Survey of PRC State-Sponsored Technology Transfers Affecting SBIR Programs: A DoD Case Study

Report by Protecting the National Security Innovation Base Study Group and OSE/Factor 8 Program

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Contents

Executive Summary

DoD's SBIR programs currently lack capabilities to conduct adequate due diligence to assess national security risks associated with firms applying for SBIR funding, or to monitor for compliance or national security concerns post award. SBIR programs' focus on unclassified R&D that typically fall outside the defense industrial base also means there is a lack of intelligence, security, or regulatory oversight (e.g., export controls). This leaves SBIR programs vulnerable to unauthorized or undesirable technology transfers by adversarial nations, especially China.

Recognizing these deficiencies, OUSD(R&E) Small Business and Technology Partnerships program reached out to the Protecting the National Security Innovation Base Study Group, jointly led by OUSD(I&S) and OUSD(R&E), to identify specific threats and vulnerabilities and pilot due diligence methods. This study reports on the results of these efforts. Based on our due diligence research, we provide case studies on how China has benefited from DoD's SBIR investments. A key challenge lies with the fact that many of the problematic areas identified in these case studies may not involve criminal activity, but nonetheless demonstrate national security concerns and can undermine future US military capabilities.

Research Methodology

OUSD(R&E) provided a list of SBIR applicants and grantees (over 10,000 firms), which was cross-referenced with Factor 8 Program data holdings on PRC state-sponsored talent recruitment programs. This study identified selectees of a PRC talent program who affiliated him or herself to an SBIR applicant or awardee company. An outside advisory firm also conducted its own searches on the SBIR grant data to identify any PRC entities that invested (typically venture capital) in these companies.

Supplemental due diligence research based on publicly available information was subsequently performed on a sampling of firms and associated entities identified from the two search methods. Research primarily involved: a) searches in both English and Chinese online sources on a company's business areas, ownership structures, known subsidiaries, investors, customers, or strategic partners; and b) background information on company leaders' (particularly founders and CEOs) activities, affiliations, or partnerships in China.

Limitations of This Study

This report focused almost exclusively on case studies involving entities that directly or indirectly support China's defense research and industrial base. Limited resources also constrained the number of case studies and due diligence research performed. Consequently, *this study represents a small data sample and should not be considered comprehensive or exhaustive.*

Key Findings

China appears to deploy many elements of its state-sponsored technology transfer and acquisition apparatus to exploit DoD's SBIR programs in unclassified areas that typically evade counterintelligence or law enforcement oversight. In fact, many of the threats identified in these case studies unlikely involve criminal activities, but nonetheless have national and economic security implications. **Nearly all cases show that China, not the U.S., is the ultimate beneficiary of DoD and other US government research investments, some of which are significant in size.** Examples of the types of risks identified included:

- Key employees of US firms receiving SBIR funding are recruited via a PRC state-sponsored talent program and relocate to China but continue research collaboration with officers of the US company where they were previously employed.
- Founders of US startups that obtained US government research funding dissolve US business(es) and return to China under PRC recruitment programs and continue their research at institutions that support PRC defense R&D.
- US firms establish PRC-based subsidiaries, and in some cases, later dissolve US operations and subsequently receive PRC government investments.
- US firms receive venture capital funding from Chinese sources, including state-owned enterprises that present foreign ownership, control, or influence risks.
- US firms partner with or sell products and services to PRC entities that support its defense R&D and industrial base.
- PRC researchers have conducted detailed analyses of US Navy SBIR programs over time to identify DOD technology development priorities and catalogue firms that receive the most SBIR funding.

Summary of Findings on Company Case Studies

The detailed case studies presented in this report derive from due diligence research. We provide a summary of these case studies below.

1. **Silvus Technologies** is a wireless communications development company that claims to have a large DoD customer base. Silvus has received over $21M in SBIR awards since 2005 and employed an engineer who returned to China under a state-sponsored talent recruitment program. The engineer in question received an SBIR grant from the US Navy prior to returning to China as faculty at Fudan University and a subordinate laboratory related to microelectronic waves that collaborates with PRC defense research entities. The former employee has co-authored papers with the founder and CEO of Silvus Technologies. The ongoing relationship between the company's CEO and this former employee raises technology transfer and national security concerns given his talent program association and affiliation with an institution known to conduct defense research.

2. **Lynntech, Inc** is a Texas-based firm that supports government and industry R&D in areas such as high-performance fuel cells for the US military, enhanced search-and-rescue components for the US Coast Guard, and biohazard detectors for DHS. Lynntech has

participated in the SBIR program since 1988 focusing on advanced energy storage technologies. One of its research scientists returned to China as a professor after recruitment into a PRC state-sponsored talent program. The former employee continues to collaborate professionally with a current Lynntech senior scientist. Similar to our findings on Silvus Technologies, the former employee's selection into a PRC talent program and research collaboration with Lynntech runs the risk of state-directed technology or knowhow transfers that can affect Lynntech and DoD equities.

3. **Solarmer Energy Inc**. develops polymer solar cells, a subtype of organic photovoltaics (OPV). The company received SBIR funding from DoD and National Science Foundation (NSF). One of its subsidiaries claims it received research funding from the Air Force Office of Scientific Research, Office of Naval Research, NSF, and the Department of Energy (DOE). Its other subsidiary operates as Shou Lun Organic Optoelectronics Technology (Beijing) Co., Ltd. in China. It appears that Solarmer Energy dissolved its US-based businesses and transferred its R&D and intellectual property to this Beijing entity. The Beijing-based business partners with a state key laboratory under the PRC government-run Chinese Academy of Sciences (CAS) and has undertaken research with intended defense applications.

4. **Soluxra, LLC,** a now dissolved opto-electronics and material sciences firm, was founded out of the University of Washington (UW) and received four DoD SBIR grants. The company's two co-founders were recruited by PRC talent programs while employed with Soluxra. The company employed a research scientist who was also selected into a national talent program during his time with the company. All three of these individuals worked on the same research at Soluxra during SBIR award solicitations; however, one of them submitted his application *after* being selected by China's flagship Thousand Talents Program. Following their recruitment into these talent programs, all three individuals joined universities that partner with China's State Administration for Science, Technology, and Industry for National Defense (SASTIND) as well as "Seven Sons of National Defense" schools that promote military-civil fusion efforts. All three individuals continue to collaborate on research with university departments known to conduct defense research, and two of them co-author publications with each other.

5. **Sun Innovations** is a Silicon Valley company developing nanotechnology and fully transparent digital display solutions. Sun Innovations has two subsidiaries: Superimaging Display Inc. and Superimaging-China (Suzhou Superimaging Technology). Its founder owns several PRC-based companies in addition to the Sun Innovations subsidiaries and is a selectee of multiple PRC talent and entrepreneurial incentive programs run at national and local levels. Sun Innovations claims to have received grants from NSF, National Institutes of Health (NIH), DOE, and NASA, in addition to over $1.8M in DoD funding. The company's website has removed references to the founder's selection into the Thousand Talents Program. The founder also helped create China's Suzhou Institute of Technology in 2007. This entity is an incubation platform jointly established by the CAS Institute of Physics and the Suzhou municipal government. As a result, Sun Innovations and its founder may be diverting US government-funded research to China, and further investigation is needed to

determine the extent to which, if any, the company continues its operations in the U.S.

6. **MKP Structural Design Associates,** an engineering firm founded by a research scientist working at the University of Michigan at the time, received $6M in SBIR grants from Air Force and Army from 2002 to 2011. Areas of development funded by SBIR included material science applications to military vehicles including armor and ballistic protections and runflat tire technologies. The founder / CEO was recruited by local PRC talent programs and concurrently holds multiple positions at PRC universities and CAS institutes that directly support defense research programs. An example is his professorship at an innovation base at the Beijing Institute of Technology, a university primarily focused on conducting ordnance and other weapons R&D for the People's Liberation Army (PLA). The founder also started a China-based firm that commercialized tire technology developed at MKP Structural Design and has partnered with PRC defense conglomerate NORINCO on wheeled combat vehicles.[1]

7. **LumosTech Inc** developed a sleep mask that alters a user's circadian rhythm to improve and adjust sleep cycles and received funding from the National Space Biomedical Research Institute and DoD. The national security concern lies with one of LumosTech's seed investors: Oriza Ventures Technology Fund. Oriza Ventures is a Santa Clara-based venture capital (VC) fund created by Suzhou Oriza Holdings Co., Ltd, one of China's largest state-owned VC firms and investment conglomerate. Oriza Holdings and Oriza Ventures' founders serve as an investment arm of China's flagship Thousand Talents Program. It is not known to what extent Oriza Ventures had influence or control over LumosTech's business operations.

8. **Skyline Software Systems**, a Virginia-based firm that provides 3D earth visualization software services to create interactive, photo-realistic 3D environments, established a joint venture with a China-based company. A PRC firm took over full ownership and control of that joint venture in 2020 and remains in the China market, but it continues to use tools developed by Skyline Software Systems which are also used by US defense and intelligence customers. The prior joint venture and now wholly-owned PRC firm directly supports PRC defense programs. Skyline Software applied for DoD SBIR funding in 2019. Further inquiry is needed to determine if the firm was awarded an SBIR grant through DoD or other federal agencies; nonetheless the concerns related to its China-based partners shows why due diligence on applicants is necessary to assess risks prior to SBIR award.

Additional Due Diligence Findings

The P-NSIB Study Group partnered with strategic consultancy firm Horizon Advisory to explore additional methods for identifying national security risks to SBIR programs posed by China. Horizon Advisory offered a sampling of findings that focused on two ways China's military-civil fusion strategy presents risks for small businesses and research ecosystems in the U.S.: revenue and partnerships tied to China and venture capital investments tied to Chinese funds.

[1] Due to pending review by DoD, the full profile of this entity is not provided in this report.

- Horizon Advisory provided examples of revenue and partner vulnerabilities: the first involves oceanographic instruments manufacturer RBR headquartered in Canada that has U.S. and China subsidiaries. RBR's China operations engages PRC government and academic institutions, several of which are tied to China's defense R&D and industrial base. While it is unclear if the firm directly conducts business with PLA entities or other defense institutions, its research applications are dual-use in nature. The second example is a company that partners with two PRC-based firms that directly support defense research institutes, military elements, and PLA-affiliated companies.

- Horizon also identified an SBIR grantee that received investments from PRC entities of concern. The company, Orbital Sidekick, was an SBIR Phase I and II recipient (Air Force) that received investments from a US-domiciled fund whose limited partners include PRC firm Qihoo 360 Technology. Qihoo has been added to the Entity List for posing "a significant risk of supporting procurement of items for military end-use in China."

Lastly, while our focus of this report is on risks to DoD's SBIR programs from China, we included in Appendix B a profile of a PRC-based biotech company (Sichuan Clover Biopharmaceuticals) and its founder that transferred technologies from a US company started by the same founder. The original US firm received SBIR funding from the Department of Health and Human Services. The PRC firm subsequently partnered with another firm receiving Operation Warp Speed funding to co-develop a COVID vaccine using the transferred technologies. That PRC business also received substantial investment from PRC state-owned enterprises and PRC government organs.

China's Monitoring, Analysis of DoD SBIR Programs

Scholars in China have written about the SBIR Program since 1989, citing it as a potential model for PRC S&T development as well as an information source about DoD'S R&D priorities. A 2020 article discussed in this study shows a recent example of China's monitoring of SBIR programs. The article, entitled, "Project Layout of SBIR / STTR Program Funded by the U.S. Navy," conducted bibliometric analysis of 5,955 SBIR / STTR grants awarded by the U.S. Navy between 2011 and 2017. The article also identified trends in funding levels, companies receiving grants, and technology areas receiving the most grants and funding. The article analyzed keyword changes in grant descriptions over time to help identify what they called new, emerging technology "hot spots."

This report did not evaluate the validity or accuracy of the analysis in this Chinese article with regards to US Navy development priorities. Nevertheless, China's open-source research on SBIR programs, such as identifying US businesses that receive multiple phases of SBIR funding, may offer opportunities for China's state-directed technology acquisition apparatus to target these enterprises and create vulnerabilities for DoD.

Recommendations

The case studies provided here, although representing a small sampling of companies, demonstrate the need for more robust vetting and due diligence of SBIR applicants and awardees, i.e., both pre- and post-award. China typically deploys its technology transfer apparatus targeting entities *after* they demonstrate capabilities, knowledge, and/or placement and access to federal grants or investments. Key recommendations include:

1. Initiate a pilot due diligence program that replicates the methodologies offered here and expand its scope.
2. Develop capabilities to incorporate semi-automated triaging and filtering of entities of potential concern that would then warrant human review (due diligence). Two vendors used to produce this study are potential candidates that can develop commercial solutions.
3. Apply a tiered approach in terms of level of screening (due diligence) and risk assessments depending on funding phase. Phase I recipients, for example, only require a cursory or semi-automated review prior to award consideration. Phase II and III require more robust, manually intensive efforts.
4. Incorporate a process for periodic monitoring for activities of national security concern and/or fraudulent behavior *post award* of Phase II and III funding.
5. Work with other OSD elements (R&E, I&S) that are developing risk assessment frameworks for academic research that may be incorporated into a pilot due diligence effort for SBIR awards.

Lastly, the P-NSIB Study Group has recommended the establishment of a new program office that details a due diligence line of effort in support of OUSD(R&E) and OUSD(A&S) elements that can overlap with or be incorporated into the pilot program recommended here. Consult with OUSD(I&S)/DDI/CL&S for further details.

Case Studies

Case Study 1: Silvus Technologies, Inc.

Summary of Findings

Silvus Technologies, Inc. is a technology development company focusing on wireless communications and claims to have a large US Department of Defense customer base.[2] Silvus Technologies has been an active participant in the SBIR program since 2005 and has received over $21M in total awards.[3] Silvus Technologies employed a Principal Wireless Engineer, Jiang YI, who was recruited by China's Young Thousand Talents Program while at Silvus. YI also obtained an SBIR grant supporting the US Navy covering a period after his employment at Silvus Technologies and his return to China. YI left Silvus Technologies to join the faculty of Fudan University, and he is affiliated with Fudan University's Key Laboratory for Information Science of Microelectronic Waves (EMW Lab), which closely collaborates with China's PLA and defense research entities. Additionally, YI co-authored papers with the founder and CEO of Silvus Technologies.[4]

Silvus Technologies' defense customer base, its participation in the SBIR program, and the ongoing relationship between Silvus Technologies' founder/CEO and former Silvus employee Jiang YI provides opportunities to transfer Silvus Technologies' R&D, intellectual property, and related knowhow to PRC research institutions that directly support PRC defense objectives. Given indications of this continued relationship, further investigation is warranted into the level of partnership/collaboration between Silvus Technologies and Chinese defense research.

Overview of Silvus Technologies, Inc.

Silvus Technologies, Inc. is a privately held technology development company that was founded in 2004 by Babak Daneshrad and is headquartered in Los Angeles, California. Silvus Technologies develops advanced multi-input, multi-output (MIMO) antennae technologies focused on improving broadband wireless connectivity for mission critical applications. Their technologies provide enhanced wireless data throughput, interference mitigation, improved range, mobility, and robustness for government and commercial customers.[5] They have participated in the SBIR program since 2005, receiving 43 SBIR grants / contracts totaling $21,114,200.60 in awards.[6]

[2] Information accessed at http://silvustechnologies.com/markets/military on 10 December 2020.
[3] Information accessed at https://www.sbir.gov/sbirsearch/award/all?firm=silvus&topic= on 23 November 2020.
[4] Information accessed at http://ieeexplore.ieee.org/document/7880688/ on 11 December 2020.
[5] Information accessed at https://www.prnewswire.com/news-releases/silvus-technologies-develops-low-observable-communications-waveform-301111546.html on 23 November 2020.
[6] Information accessed at https://www.sbir.gov/sbirsearch/award/all?firm=silvus&topic= on 23 November 2020.

Profile of Former Silvus Engineer Jiang YI

Jiang YI is a former Principal Wireless Engineer for Silvus Technologies, a selectee of China's Young Thousand Talents Program (part of the China's flagship government talent recruitment program) and currently a Professor in the Department of Communication Science and Engineering at Fudan University, China.[7] YI 's research focuses on array signal processing, Physical and Media Access Control (PHY/MAC) of wireless communications, mobile *ad hoc* networks, and matrix optimization. He received his BSc in electrical engineering and information science from the University of Science and Technology of China in 2001, and his MSc and PhD in electrical engineering from the University of Florida in 2003 and 2005, respectively.

From September 2005 to May 2007, YI worked as a postdoctoral researcher at the University of Colorado - Boulder. In May of 2007, he moved to San Diego, where he worked for multiple companies, including NextWave Wireless (May 2007 – Sep 2008), Qualcomm Corporate R&D (Sep 2008 - May 2012), IAA Incorporated (Jun 2012 – Feb 2013), and Silvus Technologies (Feb 2013 – Jul 2016). From 2014 to 2016, YI was also a part-time Researcher with the Electrical Engineering Department of the University of California at Los Angeles.[8] He was selected in the 12th round of the Young Thousand Talents Program in March 2016 and subsequently joined Fudan University in August 2016. [9] He has authored over 50 papers and one book, and is associated with 8 approved patents.[10]

Immediately prior to joining Fudan University, YI worked for three years at Silvus Technologies, which coincided with his selection into China's Young Thousand Talents Program. While at Silvus, YI received a 2016 SBIR grant for $149,772 for MIMO applications aboard US Navy vessels to improve wireless communication and video distribution. The award period ran from 11 August 2016 to 30 September 2017, *covering a period after his selection into the Young Thousand Talents Program and after which YI had relocated to China to join Fudan University*.[11] Although the extent of YI's research at Silvus Technologies is not specified, the company's website states that Silvus Technologies developed a new state-of-the-art waveform, mobile networked MIMO technology, as a result of more than ten years and $60 million in US government-funded R&D and commercial independent R&D (IRAD) in the areas of MIMO and mobile *ad hoc* networking (MANET).[12] Silvus Technologies continues to develop MIMO radio technology for military use, to include inter-vehicle communications, dismounted operations, perimeter security, maritime communications, unmanned vehicles, and unmanned systems.[13]

[7] Information accessed at https://ieeexplore.ieee.org/author/37085387856 on 23 November 2020.
[8] Information accessed at http://ieeexplore.ieee.org/document/7880688/ on 11 December 2020.
[9] Information accessed at http://www.1000plan.org/qrjh/article/64754 on 16 May 2017.
[10] Information accessed at https://www.eng.ufl.edu/news-events/events/ece-department-seminar-omnified-beamforming-massive-mimo-prof-yi-jiang-fudan-university-china/ on 1 December 2020.
[11] Information accessed at https://www.sbir.gov/sbirsearch/detail/1264085 on 25 November 2020.
[12] Information accessed at http://silvustechnologies.com/technology on 10 December 2020.
[13] Information accessed at http://silvustechnologies.com/markets/military on 10 December 2020.

