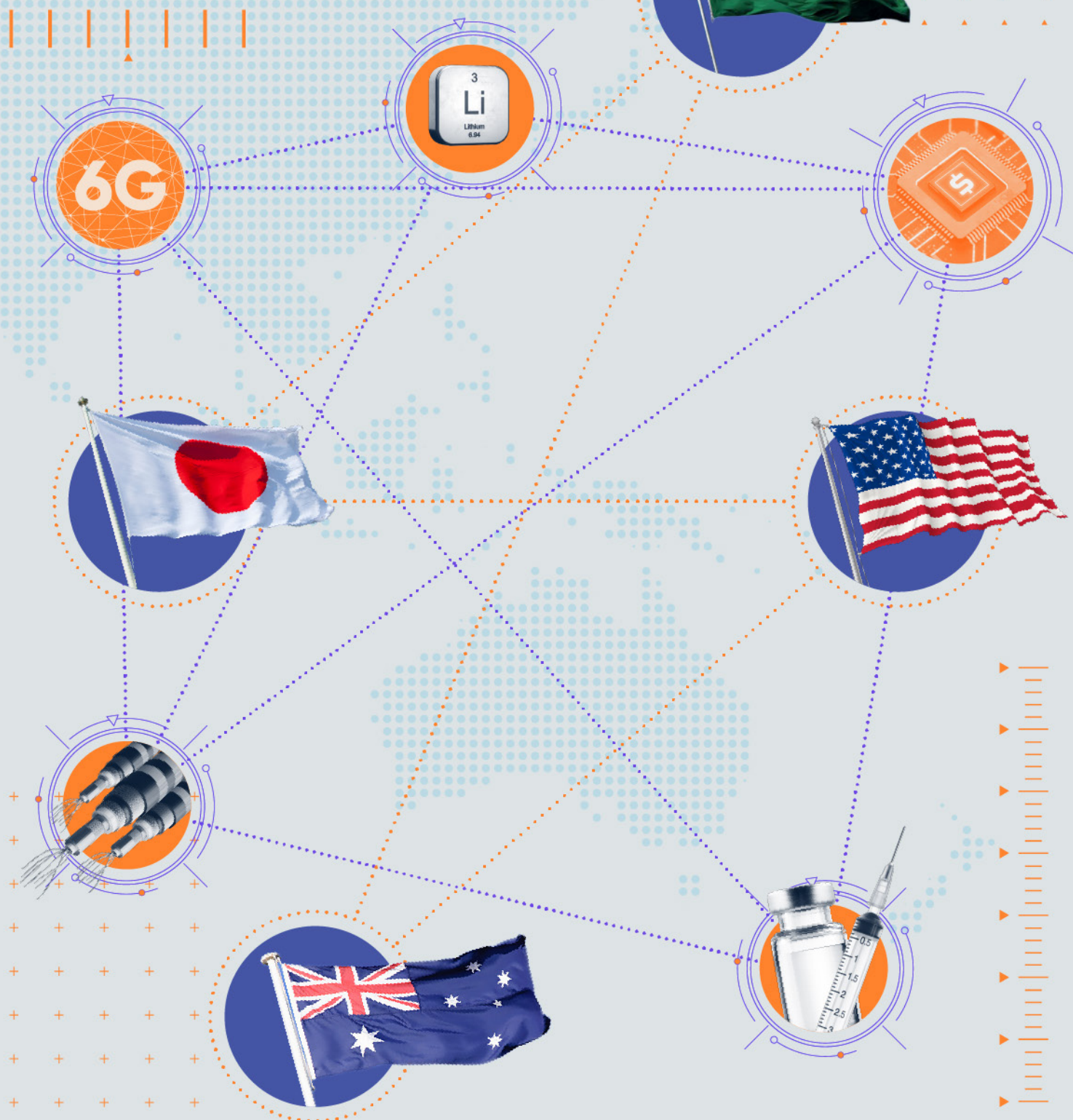


# QUAD ECONOMY & TECHNOLOGY TASK FORCE REPORT

A TIME FOR CONCERTED ACTION





# QUAD ECONOMY & TECHNOLOGY TASK FORCE: A TIME FOR CONCERTED ACTION

---

Gateway House Report  
August 2021





## Executive

Executive Director: Manjeet Kripalani

## Publication

**Editors:** Christopher Conte, Manjeet Kripalani

**Project Manager:** Kartik Ashta

**Website and Publications Associate:** Saloni Rao

**Layout Design:** Debarpan Das

**Cover Design:** Debarpan Das

**in** Gateway House: Indian Council on Global Relations

**🐦** @GatewayHouseIND

**f** @GatewayHouse.in

**📷** @GatewayHouse.in

For more information on how to participate in Gateway House's outreach initiatives, please email [outreach@gatewayhouse.in](mailto:outreach@gatewayhouse.in)

© Copyright 2021, Gateway House: Indian Council on Global Relations.

All rights reserved. No part of this publication may be reproduced, stored in or introduced into a retrieval system, or transmitted, in any form or by any means (electronic, mechanical, photocopying, recording or otherwise), without prior written permission of the publisher.

Table of Contents

1. From the Task Force Co-Chairs.....06

2. Why This Task Force?.....08

3. Members of the Task Force.....10

4. Executive Summary.....13

5. Findings and Recommendations.....15

    1. Pharmaceuticals.....15

    2. Critical Minerals.....23

    3. Fintech and Cybersecurity.....26

    4. Space and 6G.....31

    5. Undersea Communications Cables.....41

6. Conclusion.....48

7. Appendix 1 : Acronyms.....49

8. Appendix 2 : List of Figures.....52

9. Appendix 3 : List of Tables.....53

## 1. From the Task Force Co-Chairs

The Quadrilateral Security Dialogue – the “Quad” – has taken on increased relevance in recent years as its four member countries recognize that to compete effectively with a rising China, they need to combine their resources and capabilities and take collective action across the political, economic, technological and even military domains. The four nations demonstrated their commitment to the quadrilateral grouping as a key pillar of their strategies in the Indo-Pacific region by holding the first-ever Quad summit this past March. At that virtual meeting, the four countries committed to establishing working groups on vaccine production and distribution, emerging and critical technologies, and climate change.

The in-person Quad summit scheduled for late September provides an opportunity for the four countries to assert a collective role in ensuring that the development and deployment of technology bolsters democratic development, rather than strengthening autocratic trends. The four nations have a common interest in countering China’s efforts to control supply chains for certain critical minerals and technologies and to dominate the development of emerging technologies. The Quad must also work together to influence global technology standard-setting with the goal of maintaining a free, open and liberal digital order. The Quad can pool its resources and capabilities to prevent China from dominating the digital development of regions like Southeast Asia and the Pacific Islands. Quad members’ first-mover advantage in software can be leveraged to provide leadership in the critical areas of financial technologies and cyber-security. By combining their resources and expertise while bringing to bear shared democratic values that must guide technological development, the four powerful nations can succeed in shaping the landscape in which new technologies will emerge and in protecting access to critical minerals and technologies.

This Task Force report addresses areas in which the Quad can make immediate and substantial progress on economic and technology issues and provides policymakers with concrete ideas for moving the Quad discussions forward. The Task Force report focuses on five key areas: pharmaceuticals, space and 6G, critical minerals, undersea cables, fintech and cybersecurity. With contributions from experts in all five subject areas from Australia, India, Japan, and the United States, the Quad Economy and Technology Task Force report presents its findings and recommendations for sustaining trusted and secure technology ecosystems anchored in principles of transparency, security, accountability and individual control.

Some of the Task Force recommendations include bringing the unique strengths of each Quad nation to the challenge of China’s increasing involvement in subsea cable construction; establishing a maritime command center to deal with non-traditional maritime security threats; democratizing development of 6G solutions; establishing cooperative mechanisms to enhance space situational awareness; and developing common data protection standards in the fintech space—to name just a few.

The power of the Quad on pharmaceutical cooperation has already been demonstrated with the announcement in March of the vaccine production and distribution initiative to manufacture 1 billion vaccines and distribute them throughout the region by the end of 2022. The COVID-19 pandemic demonstrated the pitfalls of relying on Chinese supply chains for critical medical equipment and pharmaceuticals. The global health crisis has widened the cracks already apparent between the Chinese and democratic systems, and emphasized the need for healthy competition.



The main focus of this report is on technology cooperation that will assist the four nations in collectively competing with China's growing global digital footprint and influence.

The Task Force report also identifies barriers to Quad cooperation, such as diversity of standards and regulations across the member nations regarding economic and technological development. To help overcome these hurdles, the private sectors must play an integral role in the Quad dialogue. The role of the private sector is also critical in identifying areas that would benefit most from joint research and development programs designed to foster innovation and entrepreneurship and build upon each Quad nation's scientific, technological and academic strengths.

The imperative for enhanced Quad cooperation on the five key areas of concern has never been more urgent. The Task Force findings can help guide policy discussions, while the recommendations can serve as a roadmap for actions the Quad can take both now and in the longer term.

**Dr. Lisa Curtis,**  
Director of Indo-Pacific Security  
Centre for New American Security  
Washington, D.C.

**Dr. Surjit Bhalla**  
Executive Director for India  
International Monetary Fund  
Washington, D.C.

## 2. Why this Task Force?

The Quadrilateral Security Dialogue, or Quad, is evolving from a maritime security grouping for the Indo-Pacific into a long-term strategic partnership, with a wide spectrum of shared values and principles, a common world view, and vital interests that are in alignment.

This evolution is possible because beyond defence, the four democracies that comprise it – Australia, India, Japan, the U.S. – have much more to offer each other and the region.

All four have complementary strengths in technology, healthcare, finance – areas necessary for future economic and social development. The unique mix of the group – three developed and one developing nation, three Pacific and one Indian Ocean nation, three producer-trading nations with one massive emerging market – lends itself to innovation, experimentation and cooperation that can be a template for a new, post-pandemic geopolitical era.

Why not expand the Quad with an economic and technological dimension, and put its powerful matrix to work? Why should this interesting strategic partnership not be glued with the pragmatism of business and the ideas of entrepreneurship?

The idea had already germinated at Gateway House, Mumbai in 2019. Several conversations with industry executives, technology experts, venture funders, financiers and diplomats from the four countries over six months made this clear: everyone wanted to enhance the Quad, but no one was willing to take the first step forward.

As Covid-19 took root in 2020, the importance of the Quad became apparent, as did the urgency of putting our collective economic and technological knowledge to best use for the immediate and the long term. What started as a series of exploratory conversations began to solidify as a study for a Task Force.

In May 2020, the Gateway House team identified five immediate areas ripe for economic and technological cooperation among the Quad nations, and experts from all the four Quad countries with the knowledge of them from industry, academia, politics, the strategic community and government.

Key to any task force's success is the choice of chairs – in this case, co-chairs. Dr. Lisa Curtis, Director of Indo-Pacific Security at the Centre for New American Security and Dr. Surjit Bhalla, executive director for India, International Monetary Fund. Understanding the urgency of classifying and building a coalition of economic interests with technological transparency, both co-chairs supported the Task Force with enthusiasm.

The Task Force's first meeting was held virtually on March 23, 2021 – boosted by the first virtual summit of the Quad leaders held on March 12. After five months, the Task Force has been able to publish its findings, available in this report.



The Task Force has taken on the study of subjects that are expeditionary – emerging technologies, space, creation of new products, new standards and new supply chains essential for the world we will live in. Through multiple meetings from four time zones, members used their knowledge and their networks to bring to this report a rich understanding of the subjects and to bring promising proposals for the future.

The outcome is a blueprint for the Quad’s most urgent and pressing cooperation in the immediate term – and for the development of a long-term engagement. It is not just for the consideration of the four governments, but for all democratic stakeholders, including business, the technology world, media and academia. We hope all will use the findings of this report to prepare to face the challenges before us.

**Manjeet Kripalani,**  
Executive Director,  
Gateway House: Indian Council on Global Relations  
Mumbai

### 3. Task Force Members

#### CO-CHAIRS

---

**1. Lisa Curtis**

Senior Fellow and Director of the Indo-Pacific Security Program at the Center for a New American Security (CNAS).

**2. Surjit S. Bhalla**

Executive Director for India, International Monetary Fund

#### MEMBERS

---

**1. Rahul Bajoria**

Chief Economist – India & Antipodeans, Barclays

**2. Amit Bhandari**

Fellow, Energy and Environmental Studies Programme, Gateway House

**3. Rajiv Bhatia**

Distinguished Fellow, Foreign Policy Studies Programme, Gateway House

**4. Penny Burt**

Group CEO, Asialink

**5. Karl Eikenberry**

Former US ambassador to Afghanistan and lieutenant general, US Army, retired.

**6. David Feith**

Adjunct Senior Fellow at the Center for a New American Security (CNAS)

**7. Chaitanya Giri**

Fellow, Space and Ocean Studies Programme, Gateway House

**8. Bonnie Glick**

Senior Adviser (non-resident), Project on Prosperity and Development, CSIS

**9. Cdr. Amrut Godbole\***

Fellow, Indian Navy Studies Programme, Gateway House

*\*Commander Amrut Godbole has contributed to the section on Undersea Communications Cables. The contents of the report are his personal views, and do not reflect the official position of the Indian Navy or the Government of India.*

**10. Pawan Goenka**

Former Managing Director & CEO, Mahindra and Mahindra

## MEMBERS

---

**11. Wendy Holdenson**

Director and Executive Vice President, Mitsui & Co. Australia

**12. Masahiro Kawai**

Project Professor, Graduate School of Public Policy, University of Tokyo and Former Dean, ADB Institute

**13. Dr. I-Chung Lai**

President, Prospect Foundation

**14. Walter Lohman**

Director, Asian Studies Center, The Heritage Foundation

**15. ND Nalapat**

Professor of Geopolitics, Vice-Chair, Manipal Advanced Research Group and UNESCO Peace Chair, Department of Geopolitics and International Relations, Manipal University, India

**16. Baijayant “Jay” Panda**

National Vice-President, Bharatiya Janata Party (BJP)

**17. Cleo Paskal**

Associate fellow Energy, Environment and Resources Programme and the Asia-Pacific Programme, Chatham House

**18. Sameer Patil**

Fellow, International Security Studies Programme, Gateway House

**19. Tirthankar Patnaik**

Chief Economist, National Stock Exchange of India.

**20. David Rasquinha**

Former Managing Director and Chief Executive Officer, Export-Import Bank of India.

**21. Martijn Rasser**

Senior Fellow, Technology and National Security Program, Center for a New American Security (CNAS).

**22. Phillip Reiner**

Chief Executive Officer, Institute for Security and Technology

**23. Peter Rimmele**

Resident Representative of Konrad Adenauer-Stiftung Office, India

**24. Ari Sarker**

Co-President for Asia Pacific, Mastercard

**25. John Seaman**

Research Fellow, Centre for Asian Studies, Institut Francais des Internationales

## MEMBERS

---

**26. Sharad Sharma**

Co-Founder iSpirt Foundation

**27. HK Singh**

Director General, Delhi Policy Group

**28. Tomohiko Taniguchi**

Professor, School of SDM, Keio University and Former Advisor to the Cabinet of Shinzo Abe

**29. Matthew Turpin**

Visiting Fellow, Hoover Institution and Senior Advisor, Palantir Technologies.

