



TOWARDS SDG 17: HOW 6G CAN HELP US TO CONNECT THE UNCONNECTED

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United Nations Sustainable Development Goal 17 (SDG 17) is all about connection and partnerships, to make sure everyone works together to achieve *all* the SDGs. Satellites are often referred to as Earth's guardians because they are responsible for connecting and monitoring the world in various ways. They bring internet connectivity to remote areas, monitor agriculture and food production, and support healthcare. In this article, you will learn about connection, and how satellite technology can play a key role in achieving several challenges addressed by all the 17 SDGs. We will highlight some of our ongoing research on enhancing satellite connectivity using sixth-generation (6G) wireless technology. Finally, we highlight the potential of satellites to foster global partnerships and contribute to a more sustainable, interconnected world.

Watch an interview with the authors of this article to learn even more! (Video 1).

THE POWER OF GLOBAL PARTNERSHIPS (SDG 17)

The United Nations has created seventeen Sustainable Development Goals (SDGs) with the **aim of improving our world**. These goals address several global challenges, including making sure people have enough food and clean water, and protecting the environment against pollution and climate change. Among these goals, SDG 17, which is called Partnerships for the Goals, focuses on making global partnerships strong, so that countries with a lot of resources can share those resources and work with countries that are still developing. Without partnerships, it will be almost impossible to reach important global goals such as ending world hunger, protecting our environment, or making education accessible worldwide. But by working together, we can solve bigger problems and ensure the world becomes a better place for everyone.

So far, progress on SDG 17 is mixed. Some positive things have happened, like more help from richer countries available for low-income countries and more people having access to technology. But it is still hard for low-income countries to have everything they need to provide a good life for their people. This is because these countries must deal with rising prices, big debts, and lack of money for government projects [1]. All countries must come together to help, and this is where SDG 17 comes in.

SATELLITE

A special machine that orbits, or flies around, the Earth in space. It helps us send messages, like phone calls, and take pictures of our planet.

CONNECTIVITY

How computers and devices all over the world link together so people can share information, talk to each other, and use websites, apps, and online tools.

SCIENCE TO THE RESCUE

What role does science play in achieving SDG 17? Science helps us tackle global challenges through creative ideas and collaboration. Take **satellite**, for example—they are not just machines orbiting the Earth, they are critical for progress (Figure 1). Acting as the planet's eyes in the sky, satellites monitor environmental changes, track weather patterns, and collect essential data. They also connect the world through a vast communication network, enabling the smooth exchange of information. Harnessing satellite science and technology can strengthen global partnerships and help countries work together more effectively to achieve SDGs (Table 1). Satellite **connectivity** helps us address some of the world's biggest challenges and ensures everyone, no matter where they live, can access the data they need to address important issues [2, 3]. Our group works on satellite-based internet connectivity [4].

Figure 1

A satellite has several important parts. **(A)** The avionics are like the “brain”. They include the computers and electronics that help it communicate and stay in control. **(B)** The power system, which includes solar panels and batteries, provides the energy it needs to run. **(C)** The antenna is the satellite’s communication tool for sending and receiving information to/from Earth. **(D)** The navigation and control system keep the satellite on the right path. **(E)** The payload is the special equipment the satellite carries to do its main job, like cameras to take pictures of Earth or tools for exploring space.

