FEATURE

Technology Blog

ASPI's Critical Technology Tracker finds China ahead in 37 of 44 technologies evaluated

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The Australian Strategic Policy Institute (ASPI) finds that China is further ahead in more technologies than has been realized. It's the **leading country in 37 of the 44 technologies evaluated**, often producing more than five times as much high-impact research as its closest competitor. This means that only seven of the 44 analysed technologies are currently led by a democratic country, and that country in all instances is the U.S. Of the ten AI and ICT-related technologies examined, China dominates in seven, the study concluded.

The ASPI study is based on an analysis of the top 10% most-cited papers in each area of research published between 2018 and 2022 – a total of 2.2 million papers. It acknowledges that a widely cited piece of research does not automatically translate into successfully deployed technology. The study also does not reflect the current state of commercialization or of technology diffusion.

Here's a table showing China leading technologies:

Technology	Lead country	Technology monopoly risk
Advanced materials and manufacturing		
1. Nanoscale materials and manufacturing	China	high
2. Coatings	China	high
3. Smart materials	China	medium
4. Advanced composite materials	China	medium
5. Novel metamaterials	China	medium
6. High-specification machining processes	China	medium
7. Advanced explosives and energetic materials	China	medium
8. Critical minerals extraction and processing	China	low
9. Advanced magnets and superconductors	China	low
10. Advanced protection	China	low
11. Continuous flow chemical synthesis	China	low
12. Additive manufacturing (incl. 3D printing)	China	low
Artificial intelligence, computing and communications		
13. Advanced radiofrequency communications (incl. 5G and 6G)	China	high
14. Advanced optical communications	China	medium
15. Artificial intelligence (AI) algorithms and hardware accelerators	China	medium
16. Distributed ledgers	China	medium
17. Advanced data analytics	China	medium
18. Machine learning (incl. neural networks and deep learning)	China	low
19. Protective cybersecurity technologies	China	low
20. High performance computing	USA	low
21. Advanced integrated circuit design and fabrication	USA	low
22. Natural language processing (incl. speech and text recognition and analysis)	USA	low
Energy and environment		
23. Hydrogen and ammonia for power	China	high
24. Supercapacitors	China	high
25. Electric batteries	China	high
26. Photovoltaics	China	medium
27. Nuclear waste management and recycling	China	medium
28. Directed energy technologies	China	medium
29. Biofuels	China	low
30. Nuclear energy	China	low
Quantum		
31. Quantum computing	USA	medium
32. Post-quantum cryptography	China	low
33. Quantum communications (incl. quantum key distribution)	China	low
34. Quantum sensors	China	low
Biotechnology, gene technology and vaccines		
35. Synthetic biology	China	high
36. Biological manufacturing	China	medium
37. Vaccines and medical countermeasures	USA	medium
Sensing, timing and navigation		
38. Photonic sensors	China	high
Defence, space, robotics and transportation		
39. Advanced aircraft engines (incl. hypersonics)	China	medium
40. Drones, swarming and collaborative robots	China	medium
41. Small satellites	USA	low
42. Autonomous systems operation technology	China	low
43. Advanced robotics	China	low
44. Space launch systems	USA	low

Source: Australian Strategic Policy Institute

China leads globally in photonic sensors (43% of world's top 10% high-impact research, 3.41 times the US), quantum communications (31%, 1.89 times the US), advanced optical communications (38%, 2.95 times the US) and post-quantum cryptography (31%, 2.3 times the US).

Taken together, these observations increase the risk of Chinese communications going dark to the efforts of western intelligence services. This reduces the capacity to plan for contingencies in the event of hostilities and tensions.

China has reportedly built the physical infrastructure to claim the world's largest quantum communication network, and has even established quantum communication with moving drones and satellites. As with many things, the risk is cumulative—the risk increases as China leads in both cryptography resistant to decryption by quantum computers and the ability to share encryption keys via quantum communication. One mitigating factor is the current US lead in quantum computing (34% of world's top 10% high-impact research output, 2.26 times China).

Here are three key tech areas where China dominates in high-impact research papers:

- In advanced radiofrequency communications, including 5G and 6G, (there is no such thing as 6G radio) China ranks 1st with 29.65% vs 9.50% for the U.S. and 5.2% for the UK.
- In advanced optical communications, China ranks 1st with 37.69% vs. 12.76% for the U.S.
- In artificial intelligence (AI) algorithms and hardware accelerators, China ranks 1st with 36.62% vs. 13.26% for the U.S.

The ASPI report designates China's lead in these technologies as "high-risk," meaning it is a long way ahead of its closest competitor and that it is home to most of the world's leading research bodies in that field.

Quantum communications is another area of strength for China. USTC is the top institution irrespective of the quality metrics, and a total of eight out of 20 top institutions are based in China (see Figure 9).

Tsinghua University and Delft University of Technology in the Netherlands occupy the second and third places depending on the quality metrics. China's lead in quantum communications is especially prominent in the proportion of publications in the top 10% of highly cited papers. China's quantum research was spearheaded by the Xiangshan Science Forum for quantum information in Beijing in 1998, which resulted in experimental research in quantum information within several Chinese universities and research institutes, including USTC, Shanxi University and the Chinese Academy of Sciences' Institute of Physics.

USTC scientist Jian-Wei Pan demonstrated the potential of quantum communications to Xi Jinping and other Politburo members, and he became known as the founder of Chinese quantum science.

In China's Thirteenth Five-Year National Science and Technology Innovation Plan announced in August 2016, the CCP strengthened its quantum strategy further by listing quantum communications and computing as major science and technology projects for advances by 2030.

USTC demonstrated China's dominance in quantum communication by building the first fibre-based 'Beijing–Shanghai Quantum Secure Communication Backbone' in 2013, connecting Beijing, Shanghai, Jinan Hefei and 32 reliable nodes over a total transmission distance of more than 2,000 kilometres.

The strength of quantum communications is that it ensures secure communication due to quantum entanglement, which effectively ensures that any quantum information is modified when observed. This effectively makes it difficult to amplify quantum signals in the conventional way used for current optical communications. Pan's research team made another significant breakthrough in 2017 by using the first quantum satellite (Micius, launched in 2016), and the free space reduced attenuation to transmit image and sound information using quantum keys over 7,600 kilometres between Austria and China.

References:

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ASPI warns that China's advanced research "at the intersection of" photonic sensors, quantum communications, optical communications and post-quantum cryptography could undermine the U.S. led "Five Eyes" global intelligence network.

"Taken together, these observations increase the risk of Chinese communications going dark to the efforts of western intelligence services," the report said. ASPI said its research will be updated with the aim of assessing the future tech capabilities of nations and to highlight long-term strategic trends.