YI and PRC Defense Research

In 2015 and 2017, YI co-authored papers with Babak Daneshrad, founder and CEO of Silvus Technologies. In 2015, YI and Daneshrad co-authored a paper for the Institute for Electrical and Electronics Engineers (IEEE) Military Communications Conference, held October 2015 in Tampa, Florida. This paper, titled. "Initial Acquisition for MANET with Simultaneous Transmissions," stated YI's affiliation with Silvus Technologies and was listed in the conference proceedings under "MILCOM 2015 Track 1 – Waveforms and Signal Processing."[14] Notably, this paper is not included on YI's list of selected publications on his faculty page on Fudan University's website,[15] and is significant because applications for the 12th Round TTP were due to Fudan University's Personnel Department in July 2015.[16]. The results of the 12th Round Young TTP selection were released by the Overseas High-level Talent Introduction Work Special Office in March 2016.[17]

In 2017, YI and Daneshrad co-authored a paper titled "A Practical Approach to Joint Timing, Frequency Synchronization and Channel Estimation for Concurrent Transmissions in a MANET."[18] This paper states YI's affiliation with Fudan University and (his prior) affiliation with Silvus Technologies; however, the paper affiliates Daneshrad with the Department of Electrical Engineering at UCLA but not Silvus Technologies.[19] This paper was published in March 2017, and was cited by Daneshrad in a presentation at the IEEE Military Communications Conference in Baltimore, MD in October 2017 [20] and by YI at the October 2017 9th International Conference on Wireless Communications and Signal Processing in Nanjing, China.[21] While we cannot confirm whether the associated research was conducted after YI returned to China in 2016, co-authorship between Daneshrad and YI as well as citing each other's work at conferences (both of which occurred in 2017 after YI returned to China) indicate continued collaboration between YI and Daneshrad, which suggests collaboration between Fudan University and Silvus Technologies, Inc.

Fudan University's Department of Communication Science and Engineering (通信科学与工程系), where YI is currently employed, focuses on intelligence communications, information networks, high-speed transmission, and integrated communication components.[22] The department also houses the Ministry of Education Key Laboratory for Information Science of Microelectronic Waves (电磁波信息科学教育部重点实验室), also known as the EMW Lab. YI's biographic data on IEEE.org states that he is affiliated with the EMW Lab.[23]

[14] Information accessed at http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=7357406 on 9 December 2020.
[15] Information accessed at http://www.it.fudan.edu.cn/People.aspx?id=36130 on 16 May 2017.
[16] Information accessed at http://www.zhangjiang.net/tabid/411/ArticleID/4048/Default.aspx on 16 May 2017.
[17] Information accessed at http://www.1000plan.org/qrjh/article/64754 on 16 May 2017.
[18] Information accessed at http://ieeexplore.ieee.org/document/7880688/ on 11 December 2020.
[19] Information accessed at https://ieeexplore.ieee.org/document/7880688/authors#authors on 17 December 2020.
[20] Information accessed at https://ieeexplore.ieee.org/document/8170847 on 17 December 2020.
[21] Information accessed at https://ieeexplore.ieee.org/document/8171035 on 17 December 2020.
[22] Information accessed at http://it.fudan.edu.cn/en/content.aspx?info_lb=28&flag=3 and http://www.1000thinktank.com/gcczj/15637.jhtml on 6 June 2017.
[23] Information accessed at https://ieeexplore.ieee.org/author/37085387856 on 23 November 2020.

EMW Lab: Fudan University's EMW Lab website indicates that it closely collaborates with PRC defense entities. Specifically, the laboratory has three adjunct professors on staff whose primary positions are at the [PLA] Air Force Engineering University in Xi'an. These professors are recognized experts in radar navigation information technology, counter synthetic aperture radar (SAR), and moving target detection.[24] The laboratory signed cooperation agreements with the China Aerospace Science and Industry Corporation (CASIC) Second Academy's National Defense Key Laboratory for Electromagnetic Radiation (航天二院电磁辐射国防重点实验室) and the Air Force Engineering University in 2011, as well as the Chinese Academy of Sciences' National Space Science Center (中科院空间中心) in 2009. Additionally, Fudan University signed cooperation agreements with 12th Bureau of the (formerly known as) PLA General Staff Department's Third Department (总参三部12局)[25] and the CASC's Shanghai Academy of Spaceflight Technology (SAST / 上海航天技术研究院) in 2012.[26] According to a 2013 article published on EMW's website, graduates from the EMW Lab have made important contributions to key military research projects, such as microwave cross-sea transmission and sea surface target recognition, and have won top military S&T awards.[27]

[24] Information accessed at http://www.emwlab.fudan.edu.cn/6994/list.htm on 10 December 2020.
[25] This organization is likely now under the Strategic Support Force.
[26] Information accessed at http://www.emwlab.fudan.edu.cn/de/70/c6972a56944/page.htm on 10 December 2020.
[27] Information accessed at http://www.emwlab.fudan.edu.cn/de/b7/c7028a57015/page.htm on 10 December 2020.

Case Study 2: Lynntech, Inc.

Summary of Findings

Lynntech, Inc. has received SBIR research funding from multiple federal agencies including DoD on improving efficiency, durability, and lifespans of fuel cells. Lynntech conducts research and development projects for the US military, Coast Guard, and Department of Homeland Security. One of the research scientists, FU Yongzhu, received SBIR funding while at Lynnntech and subsequently became a selectee of China's flagship state-sponsored talent recruitment program (Young Thousand Talents Program). FU now serves as a professor in the College of Chemistry and Molecular Engineering at Zhengzhou University in China,[28] and this department runs two PRC government research programs tied to China's economic development and national defense.[29] [30] FU currently has an active grant from the US National Science Foundation in areas that directly pertain to his prior research in the U.S. and his current research in China.[31] FU is also professionally linked to Lynntech's current Senior Research Scientist who has secured over $4M in SBIR grants from USN, Army, Defense Threat Reduction Agency, DARPA, and the Department of Health and Human Services. FU's association with Lynntech and professional connections to its senior scientist, combined with Fu's selection into a PRC talent program, may provide opportunities to transfer Lynntech's R&D, intellectual property, and related knowhow supported by SBIR funding to PRC research institutions.

Overview of Lynntech, Inc.

Lynntech is a technology development company supporting R&D requirements of both government and industry. Key Lynntech products or projects include high-performance fuel cells for the military, enhanced search-and-rescue components for the Coast Guard, and cost-effective biohazard detectors for Homeland Security. Lynntech has participated in the SBIR program since 1988.[32]

Lynntech has employed two research scientists that have conducted research funded by SBIR grants on advanced energy storage technologies (e.g., various battery and supercapacitors). One of these scientists, FU Yongzhu, was recruited through China's Young Thousand Talents Program after leaving Lynntech, and is currently on the faculty at Zhengzhou University in Henan, China. FU conducts research in the same disciplines for which he received SBIR funding while at Lynntech. A second Lynntech Research Scientist, LI Xuguang, also conducts research in energy storage technology and received SBIR funding for research on fuel cells for the DoD.[33]

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[28] Information accessed at https://www.linkedin.com/in/yongzhu-fu-95bba88/ on 20 October 2020.
[29] Information accessed at https://2001-2009.state.gov/documents/organization/96437.pdf on 9 November 2020;
[30] Information accessed at HTTPS://WEBCACHE.GOOGLEUSERCONTENT.COM/SEARCH?Q=CACHE:JOZYN4K981WJ:WWW.GOV.CN/ENGLISH/2006-01/09/CONTENT_212477.HTM+&CD=4&HL=EN&CT=CLNK&GL=PH&CLIENT=FIREFOX-B-1-D ON 30 JANUARY 2020.
[31] Information accessed at https://www.nsf.gov/awardsearch/showAward?AWD_ID=1603847&HistoricalAwards=false on 27 Ocyober 2020.
[32] Information accessed at https://www.govinfo.gov/content/pkg/CHRG-113hhrg87949/html/CHRG-113hhrg87949.htm on 27 October 2020.
[33] Information accessed at https://www.sbir.gov/sbirsearch/detail/869939 on 21 October 2020.

FU Yongzhu

FU was employed by Lynntech as a Research Scientist from 2008-2011, and subsequently became a selectee of China's Young Thousand Talent Plan (YTTP). The Young (or Youth) Talents Plan (青年千人计划; YTTP) recognizes outstanding scientists under the age of 40 and is a major component of China's flagship, state-run Thousand Talents Program, accounting for more than one-third of all Thousand Talents selectees.[34] Most YTTP awardees are Chinese postdoctoral researchers or professors working abroad when the PRC government offers them monetary awards and positions at Chinese research institutions.[35] The YTTP aims to recruit experts to transfer technologies and knowhow acquired overseas, some of which is known to support China's military modernization efforts.[36]

As a professor in the College of Chemistry and Molecular Engineering at Zhengzhou University, FU conducts research on energy conversion and storage, particularly as it pertains to fuel cells, high energy density batteries, and supercapacitors. This department at Zhengzhou University runs two research projects funded and managed by China's 973 program. [37] The 973 Program was China's on-going national keystone basic research program established in 1997 and overseen by the Ministry of Science and Technology (MOST).[38] It has subsequently been absorbed into new national S&T research programs that serve the same goals: nationally-directed R&D programs that supports projects to further China's economic, social and scientific development.[39] In a 2006 report to the U.S. - China Economic & Security Review Commission, the State Department's Office of Science & Technology Cooperation in the Bureau of Oceans & International Environmental & Scientific Affairs reported that the 973 program includes safeguarding and advancing China's national defense.[40]

While at Lynntech, FU served as a Project Manager and Principal Investigator responsible for the development of advanced anion exchange membranes for alkaline fuel cells, highly selective ion-conducting membranes for redox flow batteries, and value-added chemicals and polymers from lignocellulosic biomass.[41] FU secured over $1.4 M Phase I and II SBIR funding from USDA, DOE, and DOD while at Lynntech relating to fuel cells.[42]

FU was also Principal Investigator and Co-Principal Investigator of $500K in research projects funded by NASA, NSF, Purdue Research Foundation Grants, and Indiana University

[34] Information accessed at https://cset.georgetown.edu/wp-content/uploads/CSET-Youth-Thousand-Talents-Plan-and-Chinas-Military.pdf on 6 November 2020.
[35] Information accessed at https://cset.georgetown.edu/wp-content/uploads/CSET-Youth-Thousand-Talents-Plan-and-Chinas-Military.pdf on 6 November 2020.
[36] Information accessed at https://cset.georgetown.edu/wp-content/uploads/CSET-Youth-Thousand-Talents-Plan-and-Chinas-Military.pdf on 6 November 2020.
[37] Information accessed at http://www5.zzu.edu.cn/hxxy/info/1021/2832.htm on 9 November 2020.
[38] Information accessed at HTTPS://WEB.ARCHIVE.ORG/WEB/20080704130218/HTTP://WWW.973.GOV.CN/ENGLISH/INDEX.ASPX ON 30 JANUARY 2020.
[39] Information accessed at HTTPS://WEBCACHE.GOOGLEUSERCONTENT.COM/SEARCH?Q=CACHE:JOZYN4K981WJ:WWW.GOV.CN/ENGLISH/2006-01/09/CONTENT_212477.HTM+&CD=4&HL=EN&CT=CLNK&GL=PH&CLIENT=FIREFOX-B-1-D ON 30 JANUARY 2020.
[40] Information accessed at https://2001-2009.state.gov/documents/organization/96437.pdf on 9 November 2020.
[41] Information accessed at https://www.linkedin.com/in/yongzhu-fu-95bba88/ on 21 October 2020.
[42] Information accessed at https://www.sbir.gov/sbirsearch/award/all/Yongzhu%2520fu?firm=&topic= on 20 October 2020.

Collaborative Research Grants.[43] He is the Co-PI on a $255,022 NSF grant for research on rechargeable lithium ion batteries that is active through 2021[44], and this grant overlaps with his current research at Zhengzhou University on energy conversion and fuel cell capacity involving high density batteries.[45]

FU received a B.S. in Polymer Materials and Chemical Engineering from Tsinghua University; an M.S. in Chemical Engineering from the Chinese Academy of Sciences Dalian Institute of Chemical Physics; and a Ph.D. in Chemical Engineering from the University of Texas at Austin.[46]

LI Xuguang: LI has been employed by Lynntech since April 2012, one year after FU left Lynntech.[47] He spent the first 4 years as a Research Scientist and was promoted to Senior Scientist in February 2017. LI's work focuses on batteries, supercapacitors, and fuel cells and he has secured over $4M in SBIR funding through 10 SBIR contracts supporting the US Army, US Navy, Defense Threat Reduction Agency, DARPA, and the Department of Health and Human Services.[48] Prior to his work at Lynntech, LI was a research associate at the Department of Biomolecular and Chemical Engineering at Hong Kong University of Science and Technology and a Research Assistant at Changchun Institute of Applied Chemistry, Chinese Academy of Sciences.[49] He also received a PhD from Changchun Institute of Applied Chemistry which is tied to PRC defense research.[50] LI appears to have at least a professional connection to FU Yongzhu through and he has endorsed FU on LinkedIn in Batteries, Materials Science, and Electrochemistry.[51] LI's research is similar to FU's, and given their shared associations and FU's connection to China's talent programs, further inquiry is recommended to determine if / to what extent LI collaborates on research with FU that may allow China to access and transfer Lynntech's R&D efforts.

[43] Information accessed at https://www.linkedin.com/in/yongzhu-fu-95bba88/ on 27 October 2020.
[44] Information accessed at https://www.nsf.gov/awardsearch/showAward?AWD_ID=1603847&HistoricalAwards=false on 27 October 2020.
[45] Information accessed at http://www7.zzu.edu.cn/ccme/info/1086/1826.htm on 27 October 2020.
[46] Information accessed at http://www7.zzu.edu.cn/ccme/info/1086/1826.htm on 27 October 2020.
[47] Information accessed at https://www.linkedin.com/in/xuguang-li-37055420/ on 21 October 2020.
[48] Information accessed at https://www.sbir.gov/sbirsearch/award/all/Xuguang%2520Li?firm=&topic= on 9 November 2020.
[49] Information accessed at https://www.linkedin.com/in/xuguang-li-37055420/ on 21 October 2020.
[50] Information accessed at http://dsxt.ustc.edu.cn/zj_js.asp?zzid=5531 on November 16 2020.
[51] Information accessed at Information accessed at https://www.linkedin.com/in/yongzhu-fu-95bba88/ on 20 October 2020.

Case Study 3: Solarmer Energy, Inc.

Summary of Findings

Solarmer Energy Inc. is a solar energy company developing polymer solar cells; a subtype of organic photovoltaic (OPV). Solarmer Energy has two subsidiaries: Solarmer Materials Inc and SDK Solarmer Materials. Solarmer Materials Inc. operates as Shou Lun Organic Optoelectronics Technology (Beijing) Co., Ltd., in China and has partnerships with Professor Jianhui HOU's research efforts at the Chinese Academy of Sciences Institute of Chemistry (ICCAS), which conducts R&D in national defense areas. Professor HOU is also a recipient of several PRC state-sponsored talent program awards. Solarmer appears to have diverted its business to China, as it has dissolved its US-based businesses while retaining its PRC subsidiary.

Table 3-1: Solarmer and its Subsidiaries

Company Name	Logo	URL	Business Entity Status
Solarmer Energy, Inc.		http://solarmer.com/	DISSOLVED ; 09/2020
SDK Solarmer Materials, Inc.		http://mail.solarmer.com/home.html	DISSOLVED ; 09/2013
Solarmer Materials, Inc.	朔纶有机光电科技（北京）有限公司 Solarmer Materials Inc.	http://www.solarmer-materials.com/	UNKNOWN

Overview of Solarmer Energy, Inc.

Solarmer Energy, Inc. is an 'organic' and 'printed electronics' company focused on products designed to offer renewable, affordable, and clean energy. Founded in March 2006 in San Gabriel, California, it dissolved as of September 2020. Prior to its dissolution, Solarmer Energy Inc. formed two subsidiaries: SDK Solarmer Materials Inc. (registered in El Monte, California in November 2012, and dissolved September 2013) and Solarmer Materials Inc., also known as Shou Lun Organic Optoelectronics Technology (Beijing) Co., Ltd., which claims to have been founded in Beijing in 2009.[52] "In 2009, Solarmer established a wholly owned subsidiary in China named Solarmer Energy (Beijing), Inc. The primary role of the subsidiary is materials development and large-scale synthesis to support R&D and production activities."[53] The company first presented this information in 2012; the information has been removed since 2015.