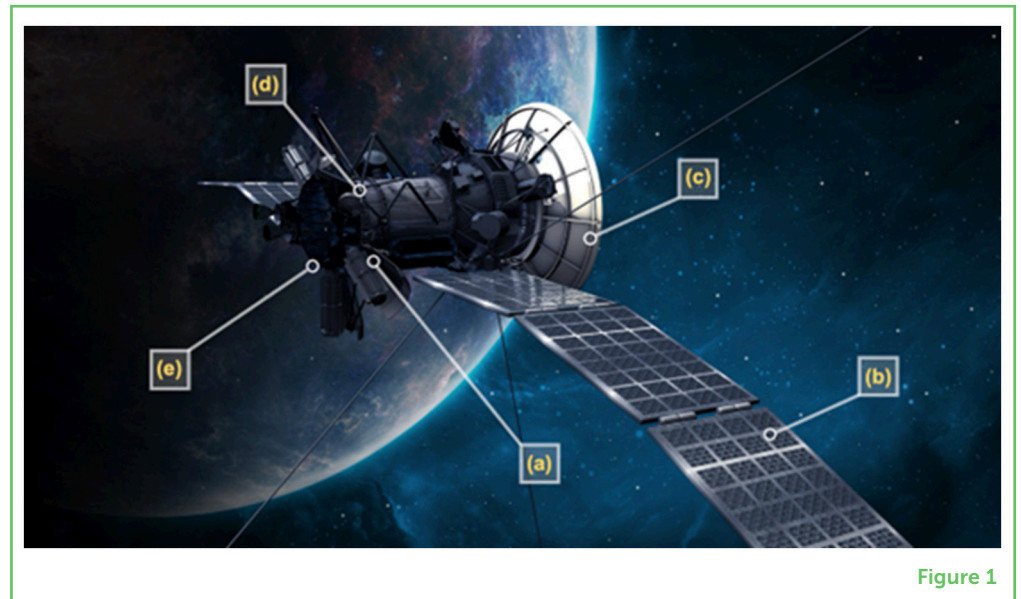


Figure 1

HOW CAN SATELLITES HELP?

But how can satellites stop people from going hungry and solve other issues on Earth? Satellites look down at farms from space to check the soil and see how crops are growing [5]. They can even communicate directly with sensors installed on farms to provide farmers with important information about the crops, soil, and environmental conditions. This helps farmers know when to plant their crops and how to take better care of them. Satellite data makes it possible for farmers to predict how much food will grow, detect crop diseases ahead of time so they can prevent them, or act to avoid droughts. When farming improves, more food is produced to feed people hunger and malnutrition are reduced. Improved farming also helps local economies by creating jobs and opportunities for trade. Ultimately, better farming means stronger, healthier communities with better lives for everyone involved.

On top of all this, satellites can help many people just by bringing internet to their areas. Internet can help reduce inequalities around the world by creating job opportunities and giving people access to education. Satellites can even allow doctors to talk to patients far away and help them stay healthy! Importantly, satellites can support internet connectivity in post-disaster situations, like after hurricanes or floods, by helping affected communities access valuable information and resources so they can recover faster [6, 7].

But that is still not all! Satellites also help keep roads and bridges safe, by taking pictures and gathering information to send back to Earth. These data help engineers plan where to build new roads and fix old ones. Good roads and bridges make it easier for businesses to grow, which helps the economy. Satellites also watch for signs of climate

Table 1

Roles of satellites in achieving SDGs.





SDG	Example roles of satellites
	Satellite sensors can detect areas being farmed, monitor road networks, and detect where people are building homes. This helps keep track of where things like roads, buildings, and services are located. At night, they can detect regions with power outages or without access to electricity, helping authorities support these areas. By sending supplies and building things like roads, schools, and power lines in the right places, we can help people live better lives and reduce poverty
	Satellite images can differentiate between healthy and unhealthy crops. This way, farmers can take care of their crops better. Weather data helps farmers with crop planning by predicting the best planting and harvesting times. Satellite sensors can also support long-term weather forecasting, while monitoring soil moisture levels to assess land dryness and guide watering strategies. All of this helps grow more food and fight hunger in communities
	Satellites help bring the internet to places that are far away or hard to reach. This lets people in those areas talk to doctors using video calls, even if there are no hospitals nearby. Doctors can see how patients are doing, give advice, and help them feel better. This helps more people around the world stay healthy
	Satellites can provide internet to places without schools, so children can access books and educational materials online as well as attend online classes from anywhere. With internet access, students can participate in remote learning, and countries can share educational resources, making quality education more accessible globally
	Satellites can take pictures and collect information from space to see how people live in different places. They can help find out if girls and women have problems getting clean water, healthy food, or safe places to live. This information helps leaders make better plans to keep everyone safe and treated fairly, so girls and boys have the same chances to grow, learn, and live healthy lives
	Satellites can watch lakes, rivers, and other water sources to check how clean they are. They can see how much water there is, if it's too salty or warm, and if it's dirty or polluted. This information helps people find safe water to drink and use, especially in places that are far away or hard to reach
	Satellites help optimize the locations for solar panels and wind turbines by monitoring sunlight and wind patterns. They track weather trends and pinpoint regions with the highest potential for renewable energy. Thus, satellite sensor data promote global collaboration, ensuring wider access to clean energy and supporting efforts to reduce reliance on fossil fuels and combat climate change

Table 1

Table 1

(Continued)