**30. Ashok Wadhwa**

Group Chief Executive Officer, Ambit

**31. Naoyuki Yoshino**

Professor Emeritus, Keio University, Former Dean of the Asian Development Bank Institute

## 4. Executive Summary

The Quad Economy and Technology Task Force was conceived in 2020 to study promising areas for increased cooperation between the Quad countries of Australia, India, Japan and the United States beyond the security maritime partnership they already have established.

The onset of the Covid-19 pandemic underlined the dependencies and vulnerabilities of the Quad nations individually and as a group. It brought an urgency to developing multi-stakeholder economic and technological cooperation between Quad members, identifying areas for collaboration, and expanding and deepening a virtuous cycle of interdependence among the four democratic nations.

The Task Force includes 31 members from the four Quad countries, and is led by co-chairs Dr. Lisa Curtis, Senior Fellow and Director of the Indo-Pacific Security Program, Centre for New American Studies, Washington D.C., and Dr. Surjit Bhalla, Executive Director for India, International Monetary Fund. Gateway House, which acts as the secretariat of the Task Force, conceived and identified five study areas for the Task Force – the Pharmaceutical Sector, Critical Minerals Supply Chains, Financial Technology and Cybersecurity, Space and 6G, and Undersea Communication Cables. The Task Force was divided into five Working Groups whose members have extensive and varied expertise on the subjects. The Task Force has run for five months, beginning with its first meeting on March 23, 2021, and culminating in the final report to be released on August 23, 2021.

The Task Force found commonalities in the five study areas – in particular, the need to increase economic and technological interdependence among the Quad countries and to establish common and updated rules and standards for emerging technologies.

Supply chains received critical attention. In the area of pharmaceuticals, the Task Force recommends the speedy production, distribution and rollout of vaccines to all regions, in particular the Indo-Pacific. On the challenging issue of the waiver of Intellectual Property Rights, a pragmatic and immediate solution is to increase the use of licensing agreements. On these and the issue of standards, efforts to engage with willing partners under the Quad Plus-Plus formula must be intensified.

Since rare earths and other minerals that are critical for the future economy are available only in certain regions, supply chains for them can be strengthened by creating deep financial markets similar to those that exist for bullion and oil. The Quad nations also can create a mechanism to monitor takeovers of rare earth assets and critical mineral supply chains, especially by state-owned enterprises, which lead to monopolies and artificial shortages.

Undersea communications cables, which carry 95% of global data, is an area where the Quad has an advantage arising from its leading companies in the sector and its growing markets in countries like India. A public-private partnership to create an independent infrastructure provider for undersea cables in the Indo-Pacific region will advance the technology. Most importantly, the Quad and its partners must actively coordinate participation in international institutions like the International Telecommunications Union to influence Information and Communications Technology (ICT) standards-setting positively. A Quad Command for non-traditional maritime security threats will be beneficial in executing these plans.

A Quad Strategy for 6G technology standards must be put in place through the Quad or the D-10 grouping with a democratic ethos and transparency built into its research, development and deployment. Establishing an ICT sub-working group within the Quad's existing Critical and Emerging Technology Working group will enhance the standards-setting exercise.

Nowhere it is more important to conceptualize and coordinate common standards for the Quad than on cyber security and data protection. The four Quad nations can jointly use their significant niche capabilities in finance and technology, and their capital, to expand access of fintech in developing countries.



## 5. Findings & Recommendations

### 1. COOPERATION ON PHARMACEUTICAL SUPPLY CHAINS

In the past two decades, global health crises have dominated the global discourse. From Ebola to SARS and MERS, and now the COVID-19 pandemic, health emergencies are increasing. Crisis-related issues have overshadowed perennial concerns such as the market power of pharmaceutical companies, and the high cost of drugs. During the present pandemic, a truly collaborative response is necessary and the reaction to Covid-19 has shown the way.

#### KEY FINDINGS

The Quad nations are important players in the global pharmaceutical supply chain. Their market size and production capacity influence the worldwide trade in pharma goods. The U.S. is the biggest pharmaceutical market,<sup>1</sup> and Japan is the third largest.<sup>2</sup> India is the third largest producer of pharma products by volume.

#### 1. Market Size and Production

- **USA:** The U.S. is currently the leading pharma player globally by value of production – US\$ 500 billion, or 40% of the world market., It also is the third largest exporter, with exports valued at around US\$ 54 billion in 2019. The domestic market for pharmaceuticals in the USA is projected to grow to US\$ 675 billion by 2030. But the USA depends heavily on China for some pharmaceutical products. In 2019, for instance, items imported from China included 72.48% of first-aid boxes and kits, and 49.86% of wadding, gauze, and similar articles.
- **India:** Globally, India ranks 14th in value of production of pharmaceutical products, but 3rd in volume. The Indian pharma industry is valued at US\$ 41 billion, with the potential to triple its size to US\$ 120–130 billion by 2030. However, India, over the years, has been importing on an average 68% of its entire supply of bulk drugs and drug intermediates from China, according to data provided by the chemicals and fertilizer ministry in reply to a parliamentary question.
- **Japan:** Globally, Japan ranks third in world by value of production of pharmaceuticals, and 18th in exports, with exports reaching US\$ 6.4 billion in 2019. The Japanese pharma market is valued at US\$ 95 billion, the third largest in the world after the U.S. and China, and with an aging population, it is only expected to grow. Recently, as part of the Japanese government's effort to diversify its supply chains and reduce reliance on a single source, all companies have been given subsidies to onshore their manufacturing capabilities or move out of China.
- **Australia:** Australia holds 2% of the global pharma market, and imports more than 90% of its medicines largely from the US majors, on which it spends over US\$ 8 billion annually (US\$ 8.7 billion in 2020.) In recent years, Australia has suffered from frequent medicine shortages due to supply chain disruptions. Additionally, Australia has limited manufacturing capacity across the domestic pharma ecosystem, apart from vaccine manufacture.

---

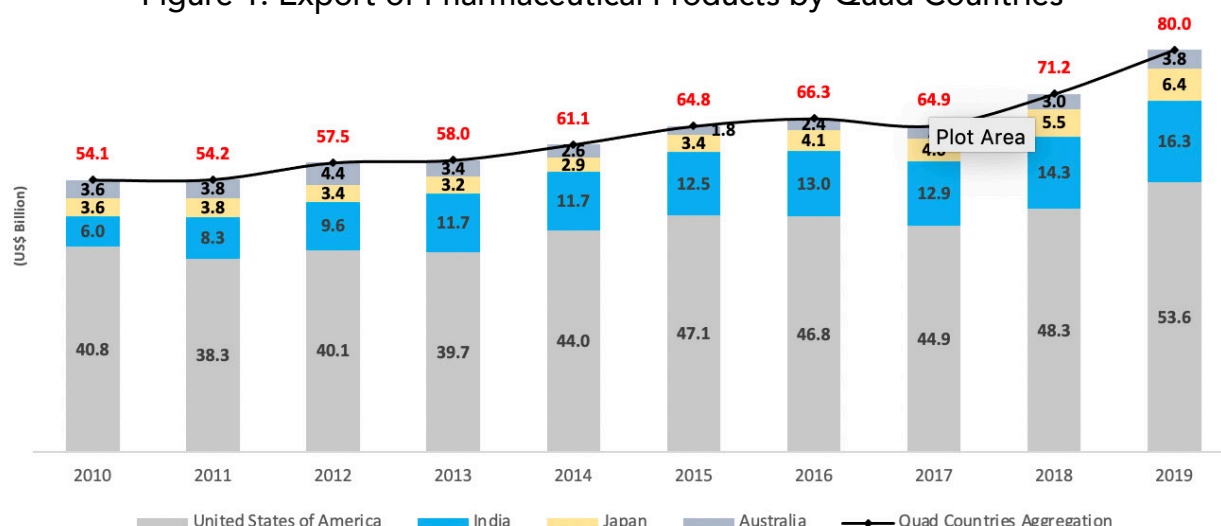
1 SelectUSA, *Biopharmaceutical Spotlight*, available at: <https://www.selectusa.gov/pharmaceutical-and-biotech-industries-united-states>

2 Eolas Biosciences, *Market Overview*, available at: <https://eolas-bio.com/market/>

## 2. Foreign Trade

- Total exports of pharmaceutical products by Quad members were recorded at US\$ 80.0 billion in 2019, accounting for about 13% of global exports of pharmaceutical products during the year, up from 12% in 2010.

Figure 1: Export of Pharmaceutical Products by Quad Countries



Source: Data accessed from ITC Trade Map, India Exim Bank Research

- Total imports by the Quad member countries, on the other hand, reached US\$ 166.4 billion in 2019, up from US\$ 88.0 billion in 2010. It may be noted that imports of pharmaceutical products by the Quad member countries represented 25% of the global imports of pharmaceutical products in 2019.
- Between 2010 and 2019, exports of pharmaceutical products by Quad member countries registered an Annual Average Growth Rate (AAGR) of 4.5%, compared to 3.8% recorded for total world exports.
- During the same period, across Quad members, the highest AAGR in exports was recorded for India (12.3%), followed by Japan (7.2%), the USA (3.2%) and Australia (3.2%).
- Collectively, between 2010 to 2019, Quad countries have been net importers of pharmaceutical products, with their trade deficit in pharmaceuticals increasing from US\$ 33.9 billion in 2010 to US\$ 86.3 billion in 2019.
- Country-wise, India was the only Quad member to consistently have a surplus in trade of pharmaceutical products. The trade surplus increased from US\$ 2.4 billion in 2010 to US\$ 13.7 billion in 2019.
- The trade deficits arising from trade in pharmaceutical products in 2019 were: US\$ 74.7 billion for the U.S., US\$ 20.8 billion for Japan, and US\$ 4.6 billion for Australia.

### 3. Drugs & Medication

- India is the largest producer of generic drugs, and the third largest producer of pharmaceutical products after the US and China, which occupy the top two positions.<sup>3</sup>
- Australia is disproportionately dependent on the U.S. and China for its drugs, 90% of which it imports.<sup>4</sup>
- Both India and the U.S. are dependent on China for Active Pharmaceutical Ingredients (APIs)<sup>5</sup> and Key Starting Materials (KSMs)<sup>6</sup>. India imports 68% of its APIs for generic-drug formulation from China.<sup>7</sup> With the advent of the COVID-19, domestic manufacturers have been taking steps to decrease this reliance and restart domestic manufacturing of these raw materials. The U.S. also is dependent on China for more than 90% of its antibiotics, and on India and China for 75% of its APIs.<sup>8</sup> The U.S. is dependent on India for other generic medicines too. The United States has identified this dependency in its 100-day review of President Biden's Executive Order 14017 on American Supply Chains and is looking for ways to reduce such reliance.<sup>9</sup>
- Chinese APIs are 35%-40% cheaper than Indian APIs,<sup>10</sup> making a switch commercially challenging. As countries, especially Quad nations come out with their own economic and industrial policies to kickstart their economies, a discussion on coordination, perhaps on the lines of Japan's subsidies programme,<sup>11</sup> would be timely.

### 4. Vaccines

- The goal of vaccinating 60-70% of the world's population against Covid-19 by the end of the year is still distant, eight months since the first vaccine was successfully developed. As of 30 June 2021, 3 billion vaccine doses have been administered globally; and an estimated 1.5 billion have been bought and stockpiled by the advanced countries. This demands a greater political resolve and a more generous response globally.
- The Quad countries are significant contributors to the COVAX initiative set up by GAVI, the WHO, and the Gates Foundation. Indian and American companies will manufacture the vaccines, while the U.S. and Japan have committed funding and Australia, its logistics and distribution capabilities.<sup>12</sup> In total, the Quad has pledged 1 billion vaccine doses for distribution to the Indo-Pacific by the end of 2022.

---

3 Indian Brand Equity Foundation, Indian Pharmaceutical Industry, available at: <https://www.ibef.org/industry/pharmaceutical-india.aspx>

4 Institute for Integrated Economic Research Australia, Australia's Medical Supply Chain, February 2020, available at: <https://defense.info/wp-content/uploads/2020/02/Australias-Medical-Supply-Chain.pdf>

5 Substances or combination of substances used in a finished pharmaceutical product (FPP), intended to furnish pharmacological activity or to otherwise have direct effect in the diagnosis, cure, mitigation, treatment or prevention of disease, or to have direct effect in restoring, correcting or modifying physiological functions in human beings

6 Intermediaries used in the process of manufacturing drugs. They are the building blocks on which drugs are made, though they may not in themselves be of therapeutic value, and their usage is critical in the manufacturing process

7 Gateway House Discussion with Experts

8 Doug Palmer and Fenbarr Bermingham, U.S. policymakers worry about China 'weaponizing' drug exports, Politico, 20 December 2019, <https://www.politico.com/news/2019/12/20/policymakers-worry-china-drug-exports-088126>

9 The White House, Building Resilient Supply Chains, Revitalizing American Manufacturing, And Fostering Broad-Based Growth, 100-Day Reviews under Executive Order 14017, June 2021, available at: <https://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf>

10 Gateway House Discussions with Industry Experts

11 See for more details: Japan External Trade Organization, Incentive Programmes, available at: [https://www.jetro.go.jp/en/invest/support\\_programs/incentive/](https://www.jetro.go.jp/en/invest/support_programs/incentive/)

12 COVAX Initiative, World Health Organization, available at: <https://www.who.int/initiatives/act-accelerator/covax>

- The global production, distribution and roll out of vaccines has been slow, and the speed of mutation of Covid-19 has posed a new and complex challenge. China's announcement in June that it has administered more than a billion doses of its vaccines to its people has added urgency to the Quad governments' commitments, implementation of which is yet to begin.
- G7 governments in June committed to produce 1 billion vaccine doses (inclusive of 500 million Pfizer doses by the U.S.) for distribution to developing countries. Overall, the G7 will distribute 2 billion doses of vaccine. Europe is now the largest exporter of Covid-19 vaccines.
- The U.S. will make available 80 million doses to its partner countries in the developing world such as Afghanistan, Brazil, Peru, India, Thailand, the African Union, Georgia, Oman, Kosovo, and the Caribbean. Of this, 75% will be distributed through the COVAX facility, and 25% through bilateral channels.<sup>13</sup>
  - India, which has the largest vaccine manufacturing capability in the world, produces 60% of the world's vaccines,<sup>14</sup> and has committed to manufacture the vaccines promised by the Quad Vaccine Working Group.
  - India exported 60 million vaccine doses under its Vaccine Maitri (friendship) programme from January-April 2021 but it suspended the programme due to the serious second wave of the virus. Its capacity is currently strained, even for production at home, so India is importing vaccines. It will resume vaccine supply to its neighbours in South Asia by July/August 2021.
  - While vaccines are being manufactured, some innovations have been made to fill in the gap. In May 2021, India's Defence Research and Development Organisation, in collaboration with Dr Reddy's Laboratories developed a drug called "2DG," which has shown promise in reducing Covid-19 mortality rates in India.<sup>15</sup>
  - Researchers at Griffiths University in Queensland, Australia too have developed a medicine that can kill 99.9% of the Covid virus. Subject to further trials and approvals, it is expected to be commercially available by 2023.<sup>16</sup>

