algorithm leverages a priori data about the search area and the missing person to learn optimal flight paths that maximize the probability of finding the missing person quickly. Experimental results show that the proposed method significantly improves search times compared to traditional algorithms. The approach also incorporates a continuous action space enabled by cubature, allowing for more nuanced flight patterns.

Nature

GW190521 as a dynamical capture of two nonspinning black holes

07 February 2025

Scientists have made a significant discovery of a millihertz quasi-periodic oscillation (QPO) near a supermassive black hole. The QPO was observed in an actively accreting supermassive black hole with a frequency that evolved over two years. The period of the QPO decreased from roughly 18 minutes to 7.1 minutes, a phenomenon that has never been seen in supermassive black hole or stellar-mass black hole QPOs. This finding challenges existing models and may have implications for our understanding of matter accretion onto supermassive black holes.

Science Daily

How satellite imagery can help monitor dangerous lakes formed by glacier surges near high-mountain communities

16 January 2025

Satellite imagery has been used to monitor the potential hazards posed by lakes formed as a result of glacier surges in high-mountain communities. A study analyzed a lake formed by a glacier surge in the Karakoram Mountains and identified six phases of filling and drainage. These lakes pose a risk to nearby communities as they can lead to floods when they drain rapidly. Monitoring and tracking glacier surges using satellite data can help identify and warn communities about increased flood risk. Measures such as early warning systems and flood protection infrastructure can help reduce the risks posed by these glacier-related hazards.

Cornell University

PMA prof's new audiobook capitalizes on hair-raising adventure

23 January 2025

Associate Professor Austin Bunn's new audiobook, "DENALI," is based on his own terrifying mountain-climbing experience. The story, set on Mt. McKinley, follows a thrilling and twist-laden narrative inspired by Bunn's real-life survival story on Mount Whitney. The audiobook will be released as an Audible Original on January 23.

The Quantum Insider

India's Himalayan Site Ideal for Transmitting Quantum Signals to Space, Study Finds

09 December 2024

IAO Hanle in the Himalayas has been identified as an ideal location in India for transmitting quantum signals into space, which could advance global quantum communication capabilities. The high altitude and stable atmospheric conditions at Hanle minimize signal loss compared to other observatories. This research underscores the importance of adaptive optics to counteract atmospheric turbulence and proposes broader studies for global high-altitude observatories. The findings have implications for creating secure global quantum networks and highlight the importance of selecting optimal ground station locations for quantum communications.

War on the Rocks

In Brief: How Will U.S. Support for Israel Impact Readiness? - War on the Rocks

23 October 2024

The United States has deployed 100 servicemembers and a THAAD system to Israel in response to Iran's missile attacks. The impact of this support on readiness is discussed by three experts.

Max Planck Society

Astronomers measure electrons from space at record energies

25 November 2024

A pulsar within a few thousand light-years of Earth may have accelerated electrons and positrons to record energies, according to researchers from the H.E.S.S. collaboration. Using data from ten years of observations, the scientists detected cosmic electrons and positrons with energies of over ten tera-electronvolts. The exceptional quality of the energy spectrum suggests that a nearby pulsar could be the source of these particles. The findings contribute to understanding the origin of cosmic radiation and the existence of powerful natural particle accelerators in the vicinity of our solar system.

Nature

First lift-off and flight performance of a tailless flapping-wing aerial robot in high-altitude environments

09 December 2024

Researchers have developed a tailless flapping-wing aerial robot called RAVEN that can perform multiple modes of locomotion including flight, walking, and hopping. The robot's bird-inspired multifunctional legs allow it to jump rapidly into flight and navigate complex terrains. The study found that jumping for take-off contributes to the robot's initial flight take-off speed and is more energy-efficient than taking off without a jump. These findings highlight the trade-off in mass distribution between legs and body in birds and demonstrate the potential of multifunctional robot legs in expanding the capabilities of traditional aircraft in challenging environments.