SDG	Example roles of satellites
 8 DECENT WORK AND ECONOMIC GROWTH	When people get internet through satellites, they can learn new skills, find jobs, and even start their own businesses. This works even better when countries work together to share knowledge and build the right tools to enable job opportunities. It helps more people find good work and grow their communities
 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	Satellites use images from sensors to monitor the condition of bridges, roads, and other infrastructure. They can detect shifts in the ground, wear on surfaces, and structural issues such as cracks or deformations. Data are sent to ground stations, where experts analyze it to prioritize repairs and improve building practices. Sharing data between countries supports stronger infrastructure and better planning, particularly in regions vulnerable to natural disasters or extreme weather
 10 REDUCED INEQUALITIES	To start a successful business, people need things like money, tools, education, and support from their community. Satellites help make the internet work, and the internet lets people share ideas, learn new things, and connect with others regardless of where they live or what problems they face
 11 SUSTAINABLE CITIES AND COMMUNITIES	Satellites help cities stay clean and safe by monitoring air and water quality, detecting pollution, and supporting efficient waste management. Satellites provide real-time data for disaster response, traffic management, and urban planning to enhance safety and sustainability
 12 RESPONSIBLE CONSUMPTION AND PRODUCTION	Satellites watch the Earth using special tools like cameras, radar, and heat sensors. They can see changes in the land, air, and water. Satellites also use GPS to find exact locations and help track things like animals, cars, weather, and how nature is changing
 13 CLIMATE ACTION	Using advanced sensors, satellites monitor Earth's climate such as atmospheric conditions, ocean temperatures, cloud cover, and greenhouse gas levels. They provide continuous, global data to track changes like rising temperatures, melting ice, and shifting weather patterns, helping scientists understand and predict climate trends
 14 LIFE BELOW WATER	Satellites monitor ocean health by detecting overfishing, illegal fishing activities, and environmental changes like coral bleaching. These data help countries collaborate on policies and enforce regulations to protect marine ecosystems and ensure sustainable fishing practices
 15 LIFE ON LAND	Satellites can see where forests are being cut down and help watch over animals' homes; and countries can work together to protect these places
 16 PEACE, JUSTICE AND STRONG INSTITUTIONS	Satellites help keep an eye on the world to make sure things are fair and peaceful, helping everyone feel safer
 17 PARTNERSHIPS FOR THE GOALS	Satellites help countries talk to each other and share important information, helping us to track progress made on all the SDGs

Table 1

WIRELESS COMMUNICATION

A way for people or devices to share messages or information without using wires, by sending invisible signals through the air.

6G

The next generation of wireless technology that will come after 5G. 6G will make our phones even faster, more powerful, and able to do more things.

Figure 2

Most wireless communication systems have three main parts: a transmitter, a base station, and a receiver. The transmitter sends out signals and the receiver collects those signals. The base station acts like a control center, making sure everything works smoothly between the transmitter and receiver. The signals travel through an invisible path called the wireless channel, allowing information to move between all the parts. This system is similar to how future 6G networks will work, but with 6G, everything will be much faster, we will be able to connect even more devices, and there will be fewer delays.

ELECTROMAGNETIC SPECTRUM

A big range of invisible energy waves that travel through space. It includes things like radio waves, microwaves, light, and X-rays.

change. They can spot high levels of pollution or when the planet gets too hot. This information helps governments and scientists come up with plans to keep our planet safe and healthy. We all know teamwork is essential for solving big global problems, and now, because of satellites, countries all over the world can share important information, helping to solve many problems.

ENHANCING SATELLITE COMMUNICATIONS WITH 6G TECHNOLOGY

One-way satellites support humanity is through **wireless communication**. Wireless technologies let us send information through the air without needing wires, which is how our cell phones and internet devices communicate (Figure 2). 5G is the fifth generation of this technology, and it made our internet much faster and more reliable than before. Now, we are moving on to **6G**, the next step, which promises even faster speeds and better connections. This new generation is linked to three key technologies we are focusing on in our research.



Figure 2

The first technology has to do with the **electromagnetic spectrum**. The electromagnetic spectrum can be understood as a giant rainbow of invisible waves, with each “color” representing a different kind of wave. The high range of the spectrum, like the far end of the electromagnetic rainbow, has waves that are faster and smaller. Traditionally, our phones use microwaves, which are in the middle part of this rainbow. By using the higher range of the electromagnetic spectrum, we can harness the power of the tinier, faster waves, which allow us to get faster connections [8].

BEAMFORMING TECHNOLOGY

A smart way for antennas to send signals in a specific direction instead of all around. It is like shining a flashlight to help the signal go straight to where it is needed, making it faster and clearer.

WI-FI HOTSPOT

Internet access point that allows you to connect your electronic device. It is handy when you are out and need to get online, like at a coffee shop.

The second technology that we focus on involves the distance satellite orbit away from Earth. The distance between Earth and our satellites affects wireless communications in several ways [9–11]. Low Earth orbit satellites are positioned closer to Earth, making them useful for sending and receiving signals for quicker communication, because the signals do not have as much of a delay. On the other hand, medium Earth orbit satellites are positioned further away, which makes them better for broadcasting videos or for navigation uses, like a car's GPS.