## 5. Medical Devices & Equipment

- The world has long been dependent on China for medical diagnostic kits, personal protective equipment, gloves and other such equipment that became necessary for pandemic response.
- The U.S. is now the world's largest producer and market for all medical devices. India, Australia and Japan are all importers. India's Production Linked Incentive Scheme for medical devices, Japan's subsidy scheme for relocation of industries and supply chains and Australia's new Modern Manufacturing Strategy, aim to build domestic resilience and reduce dependence on China.<sup>17</sup>

---

13 White House Statements and Releases, FACT SHEET: Biden-Harris Administration Announces Allocation Plan for 55 Million Doses to be Shared Globally, 21 June 2021, available at: <https://www.whitehouse.gov/briefing-room/statements-releases/2021/06/21/fact-sheet-biden-harris-administration-announces-allocation-plan-for-55-million-doses-to-be-shared-globally/>

14 Invest India, Pharmaceuticals available at: <https://www.investindia.gov.in/sector/pharmaceuticals>

15 DCGI approves anti-COVID drug developed by DRDO for emergency use, Press Information Bureau, 8 May 2021, available at: <https://pib.gov.in/PressReleasePage.aspx?PRID=1717007>

16 Deborah Marshall, Researchers develop direct-acting antiviral therapy to treat COVID-19, Griffith News, May 17, 2021 available at: <https://news.griffith.edu.au/2021/05/17/researchers-develop-direct-acting-antiviral-to-treat-covid-19/>

17 Operational Guidelines, Production Linked Incentive Scheme for Pharmaceuticals, Department of Chemicals, available at: [https://pharmaceuticals.gov.in/sites/default/files/Operational%20Guidelines%20of%20PLI%20scheme%20for%20Pharmaceuticals\\_0.pdf](https://pharmaceuticals.gov.in/sites/default/files/Operational%20Guidelines%20of%20PLI%20scheme%20for%20Pharmaceuticals_0.pdf); Government of Australia, Modern Manufacturing Strategy, available at: <https://www.industry.gov.au/data-and-publications/make-it-happen-the-australian-governments-modern-manufacturing-strategy/our-modern-manufacturing-strategy#:~:text=The%20Modern%20Manufacturing%20Strategy%20is,for%20now%20and%20future%20generations.>

## 6. Supply Chains

- Besides being overly dependent on China for medical supplies, the Quad nations are significantly interdependent. The US is dependent on India for generics, Australia relies on the U.S. for antibiotics, and the U.S. is the market leader in medical devices. The Working Group preferred to expand this virtuous interdependence.
- Supply chain interdependences have created challenges in the past. Indian companies are dependent on U.S. manufacturers for filters and bioprocessing bags for vaccine manufacturing. They faced severe shortages when the U.S. invoked its Defence Production Act to increase domestic supplies of medical items to fight Covid.<sup>18</sup> Restrictions on exports as a result of the DPA are now being relaxed. Further action is suggested includes:
  - The US should ramp up production and, if appropriate, license to India and countries closer to US shores technology involved in manufacturing filters and bioprocessing bags in ways that are likely to require little or no retrofitting of manufacturing facilities.
  - India might be able to scale up manufacturing in order to act as an alternative to China for importers of the filters and bags.
  - India, Japan and Australia formally launched the Supply Chain Resilience Initiative (SCRI) in April 2021.<sup>19</sup> This seeks to create a virtuous supply chain that is sustainable.

## 7. Research & Development

- The U.S. is currently the leader in developing cutting-edge pharmaceutical technologies and systems, innovation. Its R&D expenditures in the sector totalled an estimated \$102 billion in 2019. A strong IP protection regime ensures continued strong R&D spending.<sup>20</sup>
- India gained a foothold in the world market with reverse-engineered generic drugs and APIs. Now, it aims to be the global hub of manufacturing and R&D in pharma as well as a major player in outsourced clinical research.
- In fiscal 2019, Japanese pharma companies stepped up, spending \$14 billion on R&D – an amount equal to 16% percent of the industry's total sales.<sup>21</sup>
- Australia's total annual R&D spending in 2020 was \$922 million. The federal government's 2020-21 budget boosted it by \$2 billion for additional R&D incentives, in part to support development of domestic pharma manufacturing.<sup>22</sup>

---

18 Explained Desk, Explained: The US Defense Production Act, invoked to lift ventilator production, The Indian Express, March 30, 2020, available at: <https://indianexpress.com/article/explained/explained-us-defense-production-act-ventilator-production-coronavirus-6336374/>

19 Australia-India-Japan Trade Ministers' Joint Statement on Launch of Supply Chain Resilience initiative, Press Information Bureau, 27 April 2021, available at: <https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1714362>

20 <https://www.phrma.org/en/Advocacy/Research-Development>

21 Eolas Biosciences, Market Overview, available at: <https://eolas-bio.com/market/>

22 Australian research gets billion-dollar boost in sweeping stimulus budget, Smriti Mallapaty, Nature, available at: <https://www.nature.com/articles/d41586-020-02835-y>



- There is collaboration among Quad countries. For example, The Australia-India Strategic Research Fund has been in place since 2006, promoting collaboration between scientists in the two countries.<sup>23</sup> The latest grant round has prioritized collaborative research projects focused on contributing to the global response to the COVID-19 pandemic. Among earlier instances of collaboration, one that stands out is India's participation in the U.S. President's Emergency Plan for AIDS Relief (PEPFAR).<sup>24</sup>

## 8. Rules, Regulations & Standards

- The inequality in vaccine distribution, access and manufacturing capabilities has led to proposals to reassess Intellectual Property (IP) rules affecting emergency response. India and South Africa introduced a proposal at the World Trade Organisation (WTO) in October 2020 to waive intellectual property rights to speed up COVID vaccine production.<sup>25</sup> The U.S. and the European Parliament have now agreed to back the proposal and pursue negotiations, but other developed nations, including Switzerland and Japan, are resisting the idea. A revised proposal submitted in May 2021, would establish such a waiver for at least three years.<sup>26</sup> While IP protection has fostered innovation and the rapid development of vaccines, a contrarian view suggests that it would remain a roadblock to a truly global and equal recovery from the pandemic.
- The Working Group discussed the view that waiving IP rights is about politics and optics, and would not necessarily enhance vaccine production. Even if IP protection were waived, enhancement would require significant financial outlays to build new facilities and fund new entrants. What is required is speeding up vaccine production in existing facilities. The Working Group also heard the alternative view that IP rights waiver would be desirable for speeding up the production of vaccines and their distribution.
- International institutions have been slow or unable to respond to the pandemic. The World Health Organisation has been criticised at the World Health Assembly by many nations for being deferential to the People's Republic of China, stopping short of holding it responsible for the pandemic. The WHO's International Health Regulations have failed to meet the organization's stated aims of a swift response to emergencies. The Security Council failed to come up with a coordinated response, with any discussion or concrete solutions blocked by China.

---

23 Collaborating with India on Science and Research, Australian Government, Department of Industry, Science, Energy and Resources, India Australia Strategic Research Fund, available at: <https://www.industry.gov.au/funding-and-incentives/collaborating-with-india-on-science-and-research>

24 India US Collaboration on PEPFAR, available at: <https://in.usembassy.gov/embassy-consulates/new-delhi/sections-offices/pepfar/>

25 Waiver From Certain Provisions Of The Trips Agreement For The Prevention, Containment And Treatment Of Covid-19, Communication From India And South Africa, 2 October 2020, available at: <https://docs.wto.org/dol2fe/Pages/SS/directdoc.aspx?filename=q:/IP/C/W669.pdf&Open=True>

26 Proposal for a TRIPS waiver from intellectual property protections for COVID-19-related medicines, vaccines, diagnostics and other health technologies, Medecins Sans Frontiers, [https://msfaccess.org/sites/default/files/2021-05/COVID\\_TechBrief\\_MSF\\_AC\\_IP\\_TRIPSWaiverQ%26A\\_ENG\\_27May2021-2.pdf](https://msfaccess.org/sites/default/files/2021-05/COVID_TechBrief_MSF_AC_IP_TRIPSWaiverQ%26A_ENG_27May2021-2.pdf)



## RECOMMENDATIONS

### 1. Short Term (1-2 Years)

#### 1. Broad Policy Guidelines to the Quad governments

- a. **Reduce excessive dependence on China** for materials like Active Pharmaceutical Ingredients (APIs), Key Starting Materials (KSMs), Personal Protective Equipment (PPE), Oxygen producing equipment, and other similar goods. This can be done by the three-pronged approach of onshoring, near-shoring, or ally-shoring of manufacturing and production capacity in the Quad countries.
- b. **Develop a virtuous cycle of interdependence through coordinated government programmes** among the four member countries to insulate them from dependence on China for raw materials, vaccines and medicines. The Quad countries can coordinate their subsidies programmes or incentive schemes to create a sustainable and robust pharmaceutical manufacturing ecosystem. Inspiration can be taken from the subsidies given by the Japanese government, or India's Production-linked Incentive scheme. Discussions on a coordinated pharma industrial manufacturing policy should also take place on a ministerial and leadership level.
- c. **Strengthen supply chain resilience systematically**, comprehensively, and in a planned manner. Increased digitalisation can strengthen the pharma supply chain with continuous monitoring, predictive maintenance and remote automation. This will enhance productivity and reduce costs.

2. **Supply Chain Resilience Initiative:** This India-Australia-Japan initiative's progress should be expedited through digital technology and trade and investment promotion. Governments must involve representatives of the pharma industry. The US should be invited as an observer, if not a full member eventually. Ideally, it should evolve into a Quad SCRI.

3. **A Quad Emergency Response Mechanism** may be devised with 24-hour monitoring operations centres in each of the four Quad countries, a sophisticated capacity to monitor the spread of pandemics, foster coordination amongst disease control agencies, and oversee stockpiling of drugs and other tools so that governments can respond quickly and effectively to emergencies in the Indo-Pacific region and elsewhere. This can be modelled on the humanitarian assistance and disaster-response mechanisms developed during the Quad's coordinated action during the 2004 Indian Ocean tsunami.

4. **A Strategic Research Fund** for R&D cooperation. Based on the experience of the Australia-India Strategic Research Fund and other similar schemes, an R&D partnership will allow the Quad to pool resources and create common solutions to problems in the pharma sector. It could possibly provide funding for R&D such as envisioned by the Indian Government, which plans to set up three bulk-drug parks to carry out research and manufacturing of APIs at a cost of Rs. 143 billion. Such local initiatives can be the starting point for collaboration between the Quad countries. Quad countries should work together to streamline their research funding and grants to enhance cooperation. A thorough study of existing collaborations to see how they should be improved and coordinated may be conducted. A Quad Strategic Research Fund may be considered to address needs of the member countries.

5. **A Streamlined approach to vaccine rollout is needed**, first within the Quad countries, based on lessons from the U.S. and the successful model adopted by Israel, with involvement of local authorities. Logistics in India need special attention, given its criticality in the world's fight against Covid. The Quad as a group can subsequently support vaccination around the world, including through the COVAX initiative.

## 6. Expansion of the Quad's footprint

- Energetic, imaginative, and pro-active vaccine diplomacy is necessary, with special attention paid to branding and publicity to counter China's influence.
- Potential collaborators such as Thailand, Malaysia, Indonesia, Philippines, Bangladesh, Israel, and Taiwan can be engaged bilaterally or trilaterally, or in the Quad Plus format, which already includes Vietnam, New Zealand, and the Republic of Korea.
- Quad governments can consider encouraging or forging technical and financial collaboration under the Quad Plus Plus format, with select European countries such as the UK, the Netherlands, Germany and France. They also face excessive dependency on China for pharmaceutical raw materials and intermediate goods, and can help create a virtuous cycle of interdependence among democratic nations.

7. **A Quad Pharma Cooperation Plan for Africa and Other Areas** may be devised and announced as soon as possible in consonance with each of the four Quad countries' relationships with African countries. An expansive and inclusive approach should be followed. The Quad's role in the pharma sector also can be expanded to other regions like West Asia, Central Asia, and South America.

## 2. Medium Term (3-5 Years)

1. **Diversity of Standards and Regulations** among the Quad countries is a major barrier to cooperation. A vigorous effort is needed, in partnership with industry, to identify how these can be synchronised in a planned way. Differing regulatory practices create barriers to entry, while IP regimes close the door to universal medicines and technology. Negotiating common standards across the four Quad countries will ensure freer movement of drugs, vaccines, and equipment.
2. **A Limited Pharma Trade Deal** is desirable to eliminate existing barriers within the Quad nations. India in particular needs deeper deregulation to enable its industry to compete globally, especially vis-à-vis China. Export restrictions on raw materials for vaccines imposed by the U.S. must be addressed given their impact on the ability of others to develop vaccine resilience.
3. **The Issue of IP Rights Waivers** needs to be resolved pragmatically, given divergent views within the Working Group. The subject is being debated and negotiated and will be resolved at the WTO. A consensus view in the Working Group was that while discussions continue at WTO, licensing is the best way to move forward immediately.

## 2. COOPERATION ON CRITICAL MINERAL SUPPLY CHAINS

The global energy sector is witnessing a shift towards renewable energy, while electric vehicles are gaining ground over the internal combustion engine. The optimism surrounding these industries can be seen in the market value of Tesla, an electric-car maker worth more than the world's five largest automakers combined.

However, emerging technologies are dependent on certain minerals – lithium, rare earths, cobalt and nickel. The batteries used by electric vehicles as well as cell phones, tablets and laptops require lithium and cobalt in large quantities. Electric motors and wind turbines require powerful magnets made from rare earth minerals.

Some of the critical mineral supply chains are dominated by a single country – for instance, the Democratic Republic of Congo is the world's primary supplier of cobalt and rare earths, while China dominates in gallium and polysilicon production. Overdependence on a single country for any critical mineral is a worldwide concern. The Quad Working Group on Critical Minerals was formed to study these supply chains, identify vulnerabilities and steps that can be taken to resolve them.

The Working Group considered two groups of minerals that are important for new industries:

1. Minerals used in batteries: Lithium, Cobalt, Nickel
2. Minerals used in magnets: Rare Earth Elements (specifically NdFeB magnets)

The Working Group has focused on Cobalt, an element used in batteries, because it reflects most of the issues of supply chain vulnerability and their mitigation.

### KEY FINDINGS

#### 1. Concentration of Supply Chains

Nearly two-third of global cobalt production and more than half of reserves are in the Democratic Republic of Congo (Table 1). Cobalt must be smelted for use, and 40% of worldwide smelting capacity is in China (Table 2). New smelters are currently being built in Canada and Chile.