JSTOR Daily

Antarctica Unveiled: From Accidents to Airborne Labs

21 December 2024

Accidental discoveries and international collaboration in the 1960s and 1970s allowed scientists to map the landscape beneath the Antarctic ice using radio echo-sounding. These discoveries were made possible by incidents such as a plane crash in 1959 and encounters with mysterious interfering signals while studying aurorae. Engineers developed modified radar altimeters and physicists received funding for ice-sounding devices. With the support of various organizations, scientists built airborne laboratories equipped with radio echo-sounding devices and other instruments, slowly revealing the topography of Antarctica. This episode exemplifies "big science" in the Cold War era and paved the way for advancements in remote sensing.

Smithsonian Magazine

Detroiters Have a Newly Restored Michigan Central Station to Be Thankful for This Holiday Season

24 December 2024

Ford Motor Company has funded the restoration of the Michigan Central Station in Detroit, turning it into a technology and innovation hub. The building, which opened in 1913 and was in a dilapidated state, is now being restored to its Gilded Age grandeur. The restoration project is seen as a symbol of Detroit's revitalization and was celebrated with a holiday party attended by stakeholders and dignitaries. The event also marked the launch of a photo-driven book documenting the station's

history and restoration. The restored station is expected to play a pivotal role in the city's future development.

Science Daily

Early detection of high-altitude hypoxic brain injury

06 December 2024

Using in vivo electrochemistry, researchers have discovered characteristic changes in the oxygen content of various brain regions that occur before high-altitude hypoxic brain injury. By measuring the oxygen levels, the risk of brain damage can be predicted days in advance, offering a potential approach for early detection of high-altitude hypoxic injury. This research could be crucial in preventing life-threatening brain injuries caused by acute altitude sickness.

The Diplomat

Why Has High Speed Rail Failed in Kazakhstan?

08 November 2024

High-speed rail has failed in Kazakhstan due to several factors. Despite its vast and unpopulated land, the country lacks the population density required to sustain such a project. Additionally, the economic downturn caused by a decline in oil prices has strained the country's finances, making it difficult to invest in high-speed rail. The prioritization of freight over passenger trains has also played a role, as Kazakhstan has focused on expanding its track network for cargo transportation. Overall, the lack of population, financial constraints, and prioritization of freight have hindered the success of high-speed rail in Kazakhstan.