Solarmer Energy Inc. received SBIR funding from the DoD ($299,297) and National Science Foundation (NSF) ($249,920).[54] SDK Solarmer Materials Inc. claims it received funding from the Air Force Office of Scientific Research (AFOSR), Office of Naval

[52] Information accessed at http://www.solarmer-materials.com/ on 20 October 2020.
[53] Information accessed at https://web.archive.org/web/20130310073458/http://www.solarmer.com/about_us.html on 20 October 2020.
[54] Information accessed at https://www.sbir.gov/node/15456 on 19 October 2020.

Research (ONR), NSF, and the Department of Energy (DOE).[55] Solarmer Energy[56] and SDK Solarmer Materials maintain and promote academic partnerships with the University of California, Los Angeles (UCLA), University of Chicago, PRC-based ICCAS, and industry partnerships with Phillips 66, Organic Electronics Association (OE-A), and FlexTech Alliance.[57]

Overview of Solarmer Materials Inc.

[Shou Lun Organic Optoelectronics Technology (Beijing) Co., Ltd.]
(朔纶有机光电科技(北京)有限公司)

Shou Lun Organic Optoelectronics Technology is a Beijing-based subsidiary of Solarmer Energy.[58] It appears that Solarmer Energy has dissolved its US-based businesses and transferred its R&D and intellectual property to this Beijing entity. The company's R&D appears to have been developed via DoD funding. Solarmer Materials also partners with the central PRC government-run Chinese Academy of Sciences at a State Key Lab at ICCAS (see below) to further its R&D efforts. Solarmer Materials has undertaken research that has intended defense applications for China. According to the English-language version of its website, Solarmer Materials Inc. lists partnerships with UCLA and ICCAS (中国科学院化学研究所), and company related links for Solarmer Energy Inc, Peking University, and Tsinghua University.[59] Solarmer Materials' association to Peking and Tsinghua University remain unknown.

Overview of Jianhui HOU

Jianhui HOU's (侯剑辉) resume on the ICCAS homepage states that he has been a researcher at the ICCAS State Key Laboratory of Polymer Physics and Chemistry (高分子物理与化学国家重点实验室研究员) since 2010.[60] Solarmer sponsors research at HOU's lab at the ICCAS.[61] HOU's research specialties include the development of new polymers, which are critical to the advancement of the capabilities of Solarmer's solar cells.[62] In 2010, HOU worked on an unspecified project that was funded PRC government-led 863 Program, which primarily focuses on defense research.[63] HOU is an adjunct lecturer at the University of Science and Technology Beijing (北京科技大学),[64] which is a university co-managed by China's State Administration for Science & Technology Industry for National Defense (SASTIND) that implements military-civil fusion policies. A 2015 profile of the lab in the journal "Bulletin of Chinese Academy of Sciences" (中国科学院院刊) lists "Support to National Defense" as one of the lab's five research

[55] Information accessed at http://mail.solarmer.com/partnerships.html on 19 October 2020.
[56] Information accessed at https://web.archive.org/web/20121113012943/http://www.solarmer.com/partnerships.html on 19 October 2020.
[57] Information accessed at http://mail.solarmer.com/partnerships.html on 19 October 2020.
[58] Information accessed at http://www.solarmer-materials.com/ on 20 October 2020.
[59] Information accessed at http://www.solarmer-materials.com/ on 22 October 2020.
[60] Information accessed at http://houjianhui.iccas.ac.cn/12 on 22 October 2020.
[61] Information accessed at http://www.ps-lab.ciac.cas.cn/ on 21 October 2020.
[62] Information accessed at https://web.archive.org/web/20131206213537/http://solarmer-materials.com/index.php?_m=mod_static&_a=view&sc_id=9 on 21 October 2020.
[63] Information accessed at https://www.chemsoc.org.cn/member/senior/37492.html on 5 November 2020.
[64] Information accessed at https://www.sohu.com/a/244435595_232611 on 23 October 2020.

areas, and indicates that the lab has worked on technologies relevant to space flight, missiles, warships, and large-frame aircraft.[65] An article published in the journal "Synthetic Metals" lists HOU's affiliation as the CAS Key Laboratory of Organic Solids, Institute of Chemistry and Graduate School of the Chinese Academy of Sciences.[66]

Jianhui HOU has participated in the following PRC talent recruitment and scholastic programs:

- 2013- National Science Fund for Distinguished Young Scholars (国家杰出青年科学基金资助)
- 2014- Youth Thousand Talents Program recipient ("国家人才计划"青年拔尖人才)
- 2015- Outstanding Young Scientist Award of the Chinese Academy of Sciences (中国科学院青年科学家)
- 2016- Ministry of Science and Technology Leading Youth Innovator Talent (科技部中青年科技创新领军人才)
- 2017- National Thousand Talents Program recipient ("国家人才计划" 科技创新领军人才)

ICCAS and Support to PRC Defense Research

A description of ICCAS online states that, "With respect to national defense and security, ICCAS has created a pilot production line for poly-p-phenylene benzodioxazole fiber for use in high-end equipment and military [technology] areas, which has broken the foreign monopoly on these kinds of materials." (面向国防安全，化学所建成用于高端装备和军事领域的聚对苯撑苯并二噁唑纤维中试生产线，突破了国外对该产品的垄断)[67] It is not known if Professor HOU was directly involved in this research.

[65] Information accessed at http://www.bulletin.cas.cn/publish_article/2015/6/20150620.htm on 23 October 2020.
[66] Information accessed at https://www.sciencedirect.com/science/article/abs/pii/S0379677905009215 on 28 October 2020.
[67] Information accessed at http://news.sciencenet.cn/htmlnews/2018/1/398858.shtm on 23 October 2020.

Case Study 4: Soluxra, LLC

Summary of Findings

Soluxra, a now dissolved opto-electronics and material sciences firm, was founded at the University of Washington (UW) by three individuals, two of whom (Alex JEN and Hin-Lap YIP) were recruited by PRC state-sponsored talent programs while employed at Soluxra. The company received four DoD SBIR grants between 2010 and 2014 totaling $1,099,833. Soluxra also employed a research scientist (Chang-Zhi LI) who was selected into the Young Thousand Talents Program during his time with the company. All three of these individuals worked on the same research at Soluxra during SBIR award solicitations[68]; however, one of them (Alex JEN) submitted his solicitation after being selected by China's flagship Thousand Talents Program.[69] Following their recruitment into PRC state-sponsored talent programs, all three individuals joined universities co-managed by China's State Administration for Science, Technology, and Industry for National Defense (SASTIND) that promotes military-civil fusion policies. All three individuals continue to co-author papers with SASTIND schools, and YIP and LI continue co-author papers with each other.

Soluxra co-founder Alex JEN has coauthored papers with researchers from "Seven Sons of National Defense" universities; these schools have a primary mission of supporting China's defense R&D and industrial base.[70] JEN still serves as Professor Emeritus of the Department of Materials Science & Engineering at UW while concurrently serving as full-time faculty at the City University of Hong Kong. A biography of JEN posted online claims that JEN received over $90 million in US research funding from organizations that include DoD.[71] JEN, YIP, and LI's common research while at Soluxra, their selection to PRC-sponsored talent recruitment programs, subsequent work with Chinese universities and departments that conduct defense research, and continued co-authorships with PRC defense-related schools and each other provide opportunities to transfer Soluxra's R&D, intellectual property, and related knowhow from the United States to PRC institutions that can benefit China's military.

Overview of Soluxra, LLC

Soluxra was a start-up company formed out of the University of Washington's Co Motion Lab in 2010 by University of Washington professor Alex JEN, University of Washington post-doctoral researcher Hin-Lap YIP, and University of Washington research scientist Jingdong LUO. Soluxra's original business registration was April 7, 2010, and the registration expired on April 30, 2018. Soluxra's Unified Business Identifier (UBI) number is 603007387 and according to opencorporates.com and Washington State Corporations and Charities Filing System, the company voluntarily dissolved on 3 May 2018.[72] During its existence, Soluxra developed high performance opto-electronic and electronic polymer materials and applied device design expertise to the semiconductor, telecommunications, and clean energy industries. They focused

[68] Information accessed at https://www.sbir.gov/sbirsearch/award/all/soluxra?firm=&topic= on 20 December 2020.
[69] Information accessed at https://www.sbir.gov/sbirsearch/detail/684854 on 20 December 2020.
[70] For example, see https://www.sciencedirect.com/science/article/abs/pii/S2211285517304469 accessed 25 February 2021.
[71] Information accessed at http://silab.zju.edu.cn/2012/0222/c52660a723213/page.htm on 3 March 2021.
[72] Information accessed at https://ccfs.sos.wa.gov and https://opencorporates.com/companies/us_wa/603007387 on 2 December 2020.

on new device designs for photonic polymers and electronic materials by providing efficient, reliable, and cost-effective processed components.[73] In a 2009 article, Soluxra co-founder Alex JEN explained the commercial applications and commercial benefits of their research.[74] In a 2010 Navy SBIR research grant solicitation, principal investigator and Soluxra co-founder Hin-Lap YIP described the military benefits for the same research.[75] Soluxra received four DoD SBIR grants between 2010-2014 totaling $1,099,833.

Hin-Lap YIP: Hin-Lap YIP, who also goes by Xuanli YE in Mandarin[76], is a co-founder of Soluxra and served as its Technology Director from 2010 to 2013.[77] During that time, YIP received a Navy SBIR grant for $100,000 on organic photovoltaic (OPV) solar cells.[78] The aim of OPV is to provide an Earth-abundant and low-energy-production photovoltaic (PV) solution to provide electricity at a lower cost than first- and second-generation solar technologies. [79] In his 2010 Navy SBIR grant application, YIP states that "the availability of light-weight, flexible, and low-cost solar cells would significantly increase adoption of solar technologies in the military."[80]

Figure 1: Hin-Lap YIP

In January 2013, YIP was selected into the fourth round of the Young Thousand Talent Program, but remained with Soluxra until May 2013. Between May and June 2013, YIP returned to China and in June 2013, he joined the State Key Laboratory of Luminescent Materials and Devices and the School of Materials Science and Engineering (MSE) at the South China University of Technology (SCUT).[81] SCUT is a SASTIND-affiliated school, and in 2015, the State Key Laboratory of Luminescent Materials and Devices at SCUT listed three new projects that directly support the PRC military.[82]

YIP received his Bachelors and Masters degrees in Materials Science from the Chinese University of Hong Kong. YIP completed his PhD in Materials Science and Engineering (MSE)

[73] Information accessed at https://www.linkedin.com/in/chang-zhi-li-%EF%BC%88%E6%9D%8E%E6%98%8C%E6%B2%BB%EF%BC%89-795a3754/?originalSubdomain=cn on 2 December 2020.
[74] Information accessed at https://xconomy.com/seattle/2009/02/04/uw-startup-soluxra-to-form-around-organic-solar-cell-technology/ on 3 March 2020.
[75] Information accessed at https://www.navysbir.com/10_2/177.htm on 3 March 2021.
[76] The Chinese characters for both Hin-Lap YIP and Xuanli YE are the same. 葉軒立 and 叶轩立 are exactly the same name, just written in two different styles. The names are pronounced differently in Mandarin and Cantonese.
[77] Information accessed at http://www.skllmd.com/494.html on 2 December 2020.
[78] Information accessed at https://www.sbir.gov/sbirsearch/detail/381989 on 2 December 2020.
[79] Information accessed at https://www.energy.gov/eere/solar/organic-photovoltaics-research on 3 December 2020.
[80] Information accessed at https://www.navysbir.com/10_2/177.htm on 3 March 2021.
[81] Information accessed at http://www.omsc.org.cn/zhuanjia.php?id=690 on 3 December 2020.
[82] Information accessed at http://www.skllmd.com/2361.html on 3 December 2020.

in 2008 at UW under the guidance of Professor Alex JEN. While at UW, YIP worked as a post-doctoral researcher and started Soluxra, LLC with JEN. In May 2012, while at UW and concurrent Technology Director at Soluxra, YIP was a guest speaker at SCUT discussing his OPV research.[83] Eight months later (January 2013), YIP was selected into the fourth round of the Young Thousand Talent Program and he subsequently left UW and Soluxra to return to China. In June 2013, YIP joined SCUT as a professor in the State Key Laboratory of Luminescent Materials and Devices and the School of Materials Science and Engineering (MSE), the same lab that supports defense research.

YIP has published more than 220 papers in top journals with total number of citations ~25000 and a H-index of 80. He has been named 7 times consecutively as a "Highly Cited Researcher" from 2014-2020.[84] YIP has continued to co-author academic papers with researchers affiliated with SASTIND schools and former UW and Soluxra colleague Chang-Zhi LI.[85] In 2021, YIP joined the City University of Hong Kong (CUHK) in the School of Energy and Environment where Alex JEN is now a professor.

Chang-Zhi LI: Chang-Zhi LI (李昌治) was a research associate at UW from 2010-2013 and research scientist at Soluxra from 2013-2015.[86] In both capacities, LI worked with Alex JEN on technology translation of OPV.[87] In 2015, LI was an 11th Round Young Thousand Talents Program selectee through Zhejiang University where he is currently a professor at the Department of Polymer Science and Engineering.[88]

Figure 2: Chang-Zhi LI

Zheijiang University is a SASTIND-affiliated school, and the research team with which LI is affiliated has potential defense research applications. Zhejiang University's website identifies LI as a member of the research team at the Zhejiang University State Key Laboratory of Silicon Materials (硅材料国家重点实验室).[89] The State Key Laboratory's description of its history, research areas, and faculty on its official website do not explicitly state it is engaged in defense-

[83] Information accessed at http://www.skllmd.com/494.html on 3 March 2021.
[84] Information accessed at https://www.cityu.edu.hk/see/people/prof-hin-lap-yip-angus on 3 March 2021.
[85] Information accessed at https://www.sciencedirect.com/science/article/abs/pii/S1001841719305194 and https://www.sciencedirect.com/science/article/abs/pii/S2211285519305075 on 25 February 2021.
[86] http://polymer.zju.edu.cn/osl/redir.php?catalog_id=282&object_id=4912 on 2 December 2020.
[87] Information accessed at https://www.linkedin.com/in/chang-zhi-li-%EF%BC%88%E6%9D%8E%E6%98%8C%E6%B2%BB%EF%BC%89-795a3754/?originalSubdomain=cn on 3 December 2020.
[88] Information accessed at http://www.cnicn.org/h-nd-1316.html and http://polymer.zju.edu.cn/msfkeylab/redir.php?catalog_id=18 and https://person.zju.edu.cn/en/czli on 3 December 2020.
[89] Information accessed at http://silab.zju.edu.cn/15289/list.htm on 2 December 2020.

related research.[90] However, a 2012 news item on the lab's website cited the university's intention to focus on implementing 'military-civil fusion' (军民融合) as a key part of the university's defense-related research, and directing more of the school's basic research and technological discoveries towards military purposes.[91] An inspection team from the university visited the State Key Laboratory of Silicon Materials to receive an update on the lab's support to military-civil fusion initiatives, and representative researchers from the lab carried out a "detailed discussion" with the inspection team concerning "how the lab could serve national defense science and technology" (如何为国防科技服务).[92] Additionally, a February 2012 notice on the lab's website advertised an upcoming academic report by Alex JEN from UW's Department of Materials Science and Engineering titled "Molecular Self-Assembly and Interface Engineering for Multi-Scale Devices: From Molecular Electronics to Organic Electronics."[93] JEN's bio accompanying the notice highlighted his work on projects that were funded by US Department of Defense research organizations.[94]

LI received his bachelor's degree in applied chemistry from Fudan University and his PhD in organic chemistry from Fudan University and the Chinese Academy of Sciences Shanghai Institute of Organic Chemistry. LI's current research as a professor at Zhejiang University focuses on exploring the boundaries and fundamentals of photon-to-electron conversion with cost-effective material systems and translating them into clean energy applications. LI continues to co-author academic papers with SASTIND-run schools and with colleagues Hin-Lap YIP- and Alex JEN.[95]

Alex JEN: Alex JEN (REN Guangyu / JEN Kuangyü / 任广禹)[96] is a cofounder of Soluxra, current Professor Emeritus of the Department of Materials Science & Engineering at UW, and current Lee Shau-Kee Chair Professor of Materials Science and Chair Professor of Chemistry and Materials Science at the City University of Hong Kong. He was a full-time professor at UW's Department of Chemistry from 2003-2016 while simultaneously serving as Chair Professor at Zhejiang University, a SASTIND-affiliated school in 2012.[97] He served as CUHK Provost from 2016-2020.[98]

JEN is identified as a 2012 Thousand Talents Program selectee (using the formal, alternative name for the program: Recruitment Program of Global Experts) in a 2014 notice of an academic report he gave at Zhejiang University's Department of Polymer Science and Engineering.[99] The notice stated that he was hired by Zhejiang University via the Thousand Talents Program, and JEN's University of Washington CV confirms that in 2012 he became a "Chair Professor" in

[90] Information accessed at http://silab.zju.edu.cn/15263/list.htm on 2 December 2020.
[91] Information accessed at http://silab.zju.edu.cn/2012/0511/c15275a723022/page.htm on 2 December 2020.
[92] Information accessed at http://silab.zju.edu.cn/2012/0511/c15275a723022/page.htm on 2 December 2020.
[93] Information accessed at http://silab.zju.edu.cn/2012/0222/c52660a723213/page.htm on 2 December 2020.
[94] Information accessed at http://silab.zju.edu.cn/2012/0222/c52660a723213/page.htm on 2 December 2020.
[95] Information accessed at https://www.sciencedirect.com/science/article/abs/pii/S1001841719305194 and https://www.sciencedirect.com/science/article/abs/pii/S2211285519305075 on 25 February 2021.
[96] The Wade-Giles romanization of Alex Jen's name (the style of romanization used in Taiwan) is JEN Kuangyü (or JEN Kuang-yü), which explains why his name typically appears as 'Alex K.-Y. JEN', as it does on his University of Washington faculty page. In *pinyin* romanization, the same characters are 'REN Guangyu'. Information accessed at https://depts.washington.edu/jengroup/people/jen-bio/ on 3 December 2020.
[97] Information accessed at https://depts.washington.edu/jengroup/people/jen-bio/ on 20 December 2020.
[98] https://scholars.cityu.edu.hk/en/persons/alex-jen(4633f7ec-9b81-48bc-ba68-ba9ce187f268).html on 3 December 2020.
[99] Information accessed at http://polymer.zju.edu.cn/english/redir.php?catalog_id=50161&object_id=104384 on 3 December 2020.