Table 1: Trends in Cobalt Production (thousand tonnes)

Country	2015	2016	2017	2018	2019	Reserves
Democratic Republic of Congo	84.4	69.0	90.3	109.4	78.0	3,600
Russia	6.2	5.5	5.9	6.1	6.1	250
Australia	6.0	5.5	5.8	4.9	5.1	1,200
Philippines	4.3	4.1	4.6	4.4	4.6	260
Rest of the World	35.5	35.0	31.2	29.8	28.0	1,443

Source: BP Statistical Review of World Energy, 2020

Table 2: Cobalt Refinery Production (2016) (tonnes)

Country	Production	Share%
China	45,046	46%
Finland	12,393	12.6%
Belgium	6,329	6.6%
Zambia	4,725	4.8%
Japan	4,305	4.4%
<b>TOTAL</b>	<b>98,000</b>	

*Source: JRC, Cobalt: demand-supply balances in the transition to electric mobility*

## 2. Small Size of Industry

While cobalt is critical for the battery industry, global cobalt production is small, just 121,000 tonnes in 2019, with an industry size of an estimated \$6-7 billion. This is trivial compared with industries that produce metals such as steel and copper, which are worth hundreds of billions of dollars. Some of the companies involved in cobalt production and investment such as First Cobalt, Canada Silver Cobalt and Nickel28 have market values of less than \$100 million. Small market size means global mining majors are less interested, and state support is more important.

## 3. Availability

Cobalt is usually found in combination with other minerals like copper and nickel and occasionally silver. It is produced as a by-product. However, not all copper and nickel mines have cobalt as a by-product. In volume and revenue, cobalt is a relatively minor product for the copper/nickel companies.

## 4. High Capital Expenditures

Based on publicly available figures from two projects (Capstone/Chile<sup>27</sup>, Horizonte/Brazil<sup>28</sup>), adding cobalt separation to copper mines increases the costs significantly. This suggests that the capital expenditure (capex) required to separate cobalt from copper is high relative to its output, resulting in longer payback periods. As a result, companies try to tie up revenue by selling rights to the cobalt stream to other investors (Vale/Voisey's Bay Mine, Canada)<sup>29</sup>. New projects to refine/smelt cobalt are currently coming up in Canada and Chile as secondary production from copper mines.

## 5. Futuristic Supply Source - Deep Sea

Cobalt is also found in small concentrations in polymetallic nodules in the seabed at depths of 4,500-6,000 meters in the Clarion-Clipperton Zone in the Pacific Ocean and the Central Indian Ocean Basin. However, production of this metal is not technically or financially feasible. At best, this is a resource for the future.

27 2020 Santo Domingo Conference, available at: [https://s25.q4cdn.com/701614211/files/doc\\_downloads/BMO-2020-Conference-Santo-Domingo-43-101-Update.pdf](https://s25.q4cdn.com/701614211/files/doc_downloads/BMO-2020-Conference-Santo-Domingo-43-101-Update.pdf)

28 Horizon Mineral Annual Report 2020 available at: [https://horizonteminerals.com/news/en\\_20210421-2020-annual-report.pdf](https://horizonteminerals.com/news/en_20210421-2020-annual-report.pdf)

29 [https://www.sec.gov/Archives/edgar/data/917851/000110465918039516/a18-15200\\_16k.htm](https://www.sec.gov/Archives/edgar/data/917851/000110465918039516/a18-15200_16k.htm)

## 6. Recycling Possible

Cobalt can be recycled. However, given the expected growth in demand (projected demand in 2030 is more than thrice that of 2020), most of the supply will have to come from new production.

## 7. Lithium

Based on the data studied by the Working Group, lithium is less susceptible to shocks and disruptions in the supply chain than other metals and minerals.

## RECOMMENDATIONS

- 1. More Information:** A regular and credible source of information is needed for minerals required for clean energy and electric vehicles. The Oil Market Report, a monthly publication on developments in the oil market, published by the International Energy Agency since the 1973 oil shocks, could serve as a model. The IEA also issues occasional reports addressing changes in energy markets brought about by technology, new discoveries and other developments. Such information is not currently available for the new energy minerals. This gap must be addressed, perhaps via a dedicated IEA-like body.
- 2. Deeper Financial Markets:** Mining projects have a long lead time (4-5 years in some cases) and the life of the mine may be 20-25 years. In the oil, gold and silver industries, producers can sell contracts in the futures market, and thus lock in future revenues; silver contracts can be traded up to December 2025, for instance, while oil contracts are available beyond 2030. Having such deep financial markets in these commodities like cobalt will be helpful.
- 3. More investment firms like Nickel28:** These are necessary to provide liquidity to mining companies for which low-volume minerals like cobalt will be a minor by-product. Large companies will not find such investments profitable, so Quad governments need to provide incentives to attract speculators. The US and Australia already are working on this to encourage rare-earth mining.
- 4. Invest in a cleaner supply chain for critical minerals:** Governments and industry must address the seeming contradiction between producing clean energy from dirty metals. The mining industry has raised severe environmental concerns, allegations of labour rights violations, and complaints about poor mining practices. While lax processes hastened growth, these issues must be addressed so that the supply chain can be made more sustainable and resilient. Quad countries can work together on a cleaner extraction and processing policy not only in their own nations, but also in countries from where they extract such critical minerals, leading to long term sustainable growth.
- 5. Monitoring takeovers:** Some governments (U.S., Canada and Australia) have introduced restrictions on acquisitions by state-owned enterprises in the past. The global cobalt supply chain also needs to be given similar protection.
- 6. Increased R&D in deep-sea mining:** This is already being done by different governments and may provide a base that can later attract private firms. But the risks must be kept in mind. The seabed is a largely untapped resource, with much of it still to be studied. The Quad countries can come together to create deep sea mining standards that take into account the environmental impacts of such actions while taking advantage of the riches of the seabed.
- 7. Recycling and Replacement:** This already is being done for cobalt, but will have to be introduced for the other minerals as well. As demand stabilizes, it will gain in importance. The Quad countries can pool their research capabilities to improve battery technologies and manufacturing in a manner that reduce the use of and dependency on cobalt and nickel.

### 3. COOPERATION ON FINTECH & CYBERSECURITY

In recent years, mobile phone-based fintech and digital payment apps have revolutionised finance and payments, and are increasingly competitive with legacy financial entities such as banks. The COVID-19 pandemic has further spurred the use of mobile wallets and other digital payment services.

Constant innovation in the fintech industry has offered enormous opportunities for people, businesses and governments. It has accelerated financial inclusion, reduced corruption, ensured greater access to lending and better money management for individuals and micro-businesses. But it also has created risks and challenges. Globally, cybersecurity threats have expanded in recent years, with increasing instances of cybercrime, unauthorised transactions, ransomware attacks and data breaches.

The Working Group on Fintech and Cybersecurity examined how the Quad countries can cooperate on fintech and cybersecurity, amongst themselves and in the Indo-Pacific region. The underlying premise was that strengthened fintech and cyber capacity can help the developed world and developing regions like the Indo-Pacific. The Quad has the financial heft, talent and markets to achieve these goals.

#### KEY FINDINGS

##### 1. China's Progress in the Financial Sphere

- In the last decade, China has made tremendous progress in new financial technologies and innovation. It has excelled in moving credit from physical collateral to informational collateral.
- This progress rests on three pillars: a) Software dominance (Alipay/WeChat payments interface); b) Hardware dominance (Made in China 2025 and 5G dominance); and c) Capital & tech acquisition (Tencent/Ant Financial/China Investment Corporation).
- This ecosystem caters to Chinese citizens and diaspora. But if executed well, it can be extended to other countries in the Indo-Pacific to integrate them in the Chinese financial ecosystem.

##### 2. Development & Progress of IndiaStack

- IndiaStack is an open-source set of modular, interoperable building blocks used with a biometric identity (Aadhaar) and connected to bank accounts. It enables digital payments, government subsidies. The cashless payment layer of IndiaStack has enabled innovations such as the revolutionary Unified Payments Interface (UPI) – a real-time payment system that today averages 2 billion transactions per month. Other innovations like the Data Empowerment and Protection Architecture (DEPA) requires service providers such as insurance companies, lending firms and banks to obtain consumers' permission before using their data for secondary business activities – a protection often lacking in the digital economy. Through DEPA, India is trying to bring consensual data use to a scalable level.
- During the pandemic, this tool has been tested across India's vast, diverse population on a continental scale with food rations for migrant workers and a national vaccination programme.
- DEPA has attracted serious interest from Japan and Australia as both explore opportunities to deliver credit through bank, fintech and public infrastructure.



- An improved identity layer of the IndiaStack is a modular and open-source identity platform, better known as MOSIP or Aadhaar Version 2.0, which can help governments implement a digital, foundational ID in a cost-effective manner.<sup>30</sup> Such a framework could prove useful to developing countries. India and Japan have discussed the possibility of implementing MOSIP in third countries like Morocco, Sri Lanka and the Philippines.

### 3. Regulatory Risks & Challenges to Fintech

- As fintech has expanded, so have regulations. Instead of consolidation and interoperability, there is growing fragmentation of regulations and technical standards across different countries. Poorly designed or inconsistent regulations and differing standards can constrain innovation and derail fintech. It can also amplify cyber threats.
- It is necessary to establish uniform principles such as integrity, accountability, transparency, and privacy and security.
- India's financial orientation is defined by two guiding principles: almost-zero cost transactions and strict exchange controls. India exercises strict control over its capital account convertibility. This is out of sync with other central banks' open capital accounts, including the Quad countries. It has implications for fintech collaboration: Any Quad fintech initiative based on particular national currencies can have only limited interoperability. Such initiatives may be attempted for B2B transactions, but not B2C or C2C models.

### 4. Crypto Assets

- China has unveiled an ambitious plan for a digital Yuan and a central bank digital currency (CBDC). Despite the regulatory push, the digital Yuan hasn't taken off. Nonetheless, China's initiatives on digital currency are expected to drive other countries' CBDC initiatives.
- Private digital currencies are also proliferating. These are essentially financial assets, rather than currencies.
- Crypto assets are popular because their decentralised nature allows users to operate free of supervision by centralised, government regulators. They have been used for many innovations in the financial sector, such as peer-to-peer lending, crowd-funding and streamlined migrant remittances.<sup>31</sup>
- Some investors use private digital currencies for speculation and hedging. In many countries, criminals utilise these currencies for illegal transactions on digital black markets and ransom payments. For instance, during the ransomware attack on its pipeline in May 2021, Colonial Pipeline of the U.S. paid \$4.4 million ransomware in bitcoins to the Darkside criminal syndicate.
- Greater use of the CBDCs will require that consumers be confident that they provide the necessary protections for in-person and online transactions, interoperate seamlessly across payment types and take advantage of the capacity for existing network to facilitate broad and frictionless merchant acceptance.

---

30 "About MOSIP?" MOSIP, <https://www.mosip.io/about.php>. Identity platform is a service used by organisations to manage use of and access to citizen/user/customer identity details for various purposes. Foundational IDs are national ID systems such as population registers and national ID cards which can be used as a proof of legal identity. Both are useful tools for developing countries as they develop their national ID programmes based on digital technology.

31 Flore, Massimo, "How Blockchain-Based Technology Is Disrupting Migrants' Remittances: A Preliminary Assessment", Publications Office of the European Union, 2018, <https://core.ac.uk/download/pdf/186490943.pdf>

Table 3: Current state of CBDC in Quad countries

COUNTRY	CBDC Position
U.S.	The Federal Reserve is exploring issuing a digital dollar. No official plans announced for next steps.
Japan	The Bank of Japan is running a proof-of-concept study on CBDC feasibility.
Australia	Initially explored CBDC a few years ago but concluded that it wouldn't provide enough incremental value to proceed. May consider looking into CBDC in the future.
India	Exploring options to introduce a CBDC. It will soon introduce a Cryptocurrency and Regulation of Official Digital Currency Bill, 2021 in the Parliament.

Source: GatewayHouse Research

## 5. Cybersecurity

- Cybersecurity threats to financial systems are steadily expanding. Adversarial nation-states are engaging in debilitating attacks against critical financial infrastructure. Many countries use proxies to engage in cybercrime for profit.
- Global costs of cybercrime now total over \$1 trillion since 2018 – just more than 1% of global GDP.<sup>32</sup> Growing cyber threats can threaten the security of digital payment systems and could erode consumer trust and impede the acceptance of fintech-based products.
- India is currently one of the fastest growing fintech markets globally, but it also the weakest link in the Quad's cybersecurity. India's centralised storage of the Aadhaar database can act as a honeypot, enticing cybercriminals and hackers.
- While the Quad countries have shared cyber threat perceptions, significant differences remain. Data localisation is one such issue. India has mandated payment companies to store transaction-related data in India. A key reason was the Indian government encountered repeated difficulties in accessing cybercrime-related data stored on servers abroad. Varying legal practices further complicated the problem, despite the existence of Mutual Legal Assistance Treaties. India's preference for data localisation runs contrary to other Quad countries' preference for free flow of data – as expressed through their support for the Osaka Track for global data governance at the G20 Summit in 2019.<sup>33</sup>
- Currently, there is no adequately enforced global mechanism to detect cyberattacks and assess cyber and privacy risks to financial systems. There are several financial guidelines like the Basel norms set by the Bank for International Settlements and standards set by the Financial Stability Board (FSB) that protect the international financial system, yet comprehensive international coordination on cybersecurity has not yet materialised – a lack that is hurting the Quad countries since they are some of the world's leading digital economies.
- A core element of cybersecurity is the security of digital infrastructure based on reliable hardware. The Quad and other countries have national security and espionage concerns vis-à-vis Chinese hardware, which dominate the global market. Yet very few cost-effective and viable alternatives exist for these countries.

32 Zhanna Malekos Smith, Eugenia Lostri and James A. Lewis, "The Hidden Costs of Cybercrime", CSIS-McAfee, December 2020, <https://www.mcafee.com/enterprise/en-us/assets/reports/rp-hidden-costs-of-cybercrime.pdf>

33 Ambika Khanna, "Decoding data localisation", Gateway House, 4 July 2019, <https://www.gatewayhouse.in/data-localisation/>

Table 4: Bilateral cyber cooperation among Quad countries

<b>India-U.S.</b>	<ul style="list-style-type: none"> <li>• 2016: Framework for the U.S.-India Cyber Relationship</li> <li>• 2016: United States-India Cyber Dialogue</li> </ul>
<b>India-Australia</b>	<ul style="list-style-type: none"> <li>• 2020: Framework Arrangement on Cyber and Cyber-Enabled Critical Technologies Cooperation</li> <li>• India-Australia cyber policy dialogue</li> </ul>
<b>India-Japan</b>	<ul style="list-style-type: none"> <li>• 2020: Cybersecurity agreement with focus on 5G technology and critical information infrastructure</li> </ul>
<b>U.S.-Japan</b>	<ul style="list-style-type: none"> <li>• Cybersecurity cooperation covered under existing mutual security treaty</li> </ul>
<b>Australia-Japan</b>	<ul style="list-style-type: none"> <li>• Australia-Japan Cyber Policy Dialogue</li> </ul>
<b>Australia-U.S.</b>	<ul style="list-style-type: none"> <li>• 2020: Cyber training Capabilities Project Arrangement</li> </ul>

Source: Gateway House Research

## RECOMMENDATIONS

The Quad can enable policies, principles, standards and benchmarks to create a trusted and cyber secured ecosystem of fintech that other countries can adopt too.