Frontiers

Preprocessing LOFARgram through U-Net++ neural network

30 January 2025

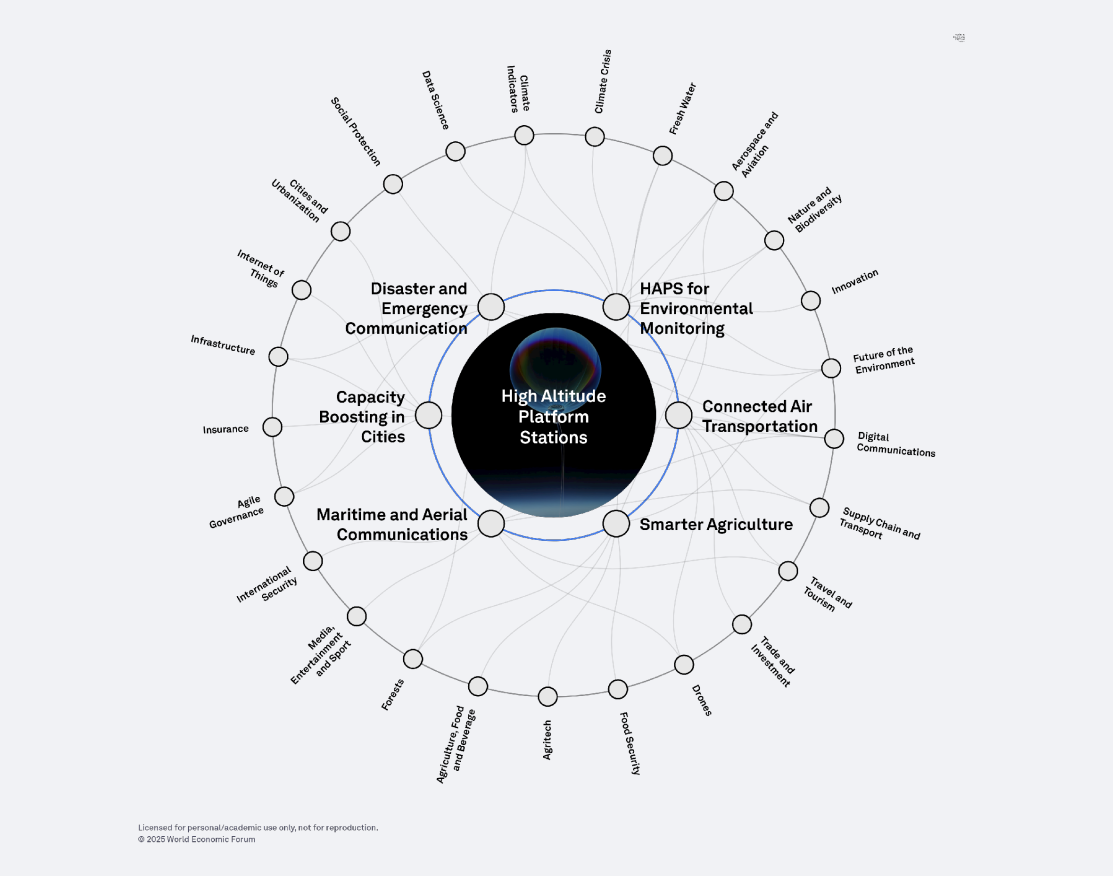
The study explores the use of the U-Net++ neural network model for preprocessing LOFARgrams, which are used to analyze ship-radiated noise and extract target motion trajectories. To train the neural network effectively, a forward model is introduced that simulates LOFARgrams from stochastic noise sources. The model uses explosive decaying cosine pulses and the KRAKEN normal mode model to create high-quality ship noise LOFARgrams. A new algorithm is also introduced to predict Closest Point of Approach (CPA) parameters using the original LOFARgrams and those processed with U-Net++. The results show that predictions based on U-Net++ enhanced LOFARgrams are more accurate. This work demonstrates the effectiveness of the forward model and U-Net++ enhanced LOFARgrams for ship-radiated noise analysis and precise prediction of target motion.

2 Strategic context

The key issues shaping High Altitude Platform Stations.

The following key issues represent the most strategic trends shaping the topic of High Altitude Platform Stations. These key issues are also influenced by the other topics depicted on the outer ring of the transformation map.

FIGURE 1 **Transformation map for High Altitude Platform Stations**



2.1 HAPS for Environmental Monitoring

High-Altitude Platform Stations can be invaluable tools to help better protect the planet

High-Altitude Platform Stations are becoming critical for environmental monitoring, at a time of serious environmental challenges. Thanks to their aerial perspective, the data collected by HAPS (equipped with advanced sensors and imaging) are invaluable for understanding environmental dynamics. Continuous observation of critical indicators like air quality, forest fires, pollution levels, and ecosystem health becomes

more possible over vast geographic areas with the technology, and with greater precision and reliability. That in turn can spur advances in climate research, improve disaster prediction models, and bolster the management of natural resources. The fact that HAPS can be deployed rapidly, and platforms can be kept operational for prolonged periods, is key for monitoring changes as they happen; this real-time tracking can be a game-changer for proactively responding to emergencies, dealing with crises, and aiding collective efforts to better protect the planet.