Polymer Science and Engineering at Zhejiang University while simultaneously holding his position with UW.[100] The Department of Polymer Science and Engineering at Zhejiang University houses the State Key Laboratory of Silicon Materials which has implied defense research, and JEN had served as Chair Professor at Zhejiang University *before* he applied for SBIR funding. JEN joined CUHK as a professor and Provost in December 2016 while remaining Professor Emeritus at UW's Department of Materials Science & Engineering.[101]

Figure 3: Alex JEN

CUHK does not state that it is engaged in defense-related research; however, JEN has co-authored papers with researchers at SASTIND-run schools (Huazhong University of Science and Technology, Wuhan University, Shanghai Jiao Tong University, South China University of Technology)[102] as well as two "Seven Sons of National Defense" universities: Nanjing University of Science and Technology and Harbin Institute of Technology.[103]

JEN received his bachelor's degree in Chemistry from Tsinghua University and his Ph.D. degree in Chemistry from the University of Pennsylvania in 1984. His research centers on the design and synthesis of functional polymers for photonic and energy applications, and he was named by Thomson Reuters as a "Highly Cited Researcher" in the past several years and one of the "World's Most Influential Scientific Minds" in 2015 and 2016 in materials science.[104] He has been recognized for his abilities in technology transfer and fund raising, and reportedly been involved in over $90 million in US research funding from organizations including the Office of Naval Research (ONR), the Air Force Office of Scientific Research (AFOSR), the Army Research Office (ARO), and (DARPA).[105]

Table 1 below provides a few examples of articles JEN has co-authored with researchers affiliated with Seven Sons of National Defense universities.

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[100] Information accessed at https://depts.washington.edu/jengroup/people/jen-bio/ on 3 December 2020.
[101] Information accessed at https://scholars.cityu.edu.hk/en/persons/alex-jen(4633f7ec-9b81-48bc-ba68-ba9ce187f268).html on 3 December 2020.
[102] Information accessed at https://www.sciencedirect.com/science/article/abs/pii/S221128552031274X, https://www.sciencedirect.com/science/article/abs/pii/S2542435120303925, https://www.sciencedirect.com/science/article/pii/S0079670019301819 and https://www.sciencedirect.com/science/article/abs/pii/S2211285519309164 on 25 February 2021.
[103] Information accessed at https://www.sciencedirect.com/science/article/abs/pii/S2211285517304469 on 25 February 2021.
[104] Information accessed at https://www.cityu.edu.hk/chem/profile/pakyj.html on 25 February 2021.
[105] Information accessed at https://scholars.cityu.edu.hk/en/persons/alex-jen(4633f7ec-9b81-48bc-ba68-ba9ce187f268).html and http://silab.zju.edu.cn/2012/0222/c52660a723213/page.htm on 3 March 2021.

Table 4-1: JEN Papers Co-Authored with Nanjing University of S&T

Co-Authorship with Seven Sons (Defense) Universities		
Co-Authors	**Article Title**	**Affiliation**
Jiangsheng Yu	"Boosting performance of inverted organic solar cells by using a planar coronene based electron-transporting layer" [106]	Key Laboratory of Soft Chemistry and Functional Materials, Ministry of Education, Nanjing University of Science and Technology
Weihua Tang	"Boosting performance of inverted organic solar cells by using a planar coronene based electron-transporting layer"[107]	Key Laboratory of Soft Chemistry and Functional Materials, Ministry of Education, Nanjing University of Science and Technology
Xiao Liu	"Fluoroalkyl-substituted fullerene/perovskite heterojunction for efficient and ambient stable perovskite solar cells"[108]	Condensed Matter Science and Technology Institute, School of Science, Harbin Institute of Technology
Ye Sun	"Fluoroalkyl-substituted fullerene/perovskite heterojunction for efficient and ambient stable perovskite solar cells"[109]	Condensed Matter Science and Technology Institute, School of Science, Harbin Institute of Technology

[106] Information accessed at https://www.sciencedirect.com/science/article/abs/pii/S2211285517304469 on 25 February 2021.
[107] Information accessed at https://www.sciencedirect.com/science/article/abs/pii/S2211285517304469 on 25 February 2021.
[108] Information accessed at https://www.sciencedirect.com/science/article/abs/pii/S2211285516304554 on 25 February 2021.
[109] Information accessed at https://www.sciencedirect.com/science/article/abs/pii/S2211285516304554 on 25 February 2021.

Case Study 5: Sun Innovations

Summary of Findings

Sun Innovations Inc. is a Silicon Valley technology company developing advanced nanotechnology and fully transparent digital display solutions. Sun Innovations has two subsidiaries: Superimaging Display Inc. and Superimaging-China (Suzhou Superimaging Technology). Sun Innovations' founder, Ted Sun, owns several PRC-based companies, and is a selectee of PRC state-run talent programs and entrepreneurial incentive programs at national and local levels. Sun Innovations claims to have received grants from NSF, National Institutes of Health (NIH), DOE, and NASA. Sun Innovations received approximately $1.8M in DoD funding. The company's website has removed references to Ted Sun's affiliations with the Thousand Talents Program. Additionally, Ted Sun facilitated the creation of the Suzhou Institute of Technology in January 2007. This entity is an incubation platform jointly established by the central-government-run Chinese Academy of Sciences, Institute of Physics (CAS) and the Suzhou New District Government. Consequently, Sun Innovations and the activities of its founder likely undermine federal investment in US innovation efforts for China's benefit.

Overview of Sun Innovations Inc.

Sun Innovations Inc. registered on June 20, 2006 in the state of California. Current subsidiary Superimaging Display Inc. has replaced Superimaging Inc., registered February 17, 2004 and dissolved April 11, 2011. Superimaging Display Inc. was registered August 20, 2020. Sun Innovations maintains corporate offices in Suzhou (Jiangsu Province) China, Taipei County, Taiwan and a headquarters in Fremont, CA. Per SBIR funding sources, Sun Innovations received grants from the following agencies: Department of Health and Human Services (HHS), NSF, DOE, DOD, and NASA. Sun Innovations officially claims NIH funding and not HHS funding, although documented funding was received from HHS.

SUN Xiaodong aka Ted Sun (孙晓东)

Education	1993 BA from University of Science and Technology of China; 1998 PhD from UC Berkeley[110]
Experience	1998-2000- GE 2000-2002- Parallel Synthesis Technologies Inc. 2002-2003- Intematix Corp.
Entrepreneurial Activity	2004- Founded Superimaging Inc. 2007- Founded Sun Innovations Corp. 2008- Founded Suzhou Juxiang Technology Co., Ltd.[111]
Talent Recruitment	2008-[Suzhou High Tech Zone S&T Innovation and Entrepreneurship Leading Talent Plan] (苏州高新区科技创新创业领军人才); [Gusu Innovative and Entrepreneurial Leadership Talent Plan]; (姑苏创新创业领军人才); Innovative Entrepreneur of Jiangsu Province (江苏省创新创业人才) 2010- Thousand Talents Program[112]

[110] Information accessed at http://www.displaysummit.com/a-novel-emissive-projection-solution-that-enables-fully-transparent-digital-display-on-any-glass-window-or-windshield/ on 3 November 2020.
[111] Information accessed at http://www.rcsz.gov.cn/index.php/show-article-cid-33-id-370.html on 3 November 2020.
[112] Information accessed at https://web.archive.org/web/20160812083640/http://superimaging-china.com/content.asp?id=2 and https://webcache.googleusercontent.com/search?q=cache:1hmP6Ab9lSUJ:liuxuehr.com/haiguirenwu/2011/0916/3771.html+&cd=1&hl=en&ct=clnk&gl=us&client=firefox-b-1-d on 4 November 2020.

In 2010, SUN Xiaodong transferred a patent filed under Superimaging Inc. to the Chinese company, Suzhou Juxiang Technology Co., Ltd. In 2011, the patent was transferred back to Superimaging Inc. before being terminated by USPTO in 2017. The patent termination was due to a non-payment of annual patent fees.[113]

Ted Sun Xiaodong is an awardee of several PRC state-run talent programs and entrepreneurial incentive programs at national and local levels, including:[114]

Figure 4: SUN "Ted" Xiaodong

- Leading Talents in Science and Technology Innovation and Entrepreneurship in Suzhou High-tech Zone
- Leading Talents in Innovation and Entrepreneurship in Suzhou
- Innovative and Entrepreneur Talents in Jiangsu Province
- 2010 National Thousand Talents Program Selectee
- "333 High-level Talents" in Jiangsu Province[115]

Table 5-1: SBIR Data on Funding for Sun Innovations Inc.

Company	Agency	Branch	Phase	Program	Award Year	Award Amount
SUN INNOVATIONS INC.	Department of Health and Human Services		Phase II	SBIR	2010	$740,641.00
SUN INNOVATIONS INC.	National Aeronautics and Space Administration		Phase II	SBIR	2009	$599,957.00
SUN INNOVATIONS INC.	National Science Foundation		Phase II	SBIR	2009	$500,000.00
SUN INNOVATIONS INC.	National Science Foundation		Phase II	SBIR	2009	$491,501.00
SUN INNOVATIONS INC.	National Science Foundation		Phase I	SBIR	2009	$100,000.00
SUN INNOVATIONS INC.	National Aeronautics and Space Administration		Phase I	SBIR	2008	$99,972.00
SUN INNOVATIONS INC.	National Science Foundation		Phase I	SBIR	2008	$100,000.00
SUN INNOVATIONS INC.	National Science Foundation		Phase I	SBIR	2008	$100,000.00
SUN INNOVATIONS INC.	Department of Health and Human Services		Phase I	SBIR	2006	$143,990.00
SUN INNOVATIONS INC.	National Science Foundation		Phase I	SBIR	2006	$100,000.00
SUN INNOVATIONS INC.	National Science Foundation		Phase I	SBIR	2006	$100,000.00
SUN INNOVATIONS INC.	Department of Energy		Phase I	SBIR	2006	$99,999.00
SUN INNOVATIONS INC.	National Science Foundation		Phase II	SBIR	2005	$497,185.00
SUN INNOVATIONS INC.	Department of Health and Human Services		Phase I	SBIR	2004	$100,000.00
SUN INNOVATIONS INC.	Department of Defense	Army	Phase II	SBIR	2004	$730,000.00
SUN INNOVATIONS INC.	Department of Defense	Missile Defense Agency	Phase I	SBIR	2004	$99,998.00
SUN INNOVATIONS INC.	Department of Energy		Phase I	SBIR	2004	$100,000.00
SUN INNOVATIONS INC.	Department of Defense	Army	Phase I	SBIR	2003	$69,738.00
SUN INNOVATIONS INC.	National Science Foundation		Phase I	SBIR	2003	$100,000.00

[113] Information accessed at https://patents.google.com/patent/CN1875318B/en?inventor=%E5%AD%99%E6%99%93%E4%B8%9C on 4 November 2020.
[114] Information accessed at https://web.archive.org/web/20160812083640/http://superimaging-china.com/content.asp?id=2 on 3 November 2020.
[115] Information accessed at https://web.archive.org/web/20160812023611/http://superimaging-china.com/list.asp?id=55 on 3 November 2020.

Superimaging Display Inc.
43239 Osgood Rd Fremont, CA 94539
[Referenced as Superimaging Technologies Inc. (STI) on the company's website]

The newly formed company's rebranding actively promotes the achievements, business relationships, and federal grants previously attributed to Sun Innovations Inc. The website states, "Superimaging Technologies Inc. (STI) has successfully conducted multiple research projects for various federal agencies, including NSF, NIH, DOE, NASA, etc. We have also conducted and delivered many developmental projects for commercial clients including VW, GM, Texas Instruments, etc." [116]

Suzhou Superimaging Technology Co., Ltd.
(苏州视由谱光电科技有限公司)

Founder and CEO: Dr. Ted SUN (孙晓东)
Address: No. 99, Northwest District Nanopolis Suzhou, Bldg. NW02, Room 405, Jinpinghu Ave., Suzhou Industrial Park, Suzhou, Jiangsu Province, China
(中国江苏省苏州工业园区金鸡湖大道99号苏州纳米城西北区NW02幢405室)[117]
Legal Representative: SUN Xiaoguang (孙晓光)

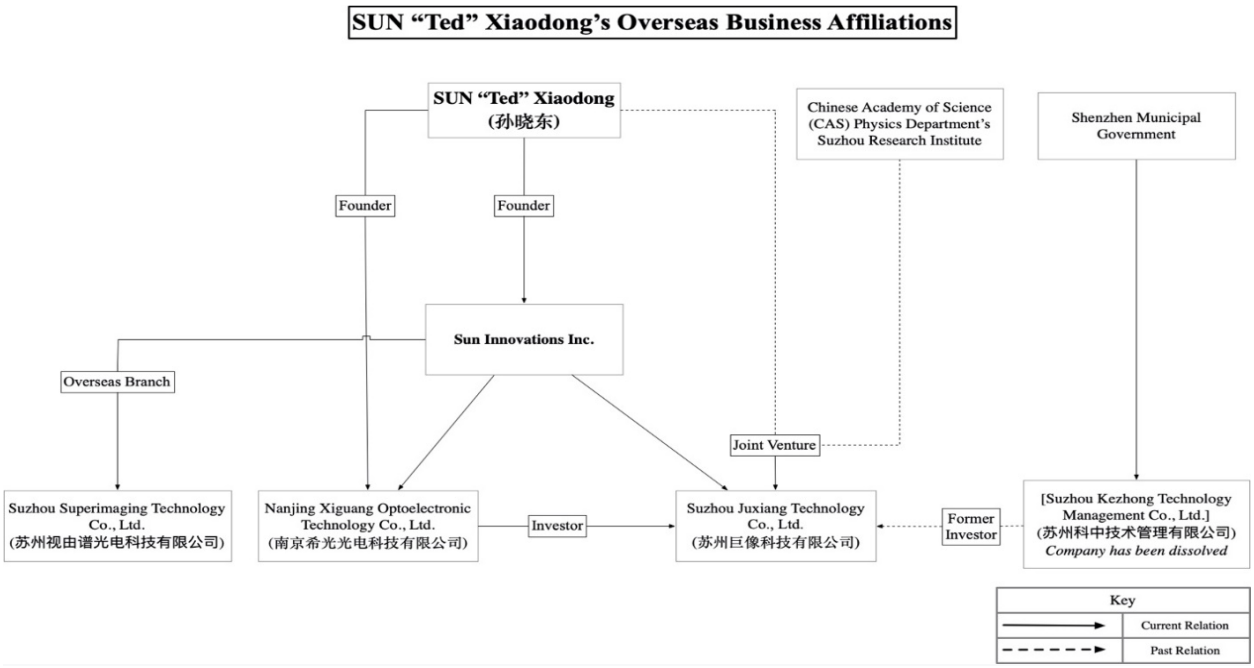
Established in 2015 at Suzhou's Nanopolis Suzhou, a high-tech industrial park, Suzhou Superimaging Technology Co., Ltd. engages in the research, development, and production of projection equipment systems and materials. The company aims to create core technologies to develop products suitable for various information display applications. The company reportedly sells fully transparent luminous projection display technology.[118] By utilizing its patented "Emissive Projection Display" (EPD) technologies, the company sells an optical film that can become a digital display for window or windshields for the automotive industry.[119] The company participated at the 2010 Shanghai International Commercial Technology Systems[120] and 2016 CES Asia exhibition.[121]

Founder Ted SUN's Stakes in PRC Companies

SUN Xiaoguang (孙晓光) (Ted SUN) is the Legal Representative of several of Sun's companies. Sun Xiaoguang holds senior positions including:

[116] Information accessed at http://www.superimaging.com/index.php/component/search/?searchword=xiao%20dong&searchphrase=all&Itemid=101 on 4 November 2020.
[117] Information accessed at https://www.qcc.com/firm/3a119cc2cf5542cb2280d2984129ced5.html on 3 November 2020.
[118] Information accessed at https://www.qcc.com/firm/3a119cc2cf5542cb2280d2984129ced5.html on 3 November 2020.
[119] Information accessed at http://www.neureuter.com.hk/ODB16/ExhibitorInfo.aspx?code=CESA2016&id=Q0VTMTZJSEMwQlJIRw===S&lang=EN on 3 November 2020.
[120] Information accessed at https://webcache.googleusercontent.com/search?q=cache:g1l_19CPbisJ:www.cnph.cn/mobile/exhibit/show-26009.html+&cd=18&hl=en&ct=clnk&gl=us&client=firefox-b-1-d on 4 November 2020.
[121] Information accessed at http://www.neureuter.com.hk/ODB16/ExhibitorInfo.aspx?code=CESA2016&id=Q0VTMTZJSEMwQlJIRw===S&lang=EN on 4 November 2020.