- 1. Identify common data protection standards:** To ensure security and privacy and enable future interoperability, the Quad can conceptualise common data- protection standards, especially at the Bank for International Settlements in Basel and the South East Asian Central Banks Centre in Kuala Lumpur. These fora can be used to create a new standards ecosystem which must be anchored in the principles of transparency, security, accountability, individual control and rights, integrity, and data minimisation. A sinking fund to support and help countries adopt common data standards and reporting practices can be a start; such a fund also could give traction to promising initiatives like India's DEPA.
- 2. Push technology in the "West" of the Indo-Pacific:** Fintech-based digital payment systems are under-developed in Africa, but potentially can provide a low-cost, high-impact banking model that leap-frogs legacy banking structures. The Quad countries can offer their technological expertise and India's MOSIP model.
- 3. Encourage wider accession (including by India) to the Budapest Convention on Cybercrime:** The 2001 Budapest Convention is the most robust and mature international mechanism to address cybercrime, including by allowing lawful access to data stored outside a country's jurisdiction. All the Quad countries except India are among the 67 signatories.<sup>34</sup> Working through its reservations about data jurisdiction will enable India to accede to the Budapest Convention and join hands with the other three Quad countries to encourage more countries to accede to the convention. This will facilitate cross-border investigations in cybercrimes.

<sup>34</sup> India was not part of the drafting process for the Budapest Convention. India has generally opposed treaties that have been drafted without its consultation. Therefore, India, along with China and Brazil, has argued that the Convention remains a treaty drafted by Europe, reflecting its priorities. India is also particularly opposed to the Clause 32 (b) of the Convention which talks about "trans-border access to stored computer data with consent or where publicly available" and specifically states that a party may, without the authorisation of another party, "access or receive, through a computer system in its territory, stored computer data located in another Party, if the Party obtains the lawful and voluntary consent of the person who has the lawful authority to disclose the data to the Party through that computer system." India perceives this clause as discriminatory and inimical to its sovereignty.

4. **Utilise financial means to encourage non-Chinese hardware:** Cost considerations are important, but security concerns will ultimately prevail in addressing the use of Chinese hardware and systems. To ensure that the countries make the right choice, the Quad can consider using its financial and market might to promote usage of the best available non-Chinese hardware.
5. **Stress-test the resilience of the digital and financial infrastructure:** Resilience of the financial sector is essential. Regular stress-tests are necessary to assess the ability of computer networks and payment systems to handle cyberattacks or incidents. Just like military exercises, the Quad countries can undertake joint exercises similar to military exercises to simulate a sustained targeting of the financial sector. This will help them develop a response to persistent, offensive cyber operations and data breaches and identify areas requiring capacity strengthening.

## 4. COOPERATION ON SPACE & 6G

Information Communications Technology (ICT), the backbone of the digital economy, is fast evolving globally. The developing economies, home to large and densely-settled human populations – and therefore massive markets – are becoming increasingly connected. A recent study estimates 59.5% of the total global population are internet users. Between January 2020 and January 2021, when most of the world was reeling under the economic impact of COVID-19, the number of internet users increased 316 million, a 7.3% growth rate.<sup>35</sup>

Growing ICT networks and ensuring internet penetration has become national policy for both developing and developed economies. They seek to raise their stakes in the global digital economy, estimated to hit \$23 trillion by 2025 – more than twice the \$11.5 trillion of 2017. That means the digital economy will be 24.3% – one quarter – of the total global economy by 2025.<sup>36</sup>

In recent years, the People's Republic of China (PRC) has progressed dramatically in the research and development (R&D) of certain applications of ICT. It now ranks first in number of Patent Cooperation Treaty (PCT)<sup>37</sup> applications in digital communications, second in innovations in computer technology, and third in audio-visual technologies.<sup>38</sup> Although the number of PCT filings, which represent a growth rate of 10.6% since 2018, do not represent qualitative intellectual property (IP) progress, it demonstrates strides that the PRC has taken to consolidate its position as an IP-generating nation. It has surpassed the US, Japan, Germany and South Korea. Of the 10 top PCT applicants in the world, four – Huawei Technologies, Guang Dong Oppo Mobile Telecom, BOE Technology Group, Ping An Technology – originate from the PRC.<sup>39</sup>

The PRC's robust intellectual property progress has facilitated its geoeconomic outreach via the Digital Silk Route, the technology-arm of the Belt and Road Initiative. Its aggressive penetration of newer markets as fifth-generation (5G) ICT are being deployed has aggravated the US-China trade war. With technology companies now in the late-stage R&D of sixth-generation (6G) ICT technologies, the hostility will deepen.

---

35 S. Kemp, "Digital 2021: Global Overview Report", Retrieved from <https://datareportal.com/reports/digital-2021-global-overview-report>

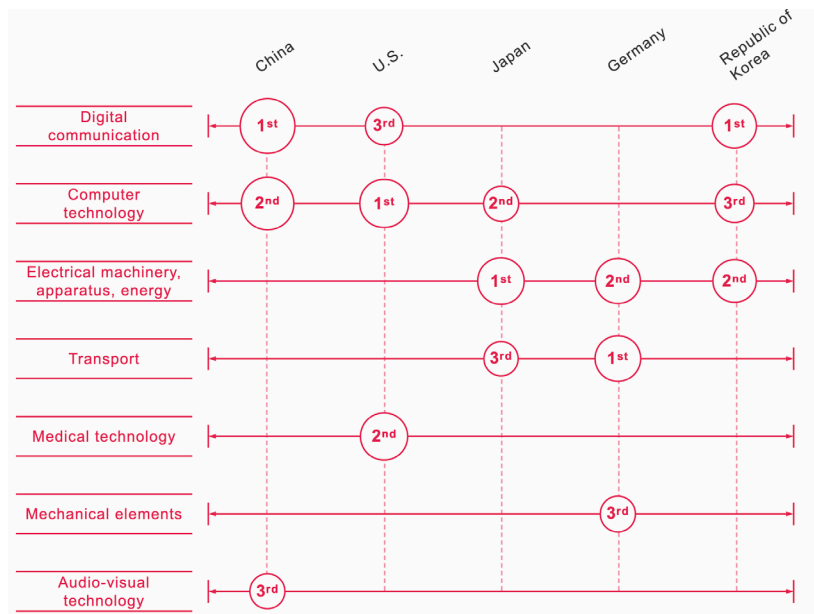
36 Huawei Technologies & Oxford Economics (2017), "Digital Spillover: Measuring the true impact of the digital economy," Retrieved from <https://www.oxfordeconomics.com/publication/open/284959#:~:text=The%20value%20of%20connectivity%20is,15.5%20percent%20of%20global%20GDP.&text=By%20then%2C%20we%20expect%20the,24.3%20percent%20of%20global%20GDP>

37 Patent Cooperation Treaty of 1970 is an international legal treaty that offers a unified procedure for inventors and innovators of member nations for filing patent applications

38 WIPO Statistics Database, September 2020, accessed on 15 May 2021, <https://www.wipo.int/edocs/infogdocs/en/ipfactsandfigures2019/>

39 WIPO Statistics Database, September 2020, accessed on 16 May 2021, [https://www.wipo.int/export/sites/www/ipstats/en/docs/infographic\\_pct\\_2019.pdf](https://www.wipo.int/export/sites/www/ipstats/en/docs/infographic_pct_2019.pdf)

Figure 2:  
The People's Republic of China has begun to top PCT patent applications in Information Communications Technology domain globally.



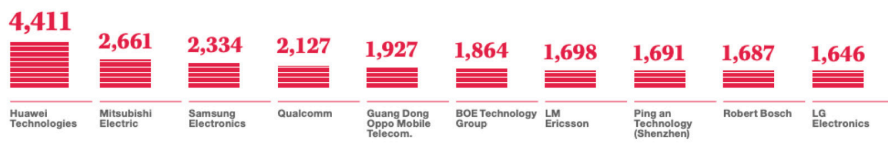
## Who filed the most PCT patent applications in 2019?

Total number of applications **265,800** ↑ 5.2%



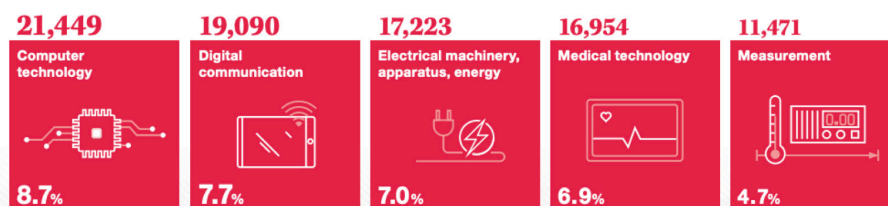
### Top 10 PCT applicants

Number of published PCT applications



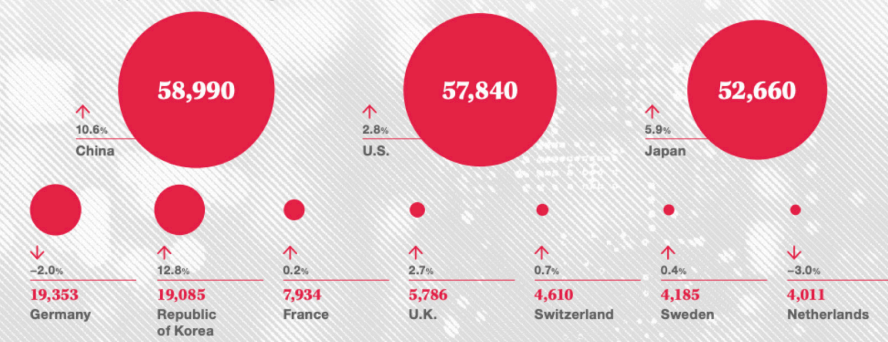
### Top 5 fields of technology

Number of published applications and share of total



### Top 10 countries

Number of PCT applications and percent growth since 2018



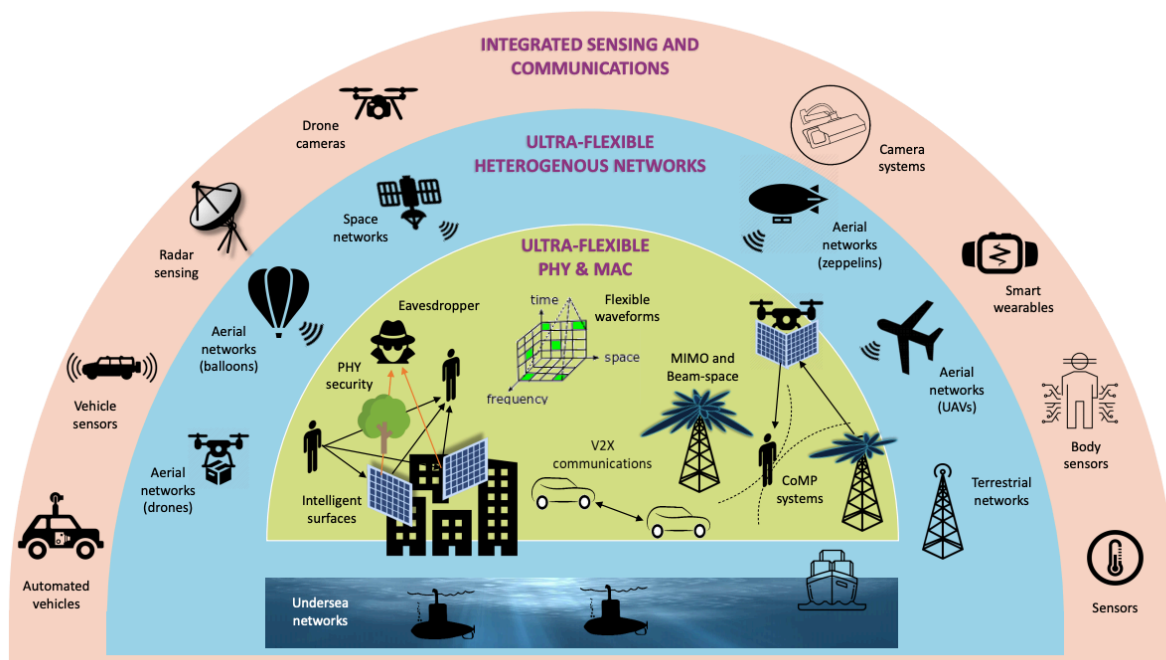


## KEY FINDINGS

### Space-based 6G, in the era of China's Digital Silk Road and BRI-Spatial Information Corridor, can Intensify Technopolitical Wars

Nations that intend to dominate certain technologies pursue R&D a generation or two ahead of its deployment, a process that includes accruing IP, controlling technology standards and ultimately deploying new products in the market. Moving from IP development to deployment of new technologies can take spans years or even a decade. It is a high risk-high-reward investment that requires an ability to endure long technology-gestation periods. While 5G is only now being deployed in some parts of the world despite its popular prospects, strategies and business plans for 6G ICT technologies have already been initiated in many places.

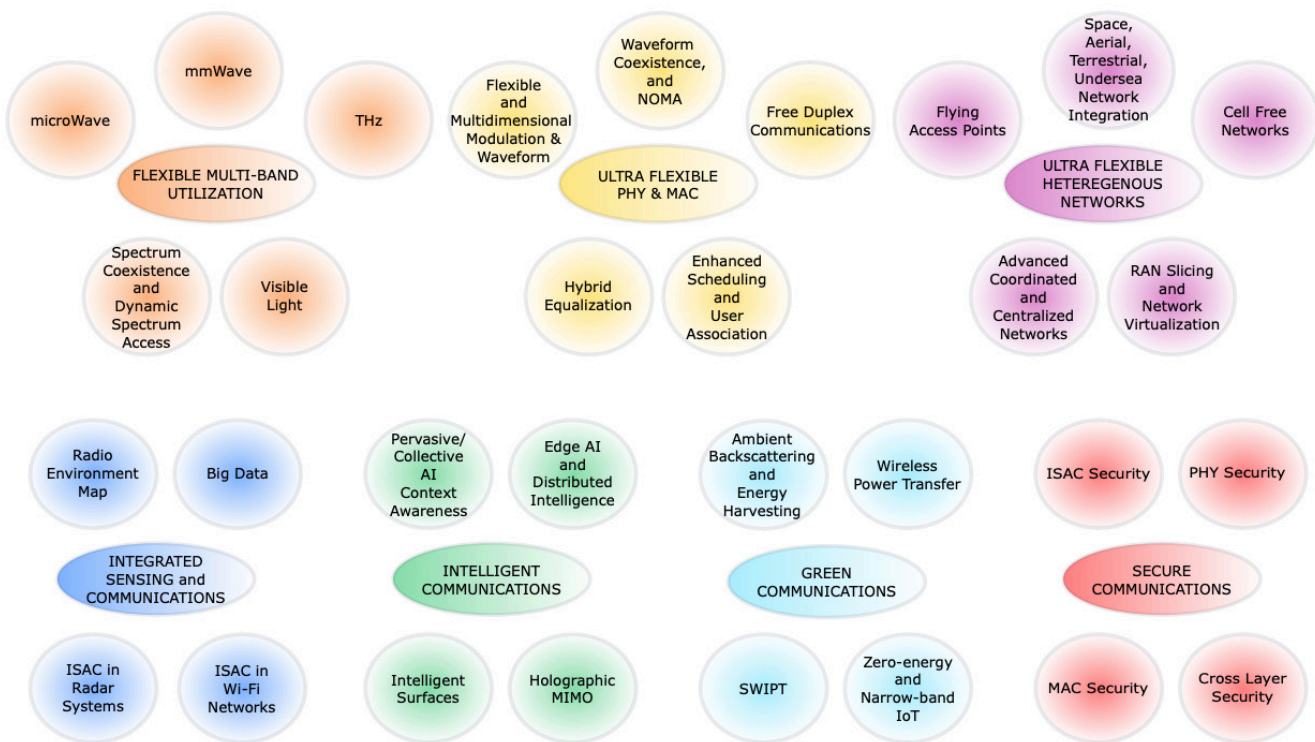
Figure 3: The exhaustive IP generation landscape of 6G ICT technologies {referred from [5]}



What makes 6G special? 5G is not fully equipped for numerous new Fourth Industrial Age applications. These Industry 4.0 applications include virtual tourism, virtual surgeries, virtual education, smart homes, work-from-anywhere, virtual and augmented reality (VR-AR), unmanned aerial vehicle networks, drone taxi, vehicle-to-everything (V2X), internet-of-things, smart city, e-medicine, holographic conferencing, disaster and emergency management, and smart clothing. Operating these will eventually demand higher bandwidth data-transmission than currently available – bit rates between 100-1000 Gbps, moving from the gigahertz (10<sup>9</sup>) into the yet unexploited terahertz (10<sup>12</sup>) spectral ranges, with a latency of under 1 microsecond, and superior reliability performance. 5G cannot perform at these levels, hence the need for 6G.<sup>40</sup>

40 A. Yazar, S.D. Tusha, H. Arslan, "6G Vision: An Ultra-Flexible Perspective," ITU Journal on Future and Evolving Technologies, Volume 1, Issue 1, December 2020. [https://www.itu.int/dms\\_pub/itu-s/opb/itu-jnl/S-ITUJNL-JFETF.V1I1-2020-P09-PDF-E.pdf](https://www.itu.int/dms_pub/itu-s/opb/itu-jnl/S-ITUJNL-JFETF.V1I1-2020-P09-PDF-E.pdf)

Figure 4: 6G ICT is more flexible (numerous rounded options) than its predecessor generations offering many enabling capabilities (oval options), each with tremendous applications {referred from [5]}.