Related topics: Data Science, Climate Indicators, Climate Crisis, Fresh Water, Aerospace and Aviation, Nature and Biodiversity, Innovation, Future of the Environment

2.2 Connected Air Transportation

A future full of autonomous flying vehicles will require the connectivity HAPS can provide

As we edge closer to a world where airborne transport options like flying taxis, or "urban air mobility" (UAM) become a reality, High-Altitude Platform Stations may prove essential for ensuring that these things can operate effectively. This quality assurance could eventually be applicable across entire logistics and delivery networks. Their positioning in the stratosphere means that HAPS will be able to supply high-bandwidth connectivity for UAM vehicles in ways that ensure seamless communication, more precise navigation, and better overall risk management and disaster avoidance - as real-time adjustments can be made based on weather conditions and other obstacles. Safety is a core advantage - particularly when it comes to the management of entire fleets of autonomous vehicles. Real-time tracking should mean less need for human resources, while in hard-to-reach areas (particularly those inaccessible by land) the technology can plug communication gaps, and provide new and flexible logistics support for people stuck in conflict and disaster zones.

Related topics: Aerospace and Aviation, Digital Communications, Supply Chain and Transport, Travel and Tourism, Trade and Investment, Drones

2.3 Smarter Agriculture

HAPS can elevate agriculture with precision farming based on data-fueled insights

High-Altitude Platform Stations can provide farmers with more data-based insights than ever before. These stratosphere-based airships enable precision farming tools, better crop management, and increased agricultural productivity by facilitating high-speed internet connectivity in rural areas. Internet of Things devices and services can be used more seamlessly by farmers, including soil sensors, animal monitors, drones, and satellite imagery. And more detailed insights into crop and animal health, soil moisture levels, and pest activity means that targeted interventions can take place - enabling the more efficient management of water, fertilizers, and pesticides. HAPS also supports automated farming equipment and real-time data analysis, which can lead to more efficient farming practices, reduced environmental impact, and better food security. Making such advanced agricultural technology more accessible, particularly in remote locations, could have a transformative impact on agriculture.

Related topics: Food Security, Nature and Biodiversity, Agritech, Fresh Water, Future of the Environment, Agriculture, Food and Beverage, Forests

2.4 Maritime and Aerial Communications

HAPS can bridge long-standing gaps in air and sea communications

High-Altitude Platform Stations can transcend the shortcomings of traditionally spotty or entirely non-existent communication connections across maritime and aerial networks. In fact, HAPS technology has the potential to enable truly reliable, high-speed connectivity across the ocean and through the air above it for the first time. For maritime operations, HAPS ensures continuous ship-to-shore and ship-to-ship messaging, supports navigation, and increases safety by facilitating real-time data exchange, weather monitoring, and emergency communications. When it comes to aviation, HAPS provides comprehensive coverage that increases the efficiency of air-traffic management, bolsters in-flight connectivity for passengers, and improves

communication between pilots and ground control. This comprehensive coverage is also pivotal for remote monitoring, search and rescue operations, and environmental surveillance over vast expanses.

Related topics: Travel and Tourism, Digital Communications, Drones, Aerospace and Aviation, Media, Entertainment and Sport, Supply Chain and Transport, International Security

2.5 Capacity Boosting in Cities

HAPS can handle increased data demand in high-population zones

Cities are densely populated, and growing - Tokyo, New Delhi, Shanghai, São Paulo, and Mexico City are among the dozens of urban areas with populations that already exceed 10 million. Infrastructure may already be in place to handle the enormous communications demands in these locales, but traditional tower- or mast infrastructure may not be able to absorb surges. High-Altitude Platform Stations, however, are flexible, relatively easy to deploy at low cost, and can be used to increase capacity by taking on traffic offloaded from congested terrestrial networks. HAPS operate from the stratosphere, and can cover vast urban regions with high-capacity wireless connectivity. They are particularly beneficial for supporting 5G networks - and 6G, likely, when that technology is rolled out. A HAPS airship can serve as an aerial base station, providing robust, temporary internet access - demand for which may only increase with the spread of “smart” city applications and the Internet of Things (IoT).

Related topics: Digital Communications, Agile Governance, Insurance, Infrastructure, Internet of Things, Cities and Urbanization

2.6 Disaster and Emergency Communication

In emergency situations HAPS can help keep channels open

Aid efforts during disasters and emergencies, particularly in the context of wars and natural disasters, are often hindered by limited access to communications networks. High-Altitude Platform Stations can bypass this problem. They extend beyond traditional ground-based communication systems and can be rapidly deployed above disaster-stricken or inaccessible regions - and remain unaffected even as ground infrastructure is damaged or destroyed. Their ability to provide high-speed data transmission can facilitate efficient coordination among emergency responders, and the speedy dissemination of critical information. Remote medical consultation therefore becomes more possible, as do critical lifelines in cases where time is in short supply.