- Suzhou Superimaging Technology Co., Ltd. (苏州视由谱光电科技有限公司) -Executive Director, Legal Representative, Sole Shareholder.[122]
- Suzhou Juxiang Technology Co., Ltd. (苏州巨像科技有限公司)- Director. Ted SUN's Sun Innovations Inc. is the majority shareholder at 87.07%.
- Nanjing Xiguang Optoelectronic Technology, which is entirely owned by Ted SUN, is Suzhou Juxiang Technology's minority shareholder and holds 12.93% equity.
- SUN directly and indirectly owns all of Suzhou Juxiang Technology's equity.[123]
- Nanjing Xiguang Optoelectronic Technology Co., Ltd. (南京希光光电科技有限公司) [124] The company's equity is entirely held by Ted SUN.
- Wuxi Baolizhen Anti-Counterfeiting Technology Co., Ltd. (□ 锡□ 丽真□ 伪□ □ □ □ □ □) - (Company status: Inactive) Executive Director, Legal Representative, Sole Shareholder.[125]



[122] Information accessed at https://www.qcc.com/firm/3a119cc2cf5542cb2280d2984129ced5.html on 3 November 2020.
[123] Information accessed at https://www.qcc.com/firm/c361bc8eb3bc608496f854ed28380d73.html on 4 November 2020.
[124] Information accessed at https://patents.google.com/patent/CN102002365B/en?inventor=%E5%AD%99%E6%99%93%E4%B8%9C and https://www.qcc.com/firm/f22437a3132970b5d34333304c1b0dd5.html on 4 November 2020.
[125] Information accessed at https://www.qcc.com/firm/5dc6cf9228b73516ab90c8e687b485d6.html on 4 November 2020.

Case Study 6: LumosTech Inc

Summary of Findings

LumosTech Inc is a consumer electronics company that has developed a sleep mask that alters the user's circadian rhythm to improve and adjust sleep cycles. The company received funding from the National Space Biomedical Research Institute (NSBRI) in 2016 [126] and DoD in 2019.[127] LumosTech raised one round of funding totaling $1M from five investors in July 2016.[128] One of these investors, Oriza Ventures Technology Fund, L.P. (元禾硅谷基金), represents national security concerns.[129] The other investors were Bolt Innovation Group, StartX (Stanford StartX Fund), Grit Ventures, and Leadon Wang;[130] (Note that an alternative source lists Plug and Play Tech Center as an "accelerator/incubator with a minority holding.[131]) Oriza Ventures is a US$100 million venture capital fund based in Santa Clara, California that started in May 2015 by Suzhou Oriza Holdings Co., Ltd. (苏州元禾控股股份有限公司). Suzhou Oriza Holdings is one of China's largest venture capital firms and a major state-owned investment conglomerate. Through this parent organization and the company's founders, Oriza Ventures is tied to PRC entities and state-sponsored talent recruitment programs, including China's flagship Thousand Talents Program, that enable the transfer of technology from the U.S. to China.

Overview of LumosTech Inc

LumosTech Inc was co-founded by Vanessa Burns and Biquan LUO in February 2016.[132] The company received the Space Medical and Related Technologies Commercialization Assistance Program (SMARTCAP) [133] Award (NCC 9-58-HFP00005) to fund a study with NSBRI that listed Vanessa Burns as the Principal Investigator and was completed November 2016.[134] Former personnel from NASA were participants in a demonstration for a LumosTech prototype; it is unclear if NASA participated in a financial or an experimental capacity.[135] LumosTech was

[126] Information accessed at https://taskbook.nasaprs.com/tbp/index.cfm?action=public_query_taskbook_content&TASKID=10646 on 4 December 2020.
[127] Information accessed at https://govtribe.com/award/federal-contract-award/purchase-order-h9240519p0044 on 4 December 2020.
[128] Information accessed at https://pitchbook.com/profiles/company/102181-87 on 4 December 2020.
[129] The firm's English name is almost always used – even in Chinese sources – so it is unclear if it has an official Chinese translation for its name. The Chinese name included here is sometimes used in Chinese sources. Information accessed at http://www.oriza.com.cn/news.aspx?action=detials&id=903&nav=23&inpage=1&typeid=0; and at http://www.sandlake.com/details.aspx?ID=336&ColumnID=18; and at https://www.sec.gov/Archives/edgar/data/1660936/000166093615000001/xslFormDX01/primary_doc.xml on 27 January 2017.
[130] Information accessed at https://www.crunchbase.com/organization/lumostech/company_financials on 4 December 2020.
[131] Information accessed at https://pitchbook.com/profiles/company/102181-87#investors on 4 December 2020.
[132] Information accessed at https://businesssearch.sos.ca.gov/CBS/SearchResults?filing=&SearchType=CORP&SearchCriteria=lumostech&SearchSubType=Keyword on 4 December 2020.
[133] Information accessed at http://nsbri.org/2015/11/space-institute-to-fund-electronic-adjustable-power-eyeglasses-and-a-smart-sleep-mask/ on 4 December 2020.
[134] Information accessed at https://taskbook.nasaprs.com/tbp/index.cfm?action=public_query_taskbook_content&TASKID=10646 on 4 December 2020.
[135] Information accessed at http://nsbri.org/researches/lumostech-smart-sleep-mask-circadian-realignment-space-earth/ on 7 December 2020.

awarded a $150,000 DoD contract for a feasibility study with U.S. Special Operations Command (SOCOM) that concluded February 2020.[136]

Overview of Oriza Ventures

The national security concerns lies with one of LumosTech's investors: Oriza Ventures.[137] This firm was the first US-based venture capital fund created by Suzhou Oriza Holdings Co., Ltd., a major state-owned investment conglomerate with 19 direct subsidiaries,[138] 51 subordinate investment funds,[139] and 41.1 billion RMB in managed funds.[140] Oriza Ventures has a portfolio of more than two dozen investments in US- and Canadian-based start-ups and a close working relationship with a component of China's flagship talent program – the Thousand Talents Start-up Contest. Oriza supports the contest's regional semi-final in Silicon Valley.

Oriza Ventures was launched as an important addition to Oriza Holdings' globalization strategy.[141] Oriza Ventures' founding partners John YU and Alex LIANG are active in assisting PRC state-backed talent recruitment program and start-up contest activities in the United States as well as part of networks of PRC state-backed investment entities. For example, Oriza Ventures debuted as a local organizer of the Silicon Valley regional semi-finals of the Thousand Talents Start-up Contest in 2016, and John Yu and Alex Liang were both active participants in the Contest.[142]

The Office of the U.S. Trade Representative (USTR) published a report in November 2018 stating that PRC state-backed venture capital firms like Oriza Ventures aim to divert U.S. technologies to China.[143] Oriza Ventures has invested approximately US$2.7 billion in U.S. startups from 2001 to 2018 [144] and established the Thousand Talents Venture Capital Center (TTVCC / 千人计划创投中心) in Suzhou, Jiangsu province.[145] As Oriza Holdings' former chairman LIN Xianghong stated at the Thousand Talents Taihu Summit in 2011, Oriza Holdings

[136] Information accessed at https://govtribe.com/award/federal-contract-award/purchase-order-h9240519p0044 on 4 December 2020.
[137] In addition to Pitchbook referenced earlier, two sources online indicate Oriza Ventures' investment in LumosTech: https://investorhunt.co/investors/alex-liang; and https://golden.com/wiki/LumosTech#Funding-rounds, accessed on 25 February 2021.
[138] Information accessed at http://www.cninfo.com.cn/finalpage/2015-11-06/1201758638 on 3 November 2016.
[139] Information accessed at http://vc.1000plan.org/details.aspx?ID=514&ColumnID=16 on 17 January 2017.
[140] Information accessed at http://www.oriza.com.cn/AboutUs.aspx on 26 January 2017.
[141] Information accessed at http://www.sandlake.com/details.aspx?ID=336&ColumnID=18 on 27 January 2017.
[142] Information accessed at http://contest.1000plan.org/news/2016-06-24/538.html; and at http://events.cwsanfrancisco.cbslocal.com/santaclara/events/1000-plan-startup-contest-silicon-valley-region-/E0-001-093312043-8 on 9 January 2017.
[143] Information accessed at https://ustr.gov/sites/default/files/enforcement/301Investigations/301%20Report%20Update.pdf on 4 December 2020.
[144] Information accessed at https://ustr.gov/sites/default/files/enforcement/301Investigations/301%20Report%20Update.pdf; and https://www.o-hr.com/html/sipac/gqzp-12.pdf on 4 December 2020.
[145] Information accessed at https://www.eventbrite.com/e/when-innovation-meets-capital-vc-summit-and-demo-day-tickets-17767801974# on 8 May 2017. Shahu Finance Service LLC, the Sandlake Equity Investment Center, and the Thousand Talents Venture Capital Center are each profiled in DGI's February 2017 report on "China's Thousand Talents Venture Capital Center."

had always focused on early-stage venture capital investment, specifically because – as a state-owned enterprise – it needed to follow government priorities.[146]

Overview of the Thousand Talents Venture Capital Center

The TTVCC is China's first and only comprehensive investment and financing platform specifically dedicated to the Thousand Talents Program, and its stated purpose is to use venture capital resources to serve Thousand Talents personnel. The program has established a comprehensive institutional ecosystem to support Thousand Talents Program entrepreneurial talents, with mentoring, networking, and substantial investment resources.

The TTVCC's presence and influence in the United States has been achieved through its organization of the annual Thousand Talents Start-up Contest, which gives entrepreneurs the chance to find investment backing to establish companies in China. The Contest holds an annual regional competition in Silicon Valley to identify and recruit promising local entrepreneurs. These regional contests attract significant interest from major PRC investment firms and have helped China establish itself in the Silicon Valley venture capital market.

Oriza Holdings established the Thousand Talents Seed Fund as a 150 million RMB fund, with the purpose of "attracting even more overseas high-level talents to return to China to start a new business, and to take advantage of the flourishing domestic venture capital opportunities for returnee entrepreneurial talents."

The state-owned investment firm, Oriza Holdings, has provided the TTVCC with its main institutional and financial backing, and plays a leading role in its activities. Oriza Holdings maintains the Thousand Talents Growth Fund (千人计划″成长基金) and Thousand Talents Seed Fund (千人计划″种子基金); both funds are associated with the TTVCC.

It is not known if the Thousand Talents Program and its start-up contest component targeted or recruited any individuals affiliated with LumosTech. Nevertheless, Oriza's state-backing and role in supporting talent recruitment activities warrant further scrutiny to determine what extent, if any, China has benefitted from LumosTech through its investments.

[146] Information accessed at http://www.oriza.com.cn/news.aspx?action=detials&id=282&nav=23&inpage=6&typeid=0 on 6 February 2017.

Case Study 7: Skyline Software Systems

Summary

Skyline Software Systems is a Virginia-based company that formed a joint venture with PRC-based company Tairui Shu Chuang Ke (Beijing) Co., Ltd. (泰瑞数创科(北京)有限公司), aka Terra-IT in 2013.[147] The joint venture was called [Tairui Tianji Technology (Beijing) Co., Ltd.], (泰瑞天际科技(北京)有限公司) and was known in English as Skyline Globe. Skyline Software Systems provides full motion video and geospatial capabilities and appears to directly support PRC defense activities and programs. Skyline Software Systems operated 41% of Skyline Globe until 2020, at which time Terra-IT assumed full ownership.[148] Skyline Globe is now a separate and fully China-owned company that uses Skyline software. Skyline Software Systems also partners with Yuneec, a Chinese drone manufacturer that sources autonomous and navigation systems from a vendor that partners with PRC defense company Inspur.[149]

Skyline Software Systems applied for a Small Business Innovation and Research (SBIR) grant through US Special Operations Command (US SOCOM) sponsorship to advance Multi-Full Motion Video Fusion 3D capabilities. Further inquiry is needed to determine if the firm was awarded an SBIR grant through DoD or other federal agencies. Skyline Software Systems' capabilities support defense training and operations through aided decision tools that assist with battlefield terrain analysis, military equipment information queries, situation mapping, GPS tracking and positioning, and coordinated operations. These capabilities stem from software used by both PRC and US defense markets that may risk exposure of US military operations, systems, or capabilities to the PRC.

Skyline Software Systems in the United States

Skyline Software Systems provides 3D earth visualization software services through a platform of applications, tools, and services to create interactive, photo-realistic 3D environments. Their products are used in both defense and commercial sectors, and they operated in China until February 2020 under the Skyline Globe name.[150] Skyline's name is still hosted on the PRC-based website skylineglobe.cn.

Skyline Software Systems primarily serves six industries: Defense and Intelligence; Public Safety; Urban and Transportation Planning; Utilities, Oil and Gas; Mapping and Surveying, and Agriculture and Mining.[151]

[147] Information accessed at http://roll.sohu.com/20130916/n386681948.shtml non 6 October 2020.
[148] Information accessed at http://skylineglobe.cn/ on 7 October 2020.
[149] Information accessed at https://www.defense.gov/Newsroom/Releases/Release/Article/2328894/dod-releases-list-of-additional-companies-in-accordance-with-section-1237-of-fy/ on 16 November 2020.
[150] Information accessed at http://skylineglobe.cn/ on 7 October 2020.
[151] Information accessed at https://www.skylinesoft.com/home on 7 October 2020.

- Defense and Intelligence: Skyline Software Systems provides geospatial capabilities to support military operations through mission planning, rehearsal, and debriefing; command and control; asset tracking; and intelligence analysis.[152] Skyline Software Systems claims these capabilities are used by the US Army, Colombian Air Force, and BlueBird UAV Systems.[153]
- Public Safety: Skyline Software provides web or desktop applications with capabilities aimed at emergency preparedness and response. Specific focus areas: planning and simulation; command and control; asset tracking.[154]
- Urban Transportation Planning: Skyline Software Systems provides support to urban transportation planning through accurate 2D and 3D geospatial data.[155]
- Utilities, Oil and Gas: Skyline Software Systems uses their 3D geospatial tools (Terrabuilder, PhotoMesh, TerraExplorer) and hosting services to optimize resources and to cost-efficiently plan and manage utility projects.[156]
- Mapping and Surveying: Skyline's geospatial software allow mapping professionals and surveyors to easily process, save, and share large (or small) volumes of data to meet schedule demands and business requirements.[157]
- Agriculture and Mining: Skyline uses authoring and dissemination tools contained in Terrabuilder, PhotoMesh, TerraExplorer and hosting services to efficiently manage land use projects.[158]
- Unmanned Aerial Systems Integrators: Skyline Software Systems developed PhotoMesh UAV, an advanced professional photogrammetry software solution for Unmanned Aerial Vehicle (UAV) users. [159]

A key concern is that Skyline Software Systems lists one of their technology partners as Yuneec, a Chinese drone manufacturer based in Jinxi, Kunshan, a town in the Chinese province of Jiangsu.[160] Yuneec specializes in the development and production of UAVs for aerial photography, and as of September 2019, they represented three percent of the US market share for commercial drones.[161] In 2016, Yuneec began sourcing autonomous navigation software from Intel Corporation who maintains a strategic partnership with Inspur, China's largest server producer which the DoD has identified as a "Communist Chinese military company".[162] [163] In 2019, the Department of Homeland Security issued an alert warning that Chinese-made drones could pose a cyber-espionage risk to American businesses and other organizations that use them.[164]

[152] Information accessed at https://www.skylinesoft.com/defense-and-intelligence-operations on 8 October 2020.
[153] Information accessed at http://www.skyline.co.il/SkylineGlobe/corporate/industries/industries.aspx on 26 October 2020.
[154] Information accessed at http://www.skyline.co.il/SkylineGlobe/corporate/industries/public_safety.aspx on 26 October 2020.
[155] Information accessed at https://www.skylinesoft.com/urban-planning-transportation on 26 October 2020.
[156] Information accessed at https://www.skylinesoft.com/utilities-oil-gas on 26 October 2020.
[157] Information accessed at https://www.skylinesoft.com/mapping-and-surveying on 26 October 2020.
[158] Information accessed at https://www.skylinesoft.com/agriculture-mining on 26 October 2020.
[159] Information accessed at https://www.skylinesoft.com/skyline-uav on 2 November 2020.
[160] Information accessed at https://www.skylinesoft.com/home on 6 October 2020.
[161] Information accessed at https://droneii.com/drone-manufacturer-market-shares-dji-leads-the-way-in-the-us on 24 November 2020.
[162] Information accessed at https://newsroom.intel.com/chip-shots/yuneec-typhoon-h-with-intel-realsense-technology-available-for-preorder/#gs.mjsu4d on 16 November 2020.
[163] Information accessed at https://www.defense.gov/Newsroom/Releases/Release/Article/2328894/dod-releases-list-of-additional-companies-in-accordance-with-section-1237-of-fy/ on 27 November 2020.
[164] https://edition.cnn.com/2019/05/20/politics/dhs-chinese-drone-warning/index.html

Skyline Software Systems Activity in China

In a company news release dated May 27th, 2013 Skyline Software Systems stated:

> "Skyline Software systems is pleased to announce that it has entered into an agreement with Terra InfoTech (Beijing) Co, Ltd, with intent to establish a joint venture company (JV) in the People's Republic of China. Skyline and Terra InfoTech believe that such a partnership will enhance the two companies' efforts to deliver world-class geospatial applications and services in the PRC. As part of the agreement and in the transition period prior to the formation of the JV, Terra InfoTech will be granted rights to distribute Skyline's products and handle the related business in the market. After the formation of the JV, it will assume exclusive distribution and marketing rights to Skyline's software in the PRC and would be responsible for providing technical support for the Skyline products. Both companies believe that the through the establishment of such a partnership, business customers, governmental customers and internet customers at a wider-range can be supported in the best way."[165]

On 29 August 2013 a Chinese online news source reported that "the first Skyline Globe China Partner and Skyline V6.5 conference with the theme of "Integration and Innovation, Win-Win cooperation" was held in Beijing. This conference appears to be the first mention of Skyline China's presence.[166] Skyline Software Systems President, Ronnie Yaron, attended the conference and was quoted by the article as saying that one direction for future product development was to "integrate richer geographic information and support as many geographic information sources as possible, such as Lidar's point cloud data, aerial remote sensing data, and three dimensional map data."[167] This product development is currently displayed on the Skyline Globe website under Solutions – "military and national defense" (军事国防).[168]

Skyline Globe Financials

The JV between Skyline Software systems and Terra-IT was established in 2014 with the name [Tairui Tianji Technology (Beijing) Co., Ltd.], (泰瑞天际科技(北京)有限公司) after ten years of partnership and cooperation between the two companies. [Tairui Tianji Technology (Beijing) Co., Ltd.] has been known by several trade names in English, including Skyline Globe, Skyline China (Skyline中国), and SmartEarth Technology Co., Ltd.[169] Prior to 2020, Skyline Software Systems, Inc. ad Terra-IT owned 49% and 51% of the joint venture respectively. As of February 2020, it is wholly owned by Tairui Shu Chuang Ke (Beijing) Co., Ltd.[170] Skyline Globe is also known as Terry Skyline Technology (Beijing) Co., Ltd. and their capability suite is referred to as the Skyline Globe series of software.[171]

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[165] Information accessed at http://www.skyline.co.il/SkylineGlobe/corporate/news/PressReleasePage.aspx?id=TerraInfoTech on 8 October 2020.
[166] Information accessed at http://roll.sohu.com/20130916/n386681948.shtml on 21 October 2020.
[167] Information accessed at http://roll.sohu.com/20130916/n386681948.shtml on 21 October 2020.
[168] Information accessed at http://www.skylineglobe.cn/sdetail.aspx?SolutionID=8 on 8 October 2020.
[169] Information accessed at http://www.tleerw.com/en/exhibitors/2018%20Exhibitors/1701.html on 16 November 2020.
[170] Information accessed at http://skylineglobe.cn/ndetail.aspx?NewsID=172 on 8 October 2020.
[171] Information accessed at http://www.tleerw.com/zsxx/zssy/2018zssy/2018/0906/1667.html on 27 October 2020.