6G most likely will not represent an incremental evolution in ICT from 5G technology. It will involve data-transmissions taking place through space and aerospace platforms.<sup>41</sup> It may operate flexibly across various wavelength ranges of the electromagnetic spectrum (microwave, millimetre wave, terahertz, and visible light). And it will involve other changes in ICT technologies, including innovations with flexible encryption for coexisting radar and cellular network wavelengths; flexible, heterogeneous networks (that includes cell-free networks, flying access points, space-aerial-terrestrial-underwater network integration); and secure, green, and intelligent communications with integrated sensing. These innovations will be crucial for providing last-mile connectivity and internet access to global internet users, bringing the those who are still without internet connection into the connected fold. Therefore, the potentially multi-trillion-dollar 6G ICT market may see an even more intense technopolitical contest than the ongoing one for 5G.

The PRC claims to have made some progress with 6G. In November 2020, it claimed to have launched the world's first 6G experimental satellite, which was jointly developed by Chengdu Guoxing Aerospace Technology, UESTC, and Beijing MinoSpace Technology.<sup>42</sup>

41 S. Song, M. Choi, Y. Goh, J. Yun, W. Yoo, W. Yang, J. Jung, J.M. Chung, "Analysis of wireless backhaul networks based on aerial platform technology for 6G systems," *Computers, Materials and Continua*, 62(2), 473-494. <https://doi.org/10.32604/cmc.2020.09052>

42 <https://news.cgtn.com/news/2020-11-07/China-sends-world-s-first-6G-communications-test-satellite-into-orbit-VdUnqnhFde/index.html>

The PRC is known to be a fast mover in developing and deploying ICT technologies, giving it a competitive edge in setting technological standards for those who follow. The PRC's ICT scientists are using 6G as a core element of their national vision to attain a Ubiquitous Intelligent Mobile Society domestically.<sup>43</sup> PRC also aims to make 6G an important constituent of the space arm of its Belt and Road Initiative, which it describes as the Space Information Corridor (SIC).<sup>44</sup> The PRC can seek to introduce Chinese characteristics into the forecasted global ITU-R IMT-2030 standards of the International Telecommunications Union (ITU).<sup>45</sup> Such introduction, which could promote China's national interests over those of other countries, must be vetted internationally, not accepted uncritically.

The PRC-led and Beijing-headquartered Asia-Pacific Space Cooperation Organization (APSCO),<sup>46</sup> the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP),<sup>47</sup> and the United Nations Office for Outer Space Affairs (UNOOSA) are important stakeholders of PRC's BRI-Space Information Corridor (Table 1).<sup>48</sup> The PRC does not work directly on its 6G aspirations through these multilaterals, but indirectly engages them in broad capacity-building domains that are linked to the development of 6G. It could aim to use capacity-building through space multilaterals to engage its BRI partners so they will become a captive market for 6G telecommunications when market deployment begins in the second half of the 2020s. Their involvement could be particularly important in addressing ground-based components of the aerospace-based 6G.

---

43 S. Chen, Y.-C. Liang, S. Sun, S. Kang, W. Cheng, M. Peng, "Vision, Requirements, and Technology Trend of 6G – How to Tackle the Challenges of System Coverage, Capacity, User Data-rate and Movement Speed," 2020, <https://arxiv.org/pdf/2002.04929.pdf>

44 "Chinese satellites will build Belt and Road in space," Oxford Analytical Daily Brief, 7 November 2019, <https://dailybrief.oxan.com/Analysis/GA247596/Chinese-satellites-will-build-Belt-and-Road-in-space>

45 "Beyond 5G: What's next for IMT?" ITU News, 2 February 2021, <https://www.itu.int/en/myitu/News/2021/02/02/09/20/Beyond-5G-IMT-2020-update-new-Recommendation>

46 Retrieved from the Asia-Pacific Space Cooperation Organization website, accessed on 15th May 2021, <http://www.apsco.int/upload/file/20180703/201807031400255205.pdf>

47 Retrieved from the Department of Economic and Social Affairs Sustainable Development – UN-ESCAP website, accessed on 15th May 2021, <https://sdgs.un.org/un-system-sdg-implementation/economic-and-social-commission-asia-and-pacific-escap-24510>; "A Study of ICT Connectivity for the Belt and Road Initiative (BRI): Enhancing the Collaboration in China-Central Asia Corridor," Working Paper by the Information and Communications Technology and Disaster Risk Reduction Division of the UN-ESCAP, available at: [https://www.unescap.org/sites/default/files/ICT\\_BRI\\_final%20v3\\_2.pdf](https://www.unescap.org/sites/default/files/ICT_BRI_final%20v3_2.pdf)

48 J. Hui, "The Spatial Information Corridor Contributes to UNISPACE+50," September 2017, Retrieved from the UNOOSA website, accessed on 15 May 2021, <https://www.unoosa.org/documents/pdf/copuos/stsc/2018/tech-08E.pdf>

Table 5: China's proactive engagements in multilateral bodies to promote its Belt-and-Road Initiative – Space Information Corridor megaproject

Multilateral Organization	Broad Cooperation with PRC	Specific ICT Projects	Specific Space Projects
United Nations Economic and Social Commission for Asia and the Pacific	Transport; Trade and Investment; ICT; Energy	Asia-Pacific Information Superhighway	Asia-Pacific Plan of Action on Space Applications for Sustainable Development
United Nations Office for Outer Space Affairs	Satellite Navigation, Telemedicine, tele-education, rail transportation, port management, fossil fuel industry, peace-making, emergency rescue, counter-terrorism	Broadband China	Data Collection Satellite System
Asia-Pacific Space Cooperation Organization	Disaster management, telemedicine, ICT, satellite navigation	Research on Atmospheric Effects on Ka-Band Rain Attenuation Modelling Project; Research on Ionospheric Modelling through Study of Radio Wave Propagation	COMSAT-based Telecommunications Network; Radiometric Calibration of Satellite Sensors Project; International Satellite Navigation Monitoring and Assessment Service Project

Source: Gateway House

The countries that comprise the Quadrilateral Security Dialogue (Quad), the Quad Plus (which currently includes Vietnam and South Korea) and the D-10 Strategy Forum,<sup>49</sup> also have initiated 6G R&D through public-private partnership (Table 2). However, many of these initiatives lack an over-arching strategic imperative akin to the PRC's BRI-SIC megaproject.

49 Retrieved from the D-10 Strategy Forum page on the Atlantic Council website, accessed on 15 May 2021, <https://www.atlanticcouncil.org/programs/scowcroft-center-for-strategy-and-security/global-strategy-initiative/democratic-order-initiative/d-10-strategy-forum/>

Table 6: Some Concrete 6G national projects led by Quad,  
Quad+ and D-10 nations (under prep)

Quad/Quad+/D-10	Concrete Strategy	Public Stakeholders	Private Stakeholders
Australia	'Secure G' Connectivity Test Lab – Digital Economy Strategy	Minister of Digital Economy	various
India		Department of Telecommunications	various
Japan		Ministry of Internal Affairs and Communications	NTT DoCoMo
United States	Next-G Alliance	Industrial Technology Research Institute (Taiwan) NC State University Johns Hopkins University – Applied Physics Laboratory Purdue University	AT&T • Apple • Bell Booz Allen Hamilton Charter Communications Ciena • Cisco • Dell Ericsson • Facebook Global Foundries Google Hewlett Packard Enterprise Intel • Interdigital • JMA Keysight Technologies LG • Lockheed Martin Mavenir • Mediatek Microsoft • Mitre NI • Nokia • Offino Qualcomm • Radisys Samsung Sharp Laboratories T-Mobile • Telnys • Telus US Cellular • Verizon Viavi Solutions

Quad/Quad+/D-10	Concrete Strategy	Public Stakeholders	Private Stakeholders
			VMWare • Xilinx Cohere Technologies NTT DoCoMo (Japan) Futurewei (Huawei affiliate) Mobile Experience NEC (Japan)
South Korea		Ministry of Science and ICT	Samsung Research SK Telecom
European Union	Hexa-X	University of Pisa (Italy) University of Oulu (Finland) Universidad Carlos III de Madrid (Spain) Technische Universität Kaiserslautern (Germany) Technische Universität Dresden (Germany) Politecnico di Torino (Italy) SZTAKI (Hungary) CEA (France) Chalmers University of Technology (Sweden) Aalto University (Finland)	Nokia Solutions and Networks (Finland) Ericsson AB (Sweden) Atos Spain SA (Spain) B-COM (France) Ericsson Arastirma (Turkey) Ericsson Magyarorszag (Hungary) Intel Deutschland (Germany) Nextworks (Italy) Nokia Solutions and Networks (Germany) Orange (France) Qamcom Research and Technology (Sweden) Siemens (Germany) Telecom Italia (Italy) Telefonica (Spain) Wings ICT Solutions (Greece)
	Digital Single Market (Next-Generation Internet)	European Commission	various



## RECOMMENDATIONS

The Quad has a strong interest in promoting democratic development, standardization and deployment of 6G.

- 1. Instil a democratic ethos in R&D and deployment of 6G.** The Quad aspires to create an Asian Arc of Democracy.<sup>50</sup> Sustaining a democratic ethos in the real world depends on the maintenance and resilience of 'freedom of expression', 'free market', 'free media', transparency, and pluralism. All these are dependent on democratization of communications and information networks and technology development. Hence, democratization of 6G should be a crucial undertaking in the larger QUAD and QUAD Plus agenda.
- 2. Establish an ICT Sub-Working Group within the Quad Critical and Emerging Technology Working Group.** In March 2020, the US initiated the first Quad+ discussion with the participation of Vietnam and South Korea.<sup>51</sup> The same meeting also saw the constitution of the Quad Critical and Emerging Technology Working Group.<sup>52</sup> An ICT Sub-Working Group under the ambit of this Working Group, can be contemplated. Such a sub-working group can initiate track-1 diplomatic discussions with participation of ICT R&D, deployment, regulation and facilitation experts nominated by the participating governments. Expertise can represent telecommunications, space launch, space situational awareness, patents, electromagnetic spectrum including 6G stakeholder agencies, departments and ministries. The country representatives in the sub-working group can discuss methodologies to reduce monopolistic technoeconomic control over ICT.
- 3. Quad Strategy for 6G Technology Standards:** As visible in Figs. 2 & 3, 6G R&D, standardization and deployment needs cross-sectoral oversight spanning various departments, ministries, or agencies nationally and internationally. The Quad requires cooperation on a domestic and grouping-wide 6G regulation-plus-facilitation architecture for executing international cooperation. In the PRC, the BRI-SIC is governed at the top by the National Development and Reform Commission (NDRC), focusing on policy and economics, while the State Administration of Science, Technology and Industry for National Defense (SASTIND), focuses on science, technology innovation, and intellectual property. The Quad can initiate a dialogue on 6G technology standards at a track-2 level. The telecommunication standard bodies of Quad and Quad+ nations recognized in the 5th Generation Partnership Project (5GPP), along with their public scientific agencies that deal with aerospace, space, electronics, engineering, laboratories, spectral allocation sectors, can co-ordinate to share best practices and understand convergences and divergences.

---

50 R. Sikri, "India's Foreign Policy Challenges," *Distinguished Lectures – Ministry of External Affairs, Government of India*, 30 January 2017, <https://www.mea.gov.in/distinguished-lectures-detail.htm?611>

51 "Foreign Secretary's Conference Call with counterparts from Indo-Pacific Countries," *Ministry of External Affairs, Government of India*, 20 March 2020, <https://mea.gov.in/press-releases.htm?dtl/32592+Foreign+Secretarys+Conference+Call+with+counterparts+from+IndoPacific+Countries>

52 "Fact sheet: Quad Summit," *The White House – Briefing Room*, 12 March 2021, <https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/12/fact-sheet-quad-summit/>



#### 4. Seek multilateral Cooperation on Space Situational Awareness for 6G Satellite Constellations:

The Quad nations can stimulate co-operative mechanisms for sharing space-situational awareness data to avoid collision of satellites in 6G constellations. The cooperation mechanism can provide a regulatory foundation for satellite ground-stations in each other's sovereign territories. Such cooperation will radially extend not only into the International Telecommunications Union and the 3GPP, but also allied space and aerospace technology standards bodies and through UNOOSA, UN-ESCAP, UN-CTAD, Group of 77 (G77), Group of 24 (G24), and the newly formed Space20 under the Group of 20 (G20) multilateral.

Table 7: Much of Asia and all of Africa and South America, which are among the world's biggest telecom markets, currently are not represented in Indo-Pacific QUAD Plus and D-10 . Leaving these regions out would give monopolistic 6G technology companies and service providers unregulated access to these markets

Quadrilateral Security Dialogue	Quadrilateral Security Dialogue Plus (QUAD+)	D-10 Strategy Forum
Australia	Australia	Australia
India	India	Canada
Japan	Japan	France
United States	United States	Germany
	New Zealand	India
	South Korea	Italy
	Vietnam	Japan
		South Korea
		United Kingdom
		United States
		European Union
		Indonesia (o)
		Poland (o)
		Spain (o)

## 5. COOPERATION ON UNDERSEA COMMUNICATION CABLES

Today, more than 95% of international internet data, including cloud and digital communication, are transmitted through undersea, fibre-optic cables, making these cables critical infrastructure for every nation. The world's reliance on undersea cables – and hence cables' strategic significance<sup>53</sup> – will continue to grow in the years ahead.