Related topics: Climate Indicators, Future of the Environment, Social Protection, Digital Communications, Infrastructure, Agile Governance, Forests

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About Strategic Intelligence

Our approach

In today's world, it can be difficult to keep up with the latest trends or to make sense of the countless transformations taking place. How can you decipher the potential impact of rapidly unfolding changes when you're flooded with information - some of it misleading or unreliable? How do you continuously adapt your vision and strategy within a fast-evolving global context? We need new tools to help us make better strategic decisions in an increasingly complex and uncertain environment.

This live briefing on High Altitude Platform Stations, harnesses the World Economic Forum's Strategic Intelligence platform to bring you the very latest knowledge, data and context from our 300+ high quality knowledge sources. Its aim is to help you understand the global forces at play in relation to High Altitude Platform Stations and make more informed decisions in the future.

Each day, our Strategic Intelligence platform aggregates, distills and synthesizes thousands of articles from around the world. We blend the best of human curation with the power of machine learning to surface high-quality content on over two hundred global issues to our one million users globally. Our hand-picked network of content partners from around the world means that we automatically exclude much of the noisy clickbait, fake news, and poor quality content that plague the Internet at large. We work with hundreds of think tanks, universities, research institutions and independent publishers in all major regions of the world to provide a truly global perspective and we are confident that our data are well positioned when it comes to the intrinsic biases inherent to open text analysis on uncurated content from the Internet. For further context on our approach, you may be interested to read Strategic trend forecasting: anticipating the future with artificial intelligence and These Are The 3 Ways Knowledge Can Provide Strategic Advantage.

↓ A leading expert presenting a transformation map at our Davos Annual Meeting

Overview of methodology

Our Transformation Maps are dynamic knowledge visualisations. They help users to explore and make sense of the complex and interlinked forces that are transforming economies, industries and global issues. The maps present insights written by experts along with machine-curated content. Together, this allows users to visualise and understand more than 250 topics and the connections and inter-dependencies between them, helping in turn to support more informed decision-making by leaders.

The maps harness the Forum network's collective intelligence as well as the knowledge and insights generated through our activities, communities and events. And because the Transformation Maps are interlinked, they provide a single place for users to understand each topic from multiple perspectives. Each of the maps has a feed with the latest research and analysis drawn from leading research institutions and media outlets around the world.

At the centre of each map is the topic itself. This is surrounded by its "key issues", the forces which are driving transformation in relation to the topic. Surrounding the key issues are the related topics which are also affected by them. By surfacing these connections, the map facilitates exploration of the topic and the landscape within which it sits.

The framework extends beyond mapping current trends by incorporating forecasts and scenarios to project potential future states of the system. Forecasts are based on observable patterns, while scenarios explore broader possibilities, including low-probability but high-impact events. These elements contextualize key issues and related topics within potential future trajectories, enhancing strategic thinking and decision-making.

Harnessing collective intelligence from the Forum network and leading research institutions, the maps synthesize diverse insights into a cohesive view. By integrating these insights with the latest research and analysis, the framework provides a comprehensive understanding of how transformations unfold and interrelate, empowering users to navigate the evolving landscape effectively.

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Our Pro membership allows you to create unlimited custom transformation maps and the ability to collaborate on them with your colleagues. You also get the ability to export transformation maps images and Powerpoint presentations. As a Pro user, you also gain access to a range of hypothetical scenarios that have the potential to impact developments in the near future; enabling you to think through and anticipate potential opportunities and risks.

To learn more, visit our membership site.

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WORLD ECONOMIC FORUM

COMMITTED TO IMPROVING THE STATE OF THE WORLD

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