Table 7-1: Corporate Registration Data for Skyline Globe[172]

Registered capital (注册资本)	7.43 million RMB	Paid-in capital (实缴资本)	N/A
Operating status (经营状态)	In operation	Date of establishment (成立日期)	2014-04-09
Legal representative (法定代表人)	LIU Junwei (刘俊伟)		
Unified social credit number (统一社会信用代码)	9111010809487359XJ	Tax ID number[173] (纳税人识别号)	9111010809487359XJ
Registration number (注册号)	110000450256398	Organization code (组织机构代码)	09487359X
Company type (企业类型)	Limited Liability Corporation (有限责任公司(法人独资)	Industry (所属行业)	Technology promotion and application services industry (科技推广和应用服务业)
Inspection date (核准日期)	2020-08-12	Registering organization (登记机关)	Beijing Administration for Industry and Commerce, Haidian branch (北京市工商行政管理局海淀分局)
Location (所属地区)	Beijing	English name (英文名)	N/A
Prior name(s) (曾用名)	N/A	Social security participants (employees) (参保人数)	28
Employees (人员规模)	Less than 50 (少于50人)	Operating period (营业期限)	2014-04-09 - 2034-04-08
Address (企业地址)	No. 1 Courtyard, South Baosheng Rd., Building 26, 5th Floor, Suite 501, Haidian District, Beijing, PRC (北京市海淀区宝盛南路1号院26号楼5层501号)		

A. Skyline Globe Shareholders and Leadership

[172] Unless otherwise noted, information for this profile found at https://www.qcc.com/firm/d4e35752b3b2e92122127b8e6faa084f.html; and at https://www.qixin.com/company/7ad1fe3a-6feb-4bcf-8268-a4a09fbd74bd on 6 October 2020.

[173] A company's Tax ID number is generally the same as its unified social credit number.

As of 20 February 2020, Terra-IT,[174] aka [Tairui Shu Chuang Ke (Beijing) Co., Ltd.][175] owns 100 percent of Skyline Globe and is its sole shareholder.[176] The corporate officers for Skyline Globe are:[177]

- Liu Junwei (刘俊伟), Director (经理) and Executive Director (执行董事) - LIU is also the majority shareholder for Skyline Globe's parent company - Terra-IT, aka Tairui Shu Chuang Ke (Beijing) Co., Ltd.[178]
- Yang Fei (杨菲), Supervisor (监事).

Prior to 20 Feb 2020, Skyline Globe was registered in China as a joint venture (合资公司) between Terra-IT and Skyline Software Systems Inc., identified as a "foreign company."[179] After 20 February 2020, Terra-IT became the sole owner and increased Skyline Globe's registered capital from 500,000 RMB (approx. US$70,000) to 3.06 million RMB (approx. US$435,000).[180]

B. Skyline Globe Support to PRC Defense

Skyline Software Systems support to PRC defense programs and activities can be traced to their SkylineGlobe 6.5 Technology Overview dated August 2013.[181] The document outlines Skyline Globe's support to "3D Defense and Intelligence" where their software solutions serve as a "defense-wide infrastructure that simultaneously supports mission planning, training and exercises, and command and control activities."[182] The SkylineGlobe 6.5 name is the same as the Skyline Globe China Partner and Skyline V6.5 conference held in Beijing; the TerraBuilder, TerraExplorer, and PhotoMesh capabilities outlined in the 2013 document are the same capabilities currently outlined on the Skyline Globe website.

Skyline Globe's website includes a page on Solutions – one section of which is listed as "military and national defense" (军事国防).[183] On this page, Skyline Globe advertises that their company "has introduced the world's advanced 3D geographic information technology into the military field, and developed a series of 3D military information comprehensive exercise products suitable for…military combat training."[184] The Skyline Globe website further states that the main functions of this capability are reproduction of battlefield terrain, aided decision tools,

[174] 2013 press release from Skyline Software Systems, Inc. announcing creation of a joint venture in China states that its Chinese partner is "Terra InfoTech (Beijing) Co., Ltd." Information accessed at http://www.skyline.co.il/SkylineGlobe/corporate/news/PressReleasePage.aspx?id=TerraInfoTech on 8 October 2020.
[175] Homepage is http://www.terra-it.cn/. It's corporate registration page is accessed at https://www.qcc.com/firm/833600f4f7300e0c1ab033fb472b3995.html on 8 October 2020.
[176] Information accessed at https://www.qixin.com/company/7ad1fe3a-6feb-4bcf-8268-a4a09fbd74bd on 6 October 2020.
[177] Information accessed at https://www.qixin.com/company/7ad1fe3a-6feb-4bcf-8268-a4a09fbd74bd on 6 October 2020.
[178] Information accessed at https://www.qcc.com/firm/833600f4f7300e0c1ab033fb472b3995.html on 8 October 2020.
[179] Information accessed at https://www.qixin.com/company/7ad1fe3a-6feb-4bcf-8268-a4a09fbd74bd on 6 October 2020.
[180] Information accessed at https://www.qixin.com/company/7ad1fe3a-6feb-4bcf-8268-a4a09fbd74bd on 6 October 2020. Currency exchange information based on 20 February 2020 exchange rate of 1 RMB = 0.1423863968 USD. Information accessed at https://www.xe.com/currencytables/?from=CNY&date=2020-02-20.
[181] Information accessed at http://www.skylineglobe.com/skylineglobe/corporate/pdf/skylineglobe%20products.pdf on 3 November 2020.
[182] Information accessed at http://www.skylineglobe.com/skylineglobe/corporate/pdf/skylineglobe%20products.pdf on 3 November 2020.
[183] Information accessed at http://www.skylineglobe.cn/sdetail.aspx?SolutionID=8 on 8 October 2020.
[184] Information accessed at http://www.skylineglobe.cn/sdetail.aspx?SolutionID=8 on 27 October 2020.

military equipment information query, situation mapping, GPS tracking and positioning, and coordinated operations.[185] Figures 4-10 below are screenshots taken from the company's website showing military applications of its products.

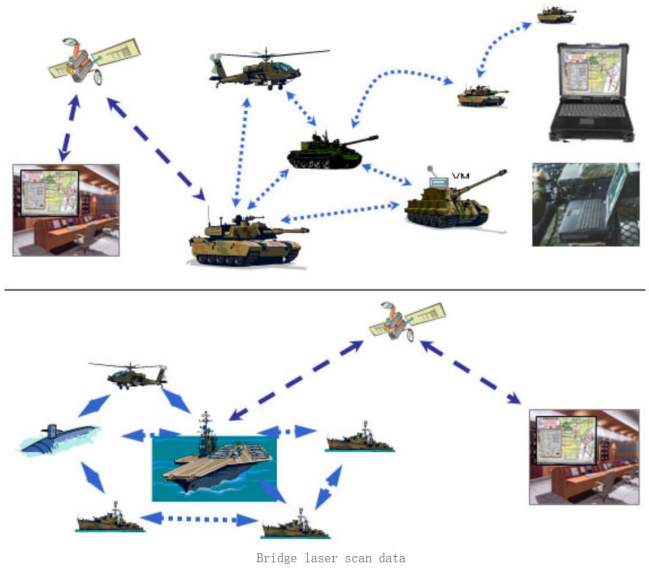

Figure 5: Skyline Globe Operational View of 3D Geospatial Support to Chinese Defense

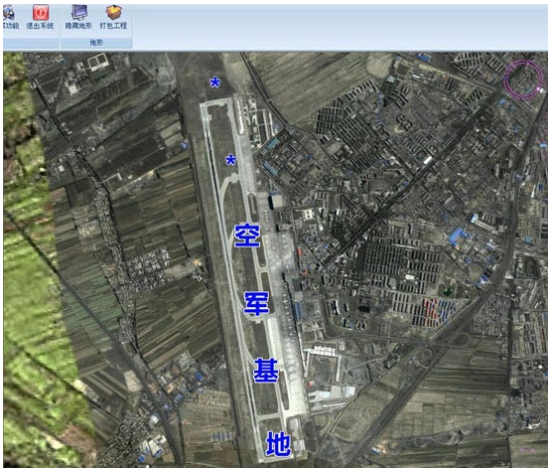

Figure 6: Skyline Globe Software Supporting Battlefield Terrain[186] ***The Chinese characters read "**Air Force Base" – the '**' is a common method of obfuscating sensitive or classified names***

[185] Information accessed at http://www.skylineglobe.cn/sdetail.aspx?SolutionID=8 on 27 October 2020.
[186] Information accessed at http://www.skylineglobe.cn/sdetail.aspx?SolutionID=8 on 8 October 2020.

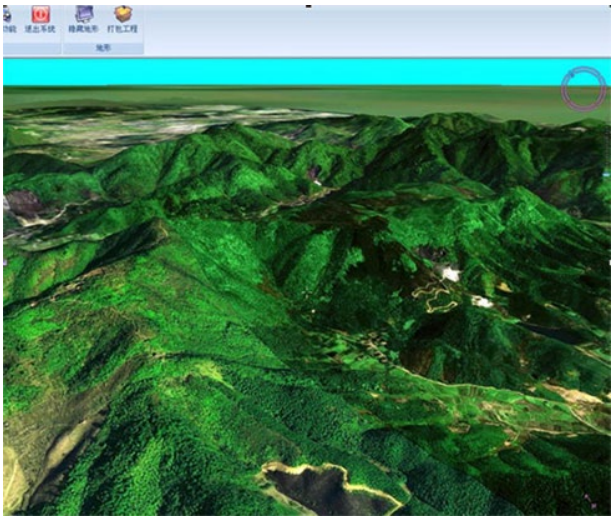

Figure 7: Skyline Globe Software Supporting Battlefield Terrain[187]

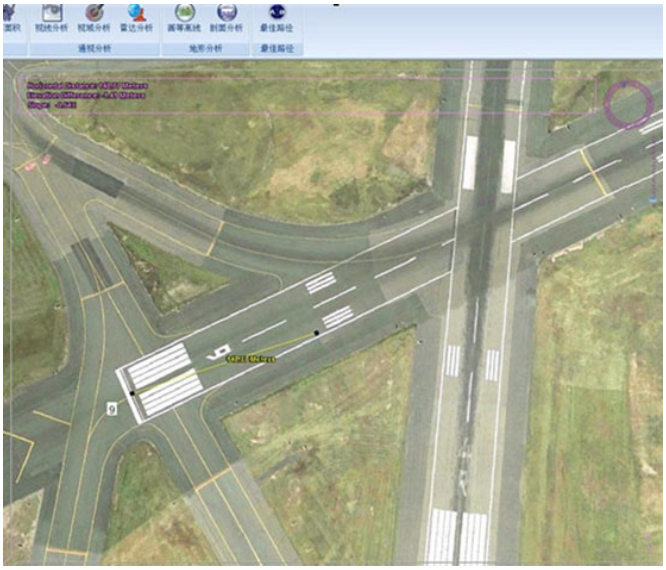

Figure 8: Skyline Globe Software Aided Decision Tools[188]

[187] Ibid.
[188] Information accessed at http://www.skylineglobe.cn/sdetail.aspx?SolutionID=8 on 8 October 2020.

Figure 9: Skyline Globe Software Military Equipment Query Tool[189]

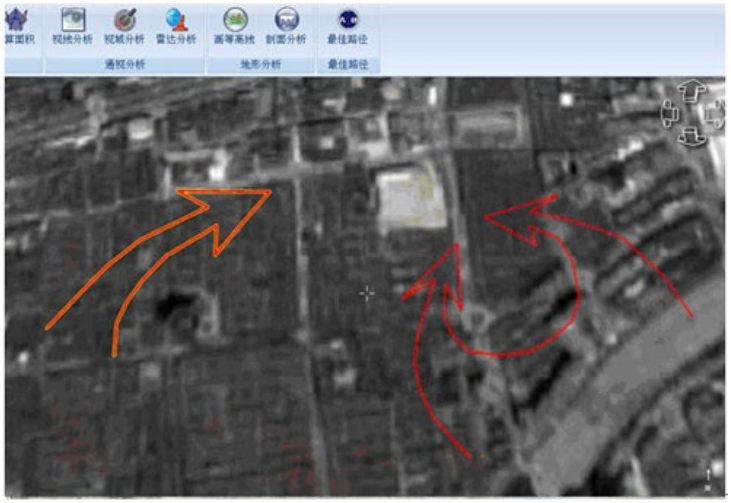

Figure 10: Skyline Globe Software Situation Mapping Tool[190]

[189] Information accessed at http://www.skylineglobe.cn/sdetail.aspx?SolutionID=8 on 8 October 2020.
[190] Information accessed at http://www.skylineglobe.cn/sdetail.aspx?SolutionID=8 on 8 October 2020.

Additional Case Studies

The P-NSIB Study Group reached out to strategic consultancy firm Horizon Advisory to explore additional methods for identifying risks or threats posed by China on SBIR grantees. Horizon Advisory offered a sampling of test results as a proof of concept that focused on two ways that Beijing's military-civil fusion strategy presents risks for small businesses and research ecosystems in the United States: through revenue and partnerships tied to China and through venture capital investments tied to Chinese funds.

Revenue and Partner Vulnerabilities

A. RBR USA Ltd

The first case example involves the US subsidiary of RBR Ltd, a Canada-based designer and manufacturer of oceanographic instruments.[191] RBR Ltd also operates in China (as 青岛亚必锐海洋仪器设备有限公司), providing direct sales and technical support services from an office in Qingdao City, Shandong Province. This creates technology transfer risks as well as client dependencies. Per RBR China's website:

> "In order to further support the growing customer demand and cooperation projects in the Chinese market, RBR (China) was officially registered in Qingdao as a wholly foreign-owned enterprise in 2018…. From equipment procurement to instrument deployment to daily maintenance, we are committed to providing comprehensive service support for all equipment and software products produced by RBR. RBR (China) will, as always, actively cooperate with universities and government agencies, organize instrument training and seminars, carry out demonstration projects, share advanced application cases at home and abroad, and provide more solid support for Chinese users' marine research and applications."[192]

That promise is borne out in RBR's procurement agreements. In September 2020, RBR China won the Ministry of Natural Resources' Second Institute of Oceanography Deepwater Multi-Parameter Water Quality Instrument project for 249,800 RMB. In July 2020, RBR won a similar contract rom Jiangsu Ocean University or 223,000 RMB.

RBR China also participates in technology and research exchange conferences in China and with Chinese counterparts. In November 2019, RBR Canada and RBR China jointly organized the RBR Ocean Instrument Training and Exchange Conference in Shanghai. The same month, RBR, represented by president Greg Johnson, as well as Qi Wang and Eric Siegel, presented at Oceanographic International China alongside Beijing Automation Control Equipment Institute, China Ship Network, China Shipbuilding Industry Corporation (CSIC), China Ocean Engineering Network, and Shanghai Jiaotong University Underwater Engineering Institute, among others. Several of these entities, most notably CSIC, are directly tied to China's defense R&D and industrial base.

[191] Information accessed at: Rbr-global.com on February 20, 2021
[192] Information accessed at: https://rbr.cn/2019/rbr%E4%B8%AD%E5%9B%BD%E6%AD%A3%E5%BC%8F%E5%BC%80%E5%A7%8B%E8%BF%90%E8%90%A5 on February 19, 2021

Further investigation is needed to determine if RBR conducts business directly with PLA entities, defense conglomerates, or other defense R&D institutions. At minimum the potential for dual-use applications -- in this case support to the PLA Navy -- raises national security concerns.

B. Scalable Network Technologies

The second example involves an L.A.-headquartered company that provides cross-domain modeling and simulation tools. The company's website lists two China-based partners on its website: Super Instruments Corp (北京华仪盛科科技有限公司) and Sinostar Co., Ltd (北京神州四达科技有限公司). Both have close connections to China's military and advertise themselves as purveyors of advanced, foreign technology. PRC websites, including docin, have picked up and published press releases on Scalable Network Technology's receipt of SBIR and other military grants.