The Quad Undersea Communication Cable Working Group was formed to identify areas where Quad nations can cooperate to provide trusted connectivity to digitally underserved nations in the Indo-Pacific, and to collaborate in multilateral forums to formulate technology standards and legal frameworks.

### KEY FINDINGS

#### 1. Importance of Undersea Cables

Undersea fibre-optic cables are the backbone of the global economy, transmitting \$10 trillion in financial transactions each day. The Indo-Pacific region, the most populous region in the world with 60% of global GDP and the world's fastest growing economies, is also home to the fastest growing undersea communication cable networks.

Table 8: Internet growth 2018-2023

Parameter	2018		2023
	Global	Asia Pacific	Global
Number of Internet Users	3.9 billion	2.1 billion	5.3 billion
Networked devices	18.4 billion	8.6 billion	29.3 billion
Mobile subscribers	5.1 billion	2.7 billion	5.7 billion
Fixed Broadband Speeds	45.9 Mbps	62.8 Mbps	110.4 Mbps

Source: Cisco Annual Internet Report (2018–2023) White Paper

While satellite communication is increasing connectivity in remote areas, undersea cable connectivity will continue to be the chief driver of internet growth in years to come due to its affordability and greater bandwidth. Between 2018 and 2020 alone, international bandwidth used by global networks more than doubled to exceed 2,000 terabits per second (Tbps). Over the next three years, \$8 billion in new investment is expected to finance more than 60 new cables totalling more than 290,000 km in length. Among the drivers of this growth are the developing world's transition to 5G, which will greatly increase its needs for bandwidth, and the developing world's efforts to bring connectivity to the nearly half of the world that is currently not online.

---

53 The United Nations, in 2011, described submarine communications cables as "critical infrastructure" that is "vitally important to the global economy and the national security of all States." [https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A\\_RES\\_66\\_231.pdf](https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_66_231.pdf)

## 2. Major Players

Japan's NEC, U.S.-based SubCom and France-headquartered Alcatel Submarine Networks are the world's top three suppliers of optical cables, with more than 90% of market share. They also own much of the technological elements of undersea networks (both wet and dry components) across the entire spectrum, including subsea geological survey, cable laying and repair capabilities. China's Huawei Marine Networks, rebranded as HMN Technologies in Oct 2020, is an up and coming fourth player.

Table 9: Undersea communication cable systems – Major Players

Country	Company	Fibre Optic Cable supplied (Kms)
U.S.	SubCom	680000
Japan	NEC	300000
France	Alcatel	330000
China	HMN Technologies	65000
Total length of submarine cables laid is 1.3 million kms		

Source: Gateway House Research

China aims to capture 60% of the world's fibre-optic communications market by 2025. That goal is directly linked to its global plans for the Digital Silk Road, and Belt and Road Initiatives. Beijing, through the Made in China 2025<sup>26</sup> and China Standards 2035 initiatives, aspires to lead both in advanced manufacturing and standard-setting related to it.<sup>27</sup>

China began focusing on the undersea cable infrastructure market in 2007. It adopted a three-fold approach:

- **Maintenance and Upgrades:** In 2007, China's Huawei Technologies entered into a joint venture (JV) with the U.K.'s Global Marine. With more than 150 years-experience in the installation and maintenance of subsea telecommunications systems, Global Marine was an ideal partner for Huawei, which in 2006 was the fastest growing vendor of optical networks, and ranked No. 2 with an 11.3% global market share. The JV led to the creation of Huawei Marine Networks, thus providing China a foothold in the business of maintaining and upgrading existing cable systems. Gaining from this experience, Chinese companies now have scaled-up their capabilities and have built or repaired almost a quarter of the world's approximately 400 submarine cables. These include – pre-2010 upgrades to a major submarine cable connecting the U.S. and Canada, as well as a cable connecting New York City and London.

54 Jayne Miller, *Just Look at All Those Cables: The 2021 Submarine Cable Map is here*, 24 May, 2021, available at : <https://blog.telegeography.com/2021-submarine-cable-map>

55 Douglas Broom, *Coronavirus has exposed the digital divide like never before*, Apr 2020, available at: <https://www.weforum.org/agenda/2020/04/coronavirus-covid-19-pandemic-digital-divide-internet-data-broadband-mobbile/>

56 US Chamber of Commerce, *Made In China 2025: Global ambitions built on local protections*, 2017, available at : [https://www.uschamber.com/sites/default/files/final\\_made\\_in\\_china\\_2025\\_report\\_full.pdf](https://www.uschamber.com/sites/default/files/final_made_in_china_2025_report_full.pdf)

57 Hearing before the committee on small business and entrepreneurship United States Senate, *Made in China 2025 and the future of American Industry*, Feb 2019, available at : <https://www.govinfo.gov/content/pkg/CHRG-116shrg35699/pdf/CHRG-116shrg35699.pdf>

- **New Projects:** China's initial foray focussed on short-haul projects (less than 2,000 kms) in shallow coastal waters that are less technology-intensive. But the 12,000 km PEACE (Pakistan and East Africa Connecting Europe) cable currently being laid by HMN Technologies – starting from Pakistan, running along Africa's east coast, and ending in Marseilles, France – represents a significant upscaling of Chinese capabilities. This cable's landing into Europe, especially in a NATO member, is a cause of concern. Meanwhile, the Institute of Peace and Conflict Studies and the Netherlands-based Leiden Asia Center estimate that China, in its pursuit of greater autonomy, has become a landing point, owner, or supplier for 11.4% of undersea communication cables globally, and more than twice that (24%) of planned cables. In Asia, China's share is close to 30% of existing cables and more than half of planned cables.
- **Cable Consortia:** While HMN Technologies is installing multiple submarine cables throughout the world, China Unicom, China Telecom, and China Mobile (three state-owned telecommunications companies) are joining cable ownership consortiums. Such consortiums give Beijing-owned firms significant voting power in awarding construction contracts<sup>61</sup> and also access to international players within the telecommunication sector to further deepen the Digital Silk Route in the Indo-Pacific to create China-centric digital connectivity in the region.

Table 10: Chinese ownership in cable consortiums

Company	Consortium System Ownership
China Unicom	40
China Mobile	54
China Telecom	33

Source: Gateway House Research

## 2. Why do Undersea Cables Matter to the QUAD

Though the majority of the currently recorded threats to undersea cable infrastructure are classified as unintentional, like fishing and trawling, the growing technological capabilities and geo-technical competition between nations pose an ever-growing risk of intentional threats such as sabotage and eavesdropping. Now that remotely operated unmanned systems are relatively accessible, the threat to critical infrastructure from both state and non-state hostile actors with relatively modest financial resources has increased substantially. The use of drones in the September 2019 attack on the Saudi Arabian Aramco oil facilities, destroying nearly 50% of the country's global supply of crude oil, should serve as a stark reminder. Mitigating threats from unmanned systems in undersea environment will be even more difficult.

In May 2009, China for the first time declared<sup>62</sup> at the UN its sovereign rights and jurisdiction over the waters, seabed and subsoil in the South China Sea on the its ill-defined 'Nine Dash Line.' Recently, one official Chinese Communist Party outlet explained, "although undersea cable laying is a business, it is also a battlefield where information can be obtained."<sup>63</sup>

61 David Feith and Lara Crouch, *Commanding Depths: China's Bid to Dominate the Cloud—Under the Sea*, Jun 2021, available at: [http://thf\\_media.s3.amazonaws.com/2021/China\\_Transparency\\_Report.pdf](http://thf_media.s3.amazonaws.com/2021/China_Transparency_Report.pdf)

62 Submission by the People's Republic of China to the Commission Establishing the Limits of the Continental Shelf, 7 May 2009, available at: [https://www.un.org/Depts/los/clcs\\_new/submissions\\_files/mysvnm33\\_09/chn\\_2009re\\_mys\\_vnm\\_e.pdf](https://www.un.org/Depts/los/clcs_new/submissions_files/mysvnm33_09/chn_2009re_mys_vnm_e.pdf)

63 Nadia Schadow and Brayden Helwig, *Protecting undersea cables must be made a national security priority*, Defence News, July 1, 2020 available at: <https://www.defensenews.com/opinion/commentary/2020/07/01/protecting-undersea-cables-must-be-made-a-national-security-priority/#:~:text=Huawei%20Marine%2C%20a%20Huawei%20subsidiary,world's%20approximately%20400%20submarine%20cables.>

Additionally, the Chinese government has approved plans for a massive undersea surveillance network in both the East and South China Seas. Although the systems are officially intended to monitor environmental changes, experts acknowledge that they will have “national defence” applications, which could include tracking the movements of foreign submarines. The plan includes a number of unspecified sensors on the ocean floor, connected via optical cables to a central processing and monitoring facility in Shanghai. China also has a fleet of 60 oceanographic research and survey vessels; the Indian Navy has stated that at any given time, four to five Chinese research vessels operate in the Indian Ocean region (IOR).

Fishing and shipping activities account for nearly two-thirds of all damage to existing cables. TeleGeography (a US-based telecommunications market research and consulting firm) and the International Cable Protection Company (a U.K.-based private consortium of telecom providers, undersea-cable manufacturers and cable ship operators) categorise these instances as “unintentional threats.” China now has the world’s largest fishing fleet, an established maritime militia and enhanced subsea domain awareness in the region – all of which can improve its capabilities in multi-domain warfare and espionage. The line between intentional and unintentional threats for subsea cables could easily be erased. In 2020, Chinese dredgers damaged undersea cables connecting Taiwanese islands on five occasions. Taiwan’s state-owned Chunghwa Telecom said it spent about \$2 million to fix the cables. It also hired a local fishing boat to conduct daily patrols to ensure safety of the cables.

Notwithstanding these threats, Quad countries have other concerns. Unlike western and developed nations, which increasingly focus on issues of data security and trust involving undersea cables, underserved markets in Africa and Pacific islands are still concerned about the need for basic digital connectivity. China will look to gain market share and undercut global competition in this sector through state-supported discounted bidding. The extent to which Chinese firms are able to undercut competition was visible in the recently suspended World Bank-led East Micronesia cable system where HMN Technologies had emerged as the lowest bidder with a margin of 20% under its nearest competitor.

In August 2020, China also launched the Year of Science, Technology and Innovation Cooperation plan with Russia<sup>70</sup> – an established player identified by NATO as having significant undersea surveillance capabilities.<sup>71</sup> This Russia-China plan has identified more than 1,000 areas of cooperation in fields such as robotics, materials science, information technology, artificial intelligence, and others.

---

64 Joseph Trevithick, *South China Sea Underwater “Environmental” Sensor Net Could Track U.S. Subs*, May 2017, available at: <https://www.thedrive.com/the-war-zone/10906/south-china-sea-underwater-environmental-sensor-net-could-track-u-s-subs>

65 Chen Yu, *There are more or fewer marine survey ships in my country*, December 19, available at: [http://digitalpaper.stdaily.com/http\\_www.kjrb.com/kjrb/html/2017-12/19/content\\_384309.htm](http://digitalpaper.stdaily.com/http_www.kjrb.com/kjrb/html/2017-12/19/content_384309.htm)

66 TeleGeography, *Submarine 101*, available at: <https://www2.telegeography.com/submarine-cable-faqs-frequently-asked-questions>

67 Miren Gutierrez, Guy Jobbins, *China’s distant-water fishing fleet: scale, impact and governance*, June 2020, available at: <https://odi.org/en/publications/chinas-distant-water-fishing-fleet-scale-impact-and-governance/>

68 Dr. Andrew S. Erickson, *Testimony before the House Armed Services Committee Seapower and Projection Forces Subcommittee*, September 2016, available at: <https://docs.house.gov/meetings/as/as28/20160921/105309/hhr-114-as28-wstate-ericksonphda-20160921.pdf>

69 Yimou Lee, *China’s latest weapon against Taiwan: The Sand Dredger*, Feb 2021, available at: <https://www.marinelink.com/news/chinas-latest-weapon-against-taiwan-sand-485108>

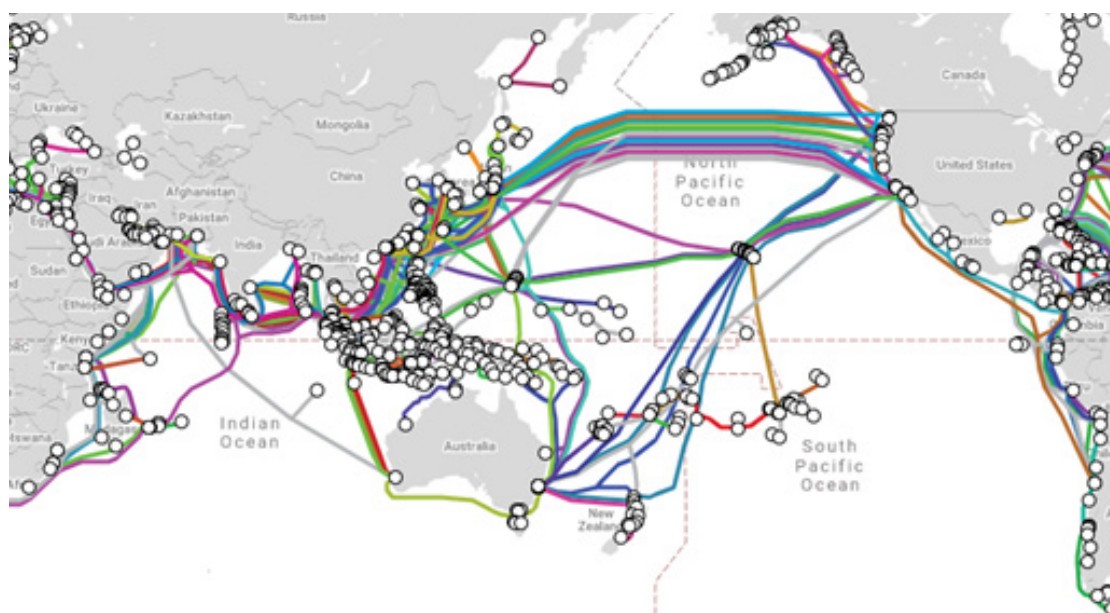
70 Foreign Minister Sergey Lavrov’s interview with Chinese media, Moscow, March 22, 2021, available at: [https://www.mid.ru/en/foreign\\_policy/news/-/asset\\_publisher/cKNonkJE02Bw/content/id/4646592](https://www.mid.ru/en/foreign_policy/news/-/asset_publisher/cKNonkJE02Bw/content/id/4646592)

71 Russian submarines have allegedly been prowling the routes of transoceanic internet cables. NATO officials have also highlighted an uptick in activity by the Yantar intelligence vessel (commissioned in 2015 – two more under construction) that acts as a mothership for a small fleet of deep-sea mini-submersibles. Yantar can act as a mothership to Rus- (AS-37) and Consul- (AS-39) class deep diving submersibles, which can operate at depths up to 6000 meters. For context, the average depth of the ocean floor is about 3,700 meters. Yantar can also be used as a mothership for ARS-600 deep diving manned submersible, which can operate at 600 meters.