Finally, our research investigates **beamforming technology**, which improves how satellites work by focusing their signals exactly where we need them—just like pointing a flashlight beam in a specific direction. Beamforming helps make the signals from satellites stronger and allows them to reach further [12].

Together, these technologies show 6G's potential to revolutionize connectivity, making it faster and more reliable across various and challenging locations. When satellite signals become stronger and faster with 6G, they can reach even the most remote places on Earth, connecting people who were once very far apart. Some of our other exciting projects involve finding new ways for satellites to communicate with each other and cooperate with Earth's existing communication infrastructure [13], and exploring how satellites can help us learn more about our oceans by looking deep below the water's surface to study marine life and water quality. We are also developing a project using solar-powered or radio energy-powered base stations to create **Wi-Fi hotspots** with a range of up to 1 km [14]. The hotspot connects to the internet via existing infrastructure or satellites, enabling people in isolated areas to browse the web, communicate, and learn using smartphones, tablets, or laptops.

WHAT WE LEARNED IN A NUTSHELL?

In this article, we explained how satellite-based connections play a vital role in achieving SDG 17 and how they also help us to advance all the other SDGs. With the help of 6G satellite communications, we can help farmers increase food production, connect people to the internet, contribute to environmental conservation, and monitor the overall health of our planet. Nonetheless, there is room for improvement. To enhance satellite technology, we must do more research, exploring ways to make these technologies work underground, underwater, and in other challenging conditions where transmitting signals is difficult. Furthermore, it is important to make satellites more maneuverable to avoid collisions, protect them from interference from other wireless sources, and improve communication security by protecting satellites from cyber threats and unauthorized access that could interfere with their function.

You can be part of this exciting journey! By nurturing your curiosity, delving into science, and dreaming big, you can support scientists in this quest. One day, you might develop groundbreaking ideas that could further enhance our world, aiding us in achieving new sustainable development targets. If you continue your exploration and collaborate with other young minds—like SDG 17 teaches us—you might just be the next hero in line to make the world a better place!

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YOUNG REVIEWERS

AILA, AGE: 15

Hello my name is Aila. I enjoy reading books in my free time, and I particularly like books with continuous and well-written character development as well as good descriptions and attention to detail. I also enjoy swimming, I&S, and L&L. I am hoping to start learning piano this year.



LOKYA, AGE: 14

Hi, my name is Lokya, and I am currently in The KAUST School. I enjoy gymnastics, playing badminton, and science.



HINA TABASSUM

Prof. Hina Tabassum received her Ph.D. from the King Abdullah University of Science and Technology (KAUST) in 2013. She is currently an associate professor with the Lassonde School of Engineering, York University, Canada. In 2023, she was appointed as the York Research Chair of 5G/6G-enabled mobility and sensing applications, and visiting faculty at the University of Toronto, Canada, in 2024. She received the Lassonde Innovation Early-Career Researcher Award in 2023 and the N2Women: Rising Stars in Computer Networking and Communications in 2022. She was listed in Stanford's list of the World's Top Two-Percent Researchers in 2021, 2022, 2023, and 2024. In her free time, she finds great value in being near water, as research shows it calms the mind and fosters creativity.



VINTON G. CERF

Dr. Vinton Gray Cerf is an American internet pioneer and is recognized as one of "the fathers of the internet", sharing this title with TCP/IP co-developer Bob Kahn. He earned his M.Sc and Ph.D. from the University of California in 1970 and 1972. He was a faculty member at the University of Stanford and has since worked in government agencies and advisory councils, and in companies such as Google. He has received over 25 honorary degrees, including doctorates from universities around the world. He has also received several awards for his work that include the National Medal of Technology, the Turing Award, the Presidential Medal of Freedom, the Marconi Prize, and membership in the National Academy of Engineering. Dr. Cerf enjoys gourmet cooking and science fiction in his free time.



MOHAMED-SLIM ALOUINI

Prof. Mohamed-Slim Alouini was born in Tunis, Tunisia. He earned his Ph.D. from the California Institute of Technology (Caltech) in 1998 before serving as a faculty member at the University of Minnesota and later at Texas A&M University at Qatar. In 2009, he became a founding faculty member at King Abdullah University of Science and Technology (KAUST), where he currently is the Al-Khawarizmi Distinguished Professor of Electrical and Computer Engineering and the holder

of the UNESCO Chair on Education to Connect the Unconnected. Prof. Alouini's research addresses the technical challenges associated with information and communication technologies in underserved regions such as rural, low-income, disaster-prone, and hard-to-reach areas. In his free time, he likes to relax and spend time with his family! *slim.alouini@kaust.edu.sa