Super Instruments Corp provides network application development, equipment, monitoring, and analysis to government agencies, research institutes, military users, and companies in China. The company's business registration information reports that it "continuously introduces the latest international products, technologies, and high-quality services into the country [China]," with its products covering the software and communication fields. Super Instruments' website lists dozens of users; a sampling is provided below with stars indicating those that have been defined by the US Department of Defense as PLA-affiliated companies:

- Huawei Technologies*
- ZTE Corporation*
- Tsinghua Tongfang
- China Telecom
- China Unicom
- China Mobile
- Beijing University of Aeronautics and Astronautics
- China Aerospace Science and Industry Corporation*
- China Ordnance Industry*
- China Shipbuilding Industry Corporation*
- China Electronics Technology Group*
- Aviation Industry Corporation of China*
- Chinese Academy of Sciences, and
- the China General Assembly[193]

China's government procurement website shows that in August 2020, Super Instruments Corp won a 600,000 RMB contract to provide the Nanjing University of Aeronautics and Astronautics (NUAA) with a virtual network platform and that in June, the company won a 1.498 million RMB project to provide the Beijing University of Posts and Telecommunications (BUPT) with EXata Satellite Optical Netowrk Simulation System software. NUAA is one of China's "Seven Sons of National Defense" universities whose primary mission is to conduct defense research and is on the BIS Entity List. BUPT is also known to conduct defense-related research.

[193] Information accessed at: Sinostars.com.cn on February 18, 2021.

Sinostar Co., Ltd is a wholly owned subsidiary of Sida (北京赛四达科技有限公司). Sinostar self-attests to having "achieved good performance in the field of battlefield simulation…In 2013, it helped a certain flight academy of the PLA Air Force build a flight training simulator and won the first prize of military scientific research. It combines domestic high-quality talents, foreign advanced technology, and strong capital advantages."

Sinostar's parent company, Sida, fills a similar niche. Its website reports that "as a supplier of high-tech simulations systems for military systems, Sida actively participates in the modernization of national defense and maintains close cooperation with many domestic military system research institutes." Sida advertises a series of "success cases" reflecting its close connections to China's military apparatus. They include cooperation with China National Aviation Corporation and with COMAC Research Institute on the C919 aircraft. They also include a flight simulator unveiled at the 2019 Military Expo. Sida's 2017 mid-year report documented that more than 60 percent of the company's business derives from the defense industry.

Sida has also received investments from government-backed entities, including Shenzhen Investment Control East China Sea Phase I Fund, which holds a 5.38 percent stake. The fund is 44.5 percent owned by Shenzhen Investment Holdings, a wholly-owned investment arm of the Shenzhen State-owned Assets and Supervision Commission.

Equity Investor Vulnerabilities

The second category of concerns relates to SBIR grantees that also receive investments from PRC entities of concern. An example is **Orbital Sidekick**, an SBIR Phase I and II recipient from USAF that received investments from 11.2 Capital. 11.2 Capital is a US-domiciled fund located in San Francisco and has invested alongside credible US venture investors such as Bessemer Venture Partners and Blumberg Capital. Less obvious from their public profile is that 11.2 Capital's limited partner base includes PRC firm Qihoo 360 Technology. Qihoo has been added to the Entity List for posing "a significant risk of supporting procurement of items for military end-use in China."

China's Monitoring, Analysis of SBIR Programs

Chinese language articles studied US SBIR programs since 1989, demonstrating China's awareness of the program and its function.[194] While these articles primarily focus on descriptions of the program and how it can serve as a model for advancing PRC S&T development, some of the articles have sought to exploit information about the program. The most recent of these was a 2020 article in the journal *Science and Technology Review* (科技导报),[195] entitled "Project Layout of SBIR / STTR Program Funded by the U.S. Navy" (美国海军小企业资助项目的布局). This article showcased the results of a bibliometric analysis of 5,955 SBIR / STTR grants awarded by the U.S. Navy between 2011 and 2017.[196] The article demonstrated how Chinese analysts are able to use publicly available information to identify SBIR grant recipients and gain insights into DoD research priorities.

Note: We did not attempt to evaluate the validity or accuracy of analysis performed in the PRC journal article highlighted here, especially with regards to US Navy R&D priorities. Nevertheless, China's analytic efforts, such as identifying US businesses that receive multiple phases of SBIR funding, may offer opportunities for state-sponsored technology acquisition or transfer apparatus to target these enterprises and may create FOCI vulnerabilities for DoD.

The article's co-authors[197] relied on data from the SBIR / STTR Program's project database at www.sbir.gov, which offered search and download functions that allowed the authors to use the 'agency' field to identify grants from the U.S. Navy (USN). According to the article, as of 31 January 2019 there were 5,955 such results. The authors retrieved data on:

- Grant contract number
- Grant title
- Grant keywords
- Grant summary / abstract
- Funding period (starting and ending year)
- Funding amount
- Company receiving the funding
- Lead researcher (primary investigator / PI) on the grant

[194] LIU Zhiming [刘志明], "The U.S. 'Small Business Innovation Research' Plan" [美国"小企业创新研究"计划], in *Guoji Keji Jiaoliu* [国际科技交流], No. 5, 1989, pp. 32-33.

[195] *Science and Technology Review* is published by the Chinese Association for Science and Technology (CAST / 中国科学技术协会) and is focused on the frontiers of scientific development in China, reporting on China's research achievements in natural sciences and engineering technology. Information accessed at http://www.kjdb.org/CN/column/column1.shtml on 23 November 2020.

[196] LI Na [厉娜], WANG Yunfei [王云飞], and CHU Zhiyong [初志勇], "Project Layout of SBIR / STTR Program Funded by the U.S. Navy" [美国海军小企业资助项目的布局], in *Science and Technology Review* [科技导报], No. 8 (2020), pp. 13-20.

[197] The three co-authors identified their institutional affiliation as the 'Qingdao Institute of Scientific and Technical *Information*' (青岛市科学技术信息研究院), also known as the 'Qingdao Institute of Science and Technology Development Strategy' (青岛市科学技术发展战略研究院). The Qingdao Institute of Scientific and Technical Information was established in 1960, and is a think tank for research on science and technology information and S&T development strategy. It provides support services to government departments, S&T companies, and research institutions in the Qingdao area. Information accessed at http://wiselab.dlut.edu.cn/info/1050/2495.htm on 14 December 2020.

The authors relied on additional sources for information about the SBIR grants in their database. First, the authors reviewed the websites of the companies receiving funding. Second, they utilized the website www.inknowvation.com, a U.S.-based information-sharing resource specifically targeting the SBIR / STTR community, which helps SBIR awardees find additional business partnerships. The site provides a database of "all SBIR / STTR awards, 1983 to the present," as shown below in Figure 1. Finally, the authors also consulted LinkedIn to find additional information about the companies receiving SBIR awards.

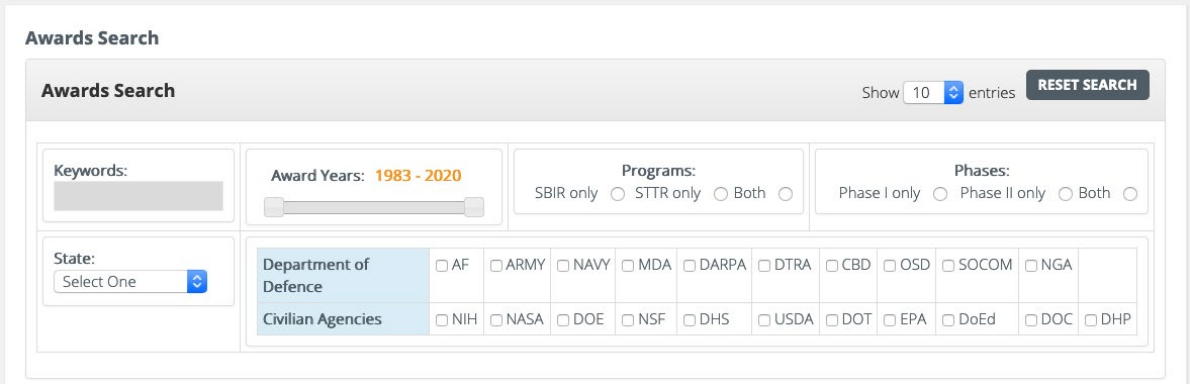

Figure 11: **Database of SBIR Awards from inknowvation.com Website**[198]

The authors analyzed their collected data to identify overall trends in SBIR funding from the U.S. Navy, noting that the number of grants declined steadily from 2011 to 2015, before starting to rebound in 2016 as a result of the Third Offset strategic concerns. See Figure 2.

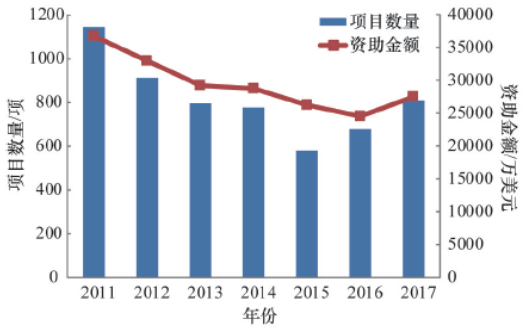

图1 美国海军SBIR/STTR计划项目数量与资助金额年度变化趋势

Figure 12: Figure of Overall Trends in U.S. Navy's SBIR / STTR Grants, 2011-2017[199]

[198] Information accessed at https://www.inknowvation.com/sbir/sbir-techbase/awards-search on 9 December 2020.
[199] Li, Wang, and Chu, "Project Layout of SBIR / STTR Program Funded by the U.S. Navy," p. 15. The Table is captioned "Figure 1: Trends in Annual Changes in the Number and Funding Amounts of U.S. Navy SBIR / STTR Program Projects". The numbers on the y-axis on the left side of the figure represent the 'number of grants', the number on the y-axis on the right side of the figure show the 'funding amount' (in units of 10,000 USD), and the x-axis covers the years 2011-2017. The blue bars represent the number of grants, and the red lines represent the amount of funding.

The authors also calculated that the 5,955 grants were awarded to 1,507 companies, and that every year roughly 25 percent of the recipients were first-time awardees. They compiled a list of the 25 companies that had received over $10 million in SBIR grants from the USN between 2011 and 2017, along with some additional data about the companies, including their main defense-related research areas. The first 16 companies from the table are included below in Figure 3.

表1　美国海军SBIR/STTR项目重点承担企业

序号	企业名称	项目数/项	资助金额/万美元	企业规模/人	I-II期项目转化率	所属州
1	物理光学公司(Physical Optics Corporation)	150	4105.66	201~500	0.29	加利福尼亚州
2	Progeny系统公司(Progeny System Corporation)	89	4078.07	201~500	0.44	弗吉尼亚州
3	克雷尔有限责任公司(Creare LLC)	104	3834.82	51~200	0.50	新罕布什尔州
4	查尔斯河分析公司(Charles River Analytics, Inc.)	110	3505.58	51~200	0.56	马萨诸塞州
5	RDR 技术公司(RDR Tec Inc.)	56	2742.43	11~50	1.10	得克萨斯州
6	自适应方法公司(Adaptive Methods, Inc.)	50	2481.37	51~201	0.60	弗吉尼亚州
7	3菲尼克斯公司(3 Phoenix, Inc.)	17	2444.63	51~200	0.67	弗吉尼亚州
8	Arete协会(Arete Associates)	60	2396.33	201~500	0.57	加利福尼亚州
9	智能自动化公司(Intelligent Automation, Inc.)	82	2288.55	51~200	0.43	马里兰州
10	Aptima公司(Aptima, Inc.)	59	2038.90	51~200	0.80	马萨诸塞州
11	Luna创新公司(Luna Innovations Incorporated)	60	1710.54	51~200	0.37	弗吉尼亚州
12	Triton系统公司(Triton Systems, Inc.)	45	1693.27	51~200	1.08	马萨诸塞州
13	索尔技术公司(Soar Technology, Inc.)	47	1664.77	51~200	0.81	密歇根州
14	SA光子学公司(SA Photonics, Inc.)	45	1650.37	11~50	0.53	加利福尼亚州
15	物理科学公司(Physical Sciences, Inc.)	51	1607.35	51~200	0.37	马萨诸塞州
16	丹尼尔·H·瓦格纳协会(Daniel H. Wagner Associates, Incorporated)	29	1587.92	11~50	0.64	宾夕法尼亚州

Figure 13: Table Ranking U.S. Companies by the Amount of SBIR Funding They Have Received[200]

The information the authors compiled about these companies revealed that all but three were relatively small companies, with less than 200 employees, and six of the companies had fewer than 50 employees. The authors also looked at the geographic distribution of the companies, noting that the majority were concentrated on the east coast, particularly in the northeast where naval-related research institutions are concentrated (涉海专业院所). The authors attributed this correlation in part to the fact that SBIR grant recipients are required to reach a cooperative R&D plan with research institutions and sign an intellectual property distribution agreement with them, and thus small businesses in the states that feature these research institutions have a natural advantage in meeting these requirements.

Third, the authors focused on technology areas that received the most grants and funding from the USN over the seven-year period, and found that they related to new materials, fatigue and damage assessment, perception and cognition, lasers and optical fiber, antennas and radio frequencies, aids for tactical decision-making, adaptive training, and energy and power. The

[200] The data columns within the table are: company name, number of [SBIR / STTR] project awards, amount of funding (in units of 10,000 USD), number of employees, conversion rate of Phase I to Phase II projects (calculated by dividing the number of the company's Phase II projects in the last five years by the number of its Phase I projects over the same period), and U.S. state where the company is located.

authors identified four key clusters of technology areas from this analysis, as well as some of the main grant recipients operating in these spaces.

1. System and component maintenance: (According to the authors) research grants in this area focused on maintaining and improving the performance of naval combat systems, enhancing the ability of platforms to adapt, and improving the operational level and reliability of systems and components. The authors identified key companies in this cluster, which according to the article, included QuesTek Innovations LLC, Luna Innovations Incorporated, NanoSonic, Inc., and Acellent Technologies, Inc.

2. Perception and cognition: (According to the authors) research grants in this area focused on ensuring environmental situational awareness and information advantages on the ocean battlefield. The article identified key companies in this cluster as being RDR Tec Inc., Areté Associates, Charles River Analytics, Inc., and Physical Optics Corporation.

3. Energy and power: (According to the authors) research grants in this area were aimed at supporting the U.S. Navy's efforts to reduce its dependence on fossil fuels, and enhancing the energy density, and safety and reliability of energy and power systems that support underwater platforms and naval operations. The article identified key companies in this cluster which included Mainstream Engineering Corporation, Lynntech Inc., and Bettergy Corporation.

4. Combat personnel capacity (According to the authors) grants in this field were focused on enhancing tactical decision-making and improving personnel training. In this area, the article named Charles River Analytics, Inc., Aptima, Inc., Adaptive Methods, Inc., and Soar Technology, Inc. as the primary companies.

Finally, the authors analyzed keyword changes in grant descriptions over time to help identify what they called new, emerging technology "hot spots" (热点): namely, additive manufacturing (3D printing) and machine learning. They identified QuesTek Innovation LLC as a key beneficiary of the U.S. Navy's interest in additive manufacturing, and Knexus Research Corporation, Tactical Edge, Inc., Soar Technology, Inc., Stottler Henke Associates, Inc., and Adaptive Methods, Inc. as notable grant recipients in machine learning.

Conclusion and Recommendations

This study, while limited in scope, demonstrates the methods by which PRC entities have transferred intellectual property and knowhow from US companies funded by DOD's SBIR program. The case studies also offer 'where are they now' examples – what has happened after knowhow or technologies were transferred to China. Much of the USG's efforts to address research security issues have focused on academia. Yet SBIR investments are vulnerable to exploitation and FOCI risks as well, and federal agency SBIR programs need to be incorporated into critical technology protection efforts.

We recommend DoD initiate a pilot due diligence program that applies the methodologies developed in the study to evaluate its effectiveness. Additionally, DoD elements need to develop capabilities to scale a monitoring and risk assessment effort to be able to screen the 10s of thousands of applicants and selectees. This should involve semi-automated triaging and filtering of entities of potential concern that would then warrant subsequent human reviews (due diligence).

Such a due diligence and security vetting program for SBIR awards should apply a tiered approach in terms of level of screening effort and risk assessments based on funding phase. Phase I applicants, for example, only require a cursory or semi-automated review prior to award consideration. Phase II and III require more robust, manually intensive efforts. *Equally important, is that this due diligence effort must include a process to monitor for activities of national security concern and/or fraudulent behavior post award of Phase II and III funding.*

The case studies and methodologies provided in this study focused exclusively on identifying risks from PRC entities and their proxies in the US. A fully implemented program should be expanded to include identifying risks associated with other adversarial nations such as Russia and Iran. However, as the scale and scope of China's technology transfer apparatus involving illicit, licit, and quasi-legal means dwarfs the rest of the world, priorities and resources should be dedicated to addressing associated threats and technology competition with China and address issues raised in the National Defense Strategy, related provisions in the NDAA, and numerous executive branch mandates.

Note that the Protecting National Security Innovation Base Study Group has recommended the establishment of a new program office that includes a due diligence line of effort in support of R&E and A&S elements that could overlap with the pilot program recommended here. Consultations with OUSD(I&S)/DDI/CL&S components may be worthwhile to provide inputs on security and vetting requirements for I&S to consider incorporating into technology protection programs at DoD.

The P-NSIB Study Group worked with two vendors on developing the methodologies and case studies. This required extensive research in Mandarin as well as access to specialized databases and other information sources that go beyond general Internet research. As such, these two commercial firms, Horizon Advisory and SOSi, are viable candidates to consider for a

recommended pilot effort. Note that each of these vendors offer some unique capabilities that in combination may enable more comprehensive solutions, but scalability via automation needs further development. Specifically:

- SOSi is developing a database on China's defense R&D and industrial base, has created a digital library of business and transaction data from domestic sources (some of which may become increasingly difficult to obtain outside China), and extensive data holdings on talent recruitment programs, supporting offices, and selectees that can be searched against. SOSi also has a large cadre of Mandarin linguists that conduct due diligence research.
- Horizon Advisory offers additional access and analysis of other data sources - both English commercial data sources on venture capital / private equity investment deals and as well as data compiled on PRC government directed investment "guidance" funds, state-owned investment entities, and industry information. Horizon is developing methods for bulk data screening for foreign investment activity in the U.S.

Cost estimates / proposals for piloting an effort that replicates these methodologies by both vendors can be provided upon request.