The high density of undersea cable networks in the South China Sea, China's excessive jurisdictional claims, its extensive underwater surveillance infrastructure and its apparent intent to tap undersea cables for "national defence" and the National Security Law that mandates individuals and organisations to assist in state intelligence all pose a serious risk to international underwater communication cable infrastructure in the region. China understands the problem. The Chinese National Security Law incidentally limits foreign access to the information and communications technology (ICT) market in China on national security grounds.<sup>72</sup>

Figure 5: Undersea Cables in the Indo-Pacific



Source - TeleGeography

### 3. QUAD Cooperation on Undersea Communication Cable Infrastructure

The Quad is in a strong position to leverage its inherent strengths and complementarities. NEC and SubCom are established leaders in this sector. India sits strategically at the head of the Indian Ocean and is fast emerging as a hub for data flows in the Indo-Pacific, thanks to its increasing domestic digital connectivity infrastructure and data consumption. In the next three years, at least eight new cable systems that will transit through India are expected to be commissioned. The Indian-led Coalition for Disaster Resilient Infrastructure,<sup>73</sup> which includes each Quad nation, France, U.K., and Germany, offers a ready platform to review undersea communication cable infrastructure for improved disaster resilience.<sup>74</sup> Australia has been at the forefront of efforts to create regulatory frameworks<sup>75</sup> for the protection of undersea cables and for cybersecurity of critical infrastructure.<sup>76</sup>

73 Coalition for Disaster Resilient Infrastructure, available at: <https://cdri.world/>

74 In December 2006, a magnitude 7.0 earthquake struck off the southwest coast of Taiwan. Eight submarine cables were cut after the earthquake and its aftershocks, catastrophically disrupting internet services in Asia by up to 90% at few places.

75 Telecommunications Legislation Amendment (Submarine Cable Protection) Bill 2013, Parliament of Australia, 46, 2013–14, 27 February 2014, available at: [https://parlinfo.aph.gov.au/parlInfo/download/legislation/billsdgs/3022582/upload\\_binary/3022582.pdf;fileType=application/pdf](https://parlinfo.aph.gov.au/parlInfo/download/legislation/billsdgs/3022582/upload_binary/3022582.pdf;fileType=application/pdf)

76 Australian Cyber Security Strategy 2020, available at: <https://www.homeaffairs.gov.au/cyber-security-subsite/files/cyber-security-strategy-2020.pdf> floor is about 3,700 meters. Yantar can also be used as a mothership for ARS-600 deep diving manned submersible, which can operate at 600 meters.

Terrestrial 5G networks have received justified attention concerning risk and trust issues associated with Chinese-origin tech supply chains. But that attention has been confined largely to terrestrial telecom networks and stop at the water's edge. Far less attention has been given to the competition for development and security of undersea cable networks, even though they may pose more economic and national security risks than the terrestrial ones since undersea cables handle 95% of global internet traffic and 5G networks are expected to carry just 25% of global mobile data traffic by 2024.<sup>77</sup>

Unlike the 5G systems where China has a lead, non-Chinese players like SubCom, Alcatel and NEC which provide end-to-end solutions, currently dominate the undersea cable tech ecosystem. With some significant cooperation, the Quad can keep the advantage over China.

## RECOMMENDATIONS

1. **Identify undersea cables as an element of cooperation under The Quad Critical and Emerging Technology Working Group announced<sup>78</sup> in March 2021.**
2. **Strengthen the Digital Connectivity and Cybersecurity Partnership<sup>79</sup>** to include financing of undersea cable infrastructure in the Indo-Pacific region, with specific focus on connectivity to emerging markets. Every future cable laid in the Indo-Pacific must explore the feasibility of extending connectivity to other remote islands in the region as part of development finance assistance. The Quad can also plug into the G7's Build Back Better World (B3W) initiative<sup>80</sup> that has identified values-driven, high-standard, and transparent infrastructure partnership in digital technology as one of the focus areas, catering to the infrastructure needs of low- and middle-income countries.
3. **Establish an Independent Infrastructure Provider (IIP)<sup>81</sup>** as a public-private-partnership that will provide affordable financing as well as services for the design, build, operate and management of new cable projects. This will increase competitiveness and drive affordability in providing much needed digital connectivity within the Indo-Pacific region, without the burden of ownership, maintenance and operation.

---

77 Ericsson Mobility Report, 2018, available at: <https://www.ericsson.com/assets/local/mobility-report/documents/2018/ericsson-mobility-report-november-2018.pdf>

78 Quad Summit Fact Sheet, White House Press Release, 12 March 2021, available at: <https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/12/fact-sheet-quad-summit/>

79 US Department of State, Digital Connectivity and Cyber Security Partnership, available at: <https://www.state.gov/digital-connectivity-and-cybersecurity-partnership/>

80 Fact Sheet: President Biden and G7 Leaders Launch Build Back Better World (B3W) Partnership, 12 June 2021, available at: <https://www.whitehouse.gov/briefing-room/statements-releases/2021/06/12/fact-sheet-president-biden-and-g7-leaders-launch-build-back-better-world-b3w-partnership/>

81 Suvesh Chattopadhyaya, What does it take to be Independent Infrastructure Provider (IIP) in India to develop Submarine Cable System, 27 February, 2019, available at: <https://www.submarinenetworks.com/en/insights/what-does-it-take-to-be-independent-infrastructure-provider-iip-in-india-to-develop-submarine-cable-system>



4. **Invest in capacity building for realigning manufacturing supply chains within the Quad and Quad Plus (U.K. and France) for each element of the undersea cable infrastructure ecosystem.**
5. **Create next-generation technology standards, and consult on international legal frameworks that promote not just improved interoperability and cyber-resilience, but also increased disaster- and climate- resilience of undersea communication cable networks.** Equipping undersea cables with sensors to help monitor and forewarn climate change and geological events must also be explored.
6. **Challenge PRC's increasing ascendancy in organisations that focus on developing technical specifications for ensuring interoperability of telecommunication systems.** Two of these include - the Third Generation Partnership Project (3GPP) where Chinese companies hold about 25% voting rights and the International Telecommunications Union (ITU)<sup>82</sup>, where PRC has gained leadership of the telecom advisory group. This would entail coordinated action on selection of secretariat positions and standards-setting working groups.
7. **Develop capacity and establish a Quad/Quad Plus maritime command<sup>83</sup> that will focus on non-traditional maritime issues including a separate undersea cable security program<sup>84</sup> that will address security, monitoring and emergency repair mechanisms.** Such formalised cable security program will help cut down response and repair timelines to cable faults within the Quad countries, which otherwise are delayed due to substantial regulatory compliance mandated by individual countries.
8. **Include attack on undersea cables as part of naval drills during the annual Malabar exercise.**

---

82 Over the past decade, China has acquired considerable technical standardization power. The Belt and Road Initiative (BRI) comes with elements of standards. In 2015, China's main macroeconomic agency, the National Development and Reform Commission (NDRC), issued its first "Action Plan for the Harmonization of Standards along the Belt and Road". At the end of 2017, the NDRC published another action plan setting further benchmarks to be fulfilled by the end of 2020. As part of the plan, China began to translate its domestic technical standards into foreign languages to facilitate their adoption in third countries. By September 2019, China had signed 90 bilateral agreements on technical standardization cooperation with 52 countries and regions. At the governance level, China is taking on more and more leadership positions in international technical standardization organizations. While still considerably behind Germany, the US, France, the United Kingdom and Japan, China is gaining more and more of the influential secretariat positions on Technical Committees, Subcommittees and Working Groups in the International Standardization Organization (ISO), the International Electrotechnical Committee (IEC), International Telecommunications Union (ITU) and the Third Generation Partnership Project (3GPP), another international technical standardization organization focused on telecommunications standards. Tim Rühlig, China, Europe and the New Power Competition over Technical Standards, 2021, available at: <https://www.ui.se/globalassets/ui.se-eng/publications/ui-publications/2021/ui-brief-no.-1-2021.pdf>

83 In Oct 2020, NATO Secretary-General Jens Stoltenberg said, "We have also established a new NATO Atlantic Command in Norfolk, and one of the new tasks of this new North Atlantic Command is also to look into how to protect, how to monitor threats against undersea infrastructure," available at: <https://www.euractiv.com/section/defence-and-security/news/nato-seeks-ways-of-protecting-undersea-cables-from-russian-attacks/>

84 The U.S. Cable Security Force (CSF) Program is a newly-authorized program intended to maintain a fleet of active, commercially viable, privately owned United States-flagged cable vessels to meet national security requirements and to maintain a United States presence in the international submarine cable services market. The CSF will consist of two vessels. In Jan 2021, the U.S. Maritime Administration (MARAD) requested applications from owners and/or operators of eligible vessels to enroll such vessels in the Cable Security Fleet (CSF), available at: <https://www.transportation.gov/regulations-fr/notices/2020-29159>

## 6. Conclusion

Today's geopolitical situation has given rise to conditions that threaten the free, open, rules-based international order – and hence represent long-term, multi-dimensional challenges to the interests, values and principles of the four democracies that comprise the Quad and to their partners. A purely military response is not enough. Economic and technological threats also need to be identified and suitable remedies crafted.

The five areas chosen for this Task Force review – Pharmaceuticals, Critical Minerals, Fintech and Cybersecurity, Space and 6G, and Undersea Communication Cables – offer immense potential for intra-Quad collaboration to protect the democratic ethos of the international system against actors who seek technology power without committing to these principles of freedom. It is advisable for the Quad governments to bring the five sectors within the purview of the three Working Groups established by the March 2021 summit and to consider carefully all the Task Force recommendations.

While governments are obviously the main players in this process, they cannot succeed without the engagement and commitment of the private sector, business leaders, the R&D community, media and civil society. Hence, this Task Force strongly advises that approaches anchored in Public-Private Partnerships are likely to produce optimal results with minimum investment and within minimum time.

Clearly, the Task Force is proposing a long journey. Those who do not believe in the principles of freedom, democracy and cooperation will try to come up with countermeasures in response to the Quad's efforts. This cannot be a one-time effort. It will have to be continuous and steady over the long term.

Gateway House, which is proud to have been the catalyst and sustainer of the Task Force's work, plans to reassess progress in the implementation of the Task Force's recommendations, examine the evolving situation, and then develop a fresh set of ideas and plans in two years by re-activating the Task Force in September 2023 for a follow-up assessment.

## 7. Appendix: Acronyms

<b>3GPP</b>	3rd Generation Partnership Project
<b>5G</b>	Fifth Generation
<b>5GPP</b>	5th Generation Partnership Project
<b>6G</b>	6th Generation
<b>AAGR</b>	Average Annual Growth Rate
<b>API</b>	Active Pharmaceutical Ingredient
<b>APSCO</b>	Asia Pacific Space Cooperation Organization
<b>B2B</b>	Business to Business
<b>B2C</b>	Business to Consumer
<b>B3W</b>	Build Back Better World
<b>BRI</b>	Belt and Road Initiative
<b>C2C</b>	Consumer to Consumer
<b>Capex</b>	Capital Expenditure
<b>CBDC</b>	Central Bank Digital Currency
<b>COVAX</b>	COVID-19 Vaccines Global Access
<b>COVID-19</b>	Coronavirus Disease
<b>DEPA</b>	Data Empowerment and Protection Architecture
<b>DPA</b>	Defense Production Act
<b>ESCAP</b>	Economic and Social Council for Asia Pacific
<b>FSB</b>	Financial Stability Board
<b>G20</b>	Group of 20
<b>G24</b>	Group of 24
<b>G7</b>	Group of 7
<b>G77</b>	Group of 77
<b>GAVI</b>	Global Alliance for Vaccines and Immunisations

<b>GDP</b>	Gross Domestic Product
<b>HMN</b>	Huawei Marine Network
<b>ICT</b>	Information and Communications Technologies
<b>IEA</b>	International Energy Agency
<b>IIP</b>	Independent Infrastructure Provider
<b>IOR</b>	Indian Ocean Region
<b>IP</b>	Intellectual Property
<b>IPR</b>	Intellectual Property Rights
<b>ITU</b>	International Telecommunications Union
<b>JV</b>	Joint Venture
<b>km</b>	Kilometre
<b>KSM</b>	Key Starting Materials
<b>MERS</b>	Middle East Respiratory Syndrome
<b>NATO</b>	North Atlantic Treaty Organisation
<b>NdFeB</b>	Neodymium Magnets
<b>NDRC</b>	National Development and Reform Commission
<b>PCT</b>	Patent Cooperation Treaty
<b>PEACE</b>	Pakistan & East Africa Connecting Europe
<b>PEPFAR</b>	U.S. President's Emergency Plan for AIDS Relief
<b>PPE</b>	Personal Protective Equipment
<b>PRC</b>	People's Republic of China
<b>R&amp;D</b>	Research and Development
<b>SARS</b>	Severe Acute Respiratory Syndrome
<b>SASTIND</b>	State Administration of Science, Technology and Industry for National Defense

<b>SCRI</b>	Supply Chain Resilience Initiative
<b>SIC</b>	Space Information Corridor
<b>tbps</b>	Terabytes per second
<b>UN</b>	United Nations Organisation
<b>UNCTAD</b>	United Nations Conference on Trade and Development
<b>UNOOSA</b>	United Nations Office for Outer Space Affairs
<b>UPI</b>	United Payment Interface
<b>US</b>	United States of America
<b>V2X</b>	Vehicle to Everything
<b>VR-AR</b>	Virtual Reality-Augmented Reality
<b>WHO</b>	World Health Organisation
<b>WTO</b>	World Trade Organisation

## 8. Appendix 2 : List of Figures

<b>Figure 1: Exports of Pharmaceutical Products by Quad Countries</b>	<b>16</b>
<b>Figure 2: The People's Republic of China has begun to top PCT patent applications in Information Communications Technology domain globally.</b>	<b>32</b>
<b>Figure 3: The exhaustive IP generation landscape of 6G ICT technologies</b>	<b>33</b>
<b>Figure 4: ICT is more flexible (numerous rounded options) than its predecessor generations offering many enabling capabilities (oval options), each with tremendous applications</b>	<b>34</b>
<b>Figure 5: Undersea Cables in the Indo Pacific</b>	<b>45</b>

## 9. Appendix 3: List of Tables

<b>Table 1: Trends in Cobalt Production</b>	<b>23</b>
<b>Table 2: Cobalt Refinery Production 2016</b>	<b>24</b>
<b>Table 3: Current state of CBDC in Quad countries</b>	<b>28</b>
<b>Table 4: Bilateral cyber cooperation among Quad countries</b>	<b>29</b>
<b>Table 5: China's proactive engagements in multilateral bodies to promote its Belt-and-Road Initiative – Space Information Corridor megaproject</b>	<b>36</b>
<b>Table 6: Some Concrete 6G national projects led by Quad, Quad+ and D-10 nations (under prep)</b>	<b>37</b>
<b>Table 7: Need for an inclusive Indo-Pacific QUAD+ and D-10 with representation from Asia, Africa and South America, which are among the biggest telecom markets.</b>	<b>40</b>
<b>Table 8: Expected internet growth 2018-2023</b>	<b>41</b>
<b>Table 9: Undersea communication cable systems – Major Players</b>	<b>42</b>
<b>Table 10: Chinese Ownership in Cable Consortiums</b>	<b>43</b>