Appendix A: Research Methodologies

OUSD(R&E) provided the authors of this study a list of SBIR grantees and applicants (over 10,000 firms). This list was cross-referenced with Factor 8 Program data holdings on PRC state-sponsored talent recruitment programs to identify individuals associated with SBIR grantee firms who were recruited by a talent program. An outside advisory firm also conducted its own searches on the SBIR grant data to identify any PRC entities that invested (typically venture capital) in grantee firms. Supplemental due diligence research (from publicly available information) was then performed on a sampling of firms and associated entities identified from these two search methods.

Once a SBIR grant recipient of interest was identified, research was conducted using English and Chinese language sources to learn more about the company and its activities. The research into these companies focused primarily on the following questions:

- Does the company have PRC-based partners or customers that are of concern?
- Does the company have any PRC-based investors?
- Have the company's corporate leaders established relationships with any PRC actors of concern?
- Have the company's corporate leaders collaborated with any PRC-based individuals or entities on research that would be cause for concern
- Have any of the company's key personnel subsequently left the company to take positions in the PRC, and after leaving did they work for (or with) any PRC institutions that engage in defense-related research?

At a basic level, research into each SBIR grant recipient involved reviewing their official website (if available) and conducting basic online searches, which provided data about the company's origins, key executives, main product lines, and partnerships. Older versions of each company's website were also reviewed via the Internet Archive (web.archive.org/) to see if those versions had additional information or contained notable content that was later edited or removed. Any evidence of PRC connections in the grant recipient's funding, technology development, key personnel, or partnerships were flagged for further research.

Each grant recipient's connections to China were reviewed primarily using Chinese-language sources and vendor firm SOSi's proprietary vernacular data collection. Chinese sources included official corporate records databases and investment news aggregators, and the vernacular data collection included Chinese language journal articles, information about talent recruitment programs and selectees, and a database of institutions engaged in defense research. These sources were used to identify PRC-based subsidiaries of the company in question, whether or not key personnel had been selected into a Chinese talent recruitment program, and whether the company or its key personnel had ties to PRC entities of concern.

- If an SBIR awardee firm or any of its key personnel had any collaborative links to a PRC company, the PRC company's official corporate records were reviewed to look for subsidiaries or parent companies with links to known defense industry or defense R&D entities.

- If the SBIR awardee firm or any of key personnel had any collaborative links to a PRC university or research organization, follow-on research was conducted to determine if these organizations, or their relevant subdivisions had any involvement in defense-related research. This entailed reviewing the relevant university or research organization's website, and journal article databases to see if affiliated departments, or labs were involved in defense research.
- Names of grantee firms' key personnel were checked on English language and PRC article databases to see if they collaborated on any research with individuals in the PRC. These reviews also checked to see if any articles they published cited funding support from the PRC government.
- Links to PRC talent programs among the firms' key personnel were ascertained by cross referencing individuals against SOSi's dataset of talent programs and known talent program selectees, as well as internet searches using relevant keywords.
- Evidence of investment in the SBIR awardee firm from PRC-based investment firms were reviewed on PRC investment news aggregators. The homepages and corporate records for any investors were reviewed for evidence of ownership links to the Chinese state or Chinese defense-related entities.

Appendix B: Profile of Sichuan Clover Biopharmaceuticals

Executive Summary

Sichuan Clover Biopharmaceuticals Inc., henceforth Clover Biopharmaceuticals, is a Chinese biopharmaceuticals company that is developing a COVID-19 vaccine with U.S.-based Dynavax Technology Corporation. The company also had a partnership with Glaxosmithkline (GSK) until February of 2021, but that partnership appears to have ended. Clover Biopharmaceuticals has received substantial PRC state-backed seed funding and support. The company was founded by LIANG Peng and several other overseas returnee scientists in 2007. These scientists are selectees of China's flagship state-sponsored talent recruitment program, the Thousand Talents Program. The company's CEO is Joshua LIANG, the founder's son. The company has four subsidiaries in China and one subsidiary in Australia and another in the U.S., though very little information was found on its US operations.

In addition to his affiliation to Clover Biopharmaceuticals, LIANG Peng was the founder of U.S.-based biotechnology firm GenHunter (1995-present), a professor at Vanderbilt University (1995-2010), a visiting professor at Sichuan University (2007-2010), which later converted into a permanent position (2010-present), and a 2009 Thousand Talent Program and Hundred Talents Program selectee. This timeline raises concerns as LIANG was still employed at Vanderbilt University while also affiliated with Sichuan University and Clover Biopharmaceuticals, as well as a selectee of the Thousand Talents Program and Hundred Talents Program during the same time period. Clover Biopharmaceutics' other co-founders were also Thousand Talents Program selectees, but the current version of the company's website has removed all references to talent programs.

Clover Biopharmaceuticals leaders have hosted PRC government officials and received research funding from PRC government programs, some of which may support defense projects. In 2016, LIANG and other Clover Biopharmaceuticals officers met with senior-level municipal government representatives at least twice, both times receiving unspecified support from the municipal government regarding their biopharmaceutical R&D. In 2013, Clover Biopharmaceuticals conducted antibody medicine technology research while being funded by the 863 Program, a national high-technology R&D program run by the Ministry of Science & Technology that prioritizes defense or dual-use research. In 2012, LIANG participated in two 973 Program projects, another PRC government research funding program, studying tumor research on behalf of Sichuan University. While there are no explicit or direct ties to China's defense R&D or industrial base, LIANG and Clover Biopharmaceutical's association with the 863 Program and Sichuan University raises national security concerns; Sichuan University is on the BIS Entity List.

In 2017, Trimer-Tag, a drug development technology, was in-licensed from GenHunter to Clover Biopharmaceuticals, companies which LIANG was both the founder and held senior leadership positions in. Following COVID-19's outbreak, Trimer-Tag was modified to become a leading PRC vaccine candidate. Its origins stem from LIANG's 2007 U.S. patent for Trimer-Tag while employed at GenHunter. Several years later, LIANG was listed as the principal investigator for a 2011 Small Business Innovation Research (SBIR) grant to advance Trimer-Tag from preclinical development to field use.

National / Economic Security Implications

This profile provides an example of how China's state-supported technology transfer apparatus was able to exploit or benefit from R&D originating in and partially funded by the U.S. government. While efforts to mitigate potential damage to the US government (such as possible grant fraud or regulatory / compliance violations) may be too late, this study nonetheless provides a 'where are they now' case study on what were the results and ultimate beneficiary of U.S. investments.

The founder of the firm appeared to have set up commercial applications whose origins began at a U.S. university and received subsequent support from the SBIR program. The founder simultaneously benefited from PRC state-sponsored talent recruitment programs, received supplemental PRC government research funding, and transferred the intellectual property from his U.S.-based company to a China business he also founded. That PRC business received substantial investment from PRC entities, included state-owned enterprises and PRC government organs, and then received additional foreign investment, especially after the underlying intellectual property can support the development of a COVID vaccine.

Background

Clover Biopharmaceuticals (三叶草生物制药 / 四川三叶草生物制药有限公司) is a Chinese biopharmaceutical company located in Chengdu Incubation Park's high-tech district in Sichuan province.[201] Clover Biopharmaceuticals employs approximately 50 to 100 individuals and specializes in biopharmaceutical research, development, and manufacturing.[202] Founded by LIANG Peng (梁朋) in 2007,[203] Clover Biopharmaceuticals is currently developing a COVID-19 vaccine with U.S.-based Dynavax Technology Corporation.[204] Clover Biopharmaceutical was partnering with Glaxosmithkline (GSK) PLC and Dynavax up until 1 February 2021, however, ended their partnership with GSK due to "scale-up manufacturing considerations."[205] The company is privately owned but has received substantial seed investments from state-owned entities.[206] The company's CEO is Joshua LIANG (AKA LIANG Guo / 梁果), LIANG's son.[207] Details confirming this relationship is discussed below.

Clover Biopharmaceuticals describes itself on its website as a company that was established by leading overseas returnee scientists (海归).[208] This refers to Clover Biopharmaceuticals founder, Chief Scientific Officer, and Chairman of the Board LIANG Peng, who is a 2009 Thousand Talents Program and Sichuan Provincial Hundred Talents Program selectee.[209] A 2016 webcache of the company's website states that

[201] Information accessed at https://www.qcc.com/firm/339c4c3bdb5f320dbd02b2c9881fdd14.html on 24 January 2021.
[202] Information accessed at https://www.qcc.com/firm/339c4c3bdb5f320dbd02b2c9881fdd14.html on 24 January 2021.
[203] This report follows native Chinese naming conventions of having the surname preceding their given names. Chinese surnames are capitalized to clarify surnames. This
[204] Information accessed at https://www.fiercebiotech.com/biotech/using-gsk-dynavax-tech-clover-kickstarts-covid-vax-trial-data-drop-august on 16 October 2020.
[205] Information accessed at https://www.fiercepharma.com/vaccines/clover-picks-dynavax-adjuvant-over-gsk-for-late-stage-coronavirus-vaccine-testing on 9 February 2021.
[206] Information accessed at https://www.qcc.com/firm/339c4c3bdb5f320dbd02b2c9881fdd14.html on 24 January 2021.
[207] Information accessed at https://s3.amazonaws.com/pastperfectonline/images/museum_445/042/2018089-2.jpg and https://www.facebook.com/liangj10 on 9 February 2021.

[208] Information accessed at http://www.cloverbiopharma.com/index.php?m=content&c=index&a=lists&catid=34&langId=2 on 8 December 2020.
[209] Information accessed at http://www.cloverbiopharma.com/index.php?m=content&c=index&a=show&catid=11&id=10&langId=2; http://www.tfsv.com/article/39459.html; and http://www.chinanews.com/lxsh/2010/10-12/2581304.shtml on 8 December 2020.

the company's other two co-founders, WANG Xiaodong (王晓东) and ZHU Jianwei (朱建伟), are also Thousand Talents Program selectees, as are the company's Scientific Advisory Board (SAB) members ZHANG Jinyou (张劲游) and LUO Shun (罗顺).[210] This information has since been removed from its current website and in late 2020, the SAB was renamed as the Corporate Advisory Board (CAB).[211] In 2009, the company was recognized by the State Council's Overseas Chinese Affairs Office (国务院侨务办公室) as a "key overseas Chinese innovation group (重点华侨华人创业团队)."[212] [213] The company has also received research grants from the PRC government, including the 863 Program – a strategic R&D program that supports dual-use research – for unspecified critical antibody medicine technology R&D.[214] LIANG also worked on two 973 Program projects, another PRC government strategic R&D program, [215] one of which appeared to involve researchers from a PRC military medical entity.[216]

Profile of LIANG Peng

LIANG Peng is the founder and chairman of Clover Biopharmaceuticals. He holds a PhD in biochemistry from the University of Illinois at Urbana-Champaign (1990) and a B.S. in biology from Peking University (1982). During his postdoctoral study at Harvard Medical School from 1991 to 1995, LIANG was a co-investor of Differential Display, a gene expression analysis technique, with Dr. Arthur Pardee.[217]

Following his postdoctoral study at Harvard, LIANG was appointed as a Professor at Vanderbilt University from 1995 to 2010.[218] While employed at the university, LIANG worked on several National Institute of Health (NIH) grants from 1998 to 2007.[219] In 1995, LIANG founded Tennessee-based biomedical company GenHunter Corporation. While employed at GenHunter, LIANG developed and patented Trimer-Tag in 2007, a novel drug development technology that is detailed below. GenHunter also received at least three U.S. government Small Business Innovation Research (SBIR) grants from the Department of Health and Human Services in 1994, 2008, and 2011.[220] Notably, the 2011 SBIR grant's research topic was to research and develop Trimer-Tag technology from preclinical to field-use.[221]

According to business records accessed from the Tennessee Secretary of States website, GenHunter is an

[210] Information accessed at https://web.archive.org/web/20161023230222/http://www.cloverbiopharma.com/index.php?m=content&c=index&a=lists&catid=34.
[211] The December 2020 restructuring announcement information can be found at https://www.cloverbiopharma.com/about-us/note-from-ceo/. The updated leadership page is now https://www.cloverbiopharma.com/about-us/leadership/. Information accessed on 2 March 2021.

[212] The program is supported by the State Council of China and selects 10-20 entities a year. Recipients receive 15-30 thousand USD a year for an unspecified amount of time, access and invitation to events and meetings held by the Overseas Chinese Affairs Office, and publicization and general support from the Overseas Chinese Affairs Office. Information accessed at www.shibeiht.com/system_dntb/upload/201282311925482.doc on 25 January 2021.
[213] Information accessed at http://www.cloverbiopharma.com/index.php?m=content&c=index&a=lists&catid=34&langId=2 on 8 December 2020.
[214] Information accessed at http://www.cloverbiopharma.com/index.php?m=content&c=index&a=lists&catid=34&langId=2 on 8 December 2020.
[215] Information accessed at https://liangpenglab.weebly.com/ on 10 March 2021.
[216] See section on PRC Government Funding for more details.
[217] Information accessed at https://www.linkedin.com/in/peng-liang-b006517 on 19 March 2021.
[218] Information accessed at https://www.facebook.com/peng.liang.507? on 31 December 2020.
[219] Information accessed at https://grantome.com/search?q=@author%20%20Peng%20Liang on 3 March 2021.
[220] Information accessed at https://www.sbir.gov/sbc/genhunter-corporation on 9 December 2020.
[221] Information accessed at https://www.sbir.gov/sbirsearch/detail/378958 on 24 January 2021.

ongoing concern that has filed an annual report as recent as May 2020.[222] According to its 2020 business record, the company's registered agent is GUO Zhen, LIANG's spouse.[223] LIANG's self-reported information on LinkedIn states that he is still affiliated with GenHunter as the company's founder –an affiliation that he used in a publication as recent as 2018.[224] It is unclear when GUO became the company's legal representative, the exact breakdown of the company's leadership, and LIANG's current influence. It is also unclear whether LIANG or GUO currently reside in their Nashville, Tennessee home; however, a property record states that their property taxes were paid as recently as 2020.[225]

In addition to patenting Trimer-Tag technology and establishing Clover Biopharmaceuticals in 2007, LIANG appeared to have taken a position as Visiting Professor at Sichuan University's School of Life Sciences (四川大学生命科学学院).[226] This position developed into a Professorship in 2010, an appointment LIANG continues to hold.[227] In 2008, LIANG was named a [Chengdu 4th Round Science and Technology Advisor] (成都市第四届科技顾问团顾问), a position he held until at least 2016.[228] No information was found during the course of this report on what advice (or to whom) LIANG offered during this appointment. In 2009, LIANG was listed as a 2009 Thousand Talents Program and Sichuan Province Hundred Talents Program[229] selectee.[230] From 2012 to at least 2015, LIANG was affiliated with the State Key Laboratory for Gene and Cell Therapy at Sichuan University (生物资源与生态环境教育部重点实验室).[231] Lastly, in 2012 and in 2013, LIANG worked on at least three multiyear PRC government funded projects, which are detailed below.

LIANG's employment, activities, and affiliations from 2007 to 2010 raise conflicts of interest or commitment concerns as he held multiple concurrent roles at several institutions. As outlined above, LIANG held concurrent positions at Clover Biopharmaceuticals, Sichuan University, Vanderbilt University, and GenHunter. It is unclear to what degree his obligations were to each of these entities and how much time he spent overseas in China while employed at Vanderbilt University and GenHunter. No evidence of LIANG publishing articles while affiliated with Sichuan University from 2007 to 2010 was found. There is also no evidence of LIANG holding meetings or giving lectures in the PRC from 2007 to 2010. Several publications with LIANG's affiliation to Vanderbilt University were published between

[222] Information accessed at https://tnbear.tn.gov/Ecommerce/FilingDetail.aspx?CN=06602806122016219412620704024903414916706808600 5 on 9 February 2021.

[223] Information accessed at https://www.davidsonportal.com/gis/file.php?book=00010023&page=0000816 on 9 February 2021.
[224] Information accessed at https://pubmed.ncbi.nlm.nih.gov/29743640/ on 19 March 2021.
[225] Information accessed at https://nashville-tn.mygovonline.com/mod.php?mod=propertytax&mode=public_view&id=4607659 on 9 February 2021.
[226] Information accessed at http://www.kaoyan1v1.com/xinxi/daoshi/2945545.html and https://liangpenglab.weebly.com/ on 30 December 2020.
[227] Information accessed at http://www.kaoyan1v1.com/xinxi/daoshi/2945545.html and https://liangpenglab.weebly.com/ on 30 December 2020. Liang's undated LinkedIn profile, however, conflicts this timeline and claims that he departed Sichuan University by 2018. Information accessed at https://www.linkedin.com/in/peng-liang-b006517 on 19 March 2021.
[228] Latest source with a timestamp for this information was for 2016. Information accessed at http://www.kaoyan1v1.com/xinxi/daoshi/2945545.html on 30 December 2020.
[229] Information accessed at http://www.cloverbiopharma.com/index.php?m=content&c=index&a=show&catid=11&id=10&langId=2; http://www.tfsv.com/article/39459.html; and http://www.chinanews.com/lxsh/2010/10-12/2581304.shtml on 8 December 2020.
[230] The Hundred Talents Program is run by the Chinese Academy of Sciences and was one of the earliest talent programs established by the PRC Government. These programs were subsequently replicated at provincial and municipal levels.
[231] Information accessed at https://www.nature.com/articles/gene201613#Aff3 and https://www.sciencedirect.com/science/article/abs/pii/S1046592815000224?via%3Dihub on 15 March 2021.

2007-2010.[232] Publications with LIANG's affiliation to Sichuan University, however, began to appear in the public record after his departure from Vanderbilt University.

Public sources indicate that Clover Biopharmaceuticals CEO Joshua LIANG is LIANG Peng's son.[233] A local Tennessee newspaper clipping dated 2 June 2010, states that Joshua LIANG, LIANG Peng, and GUO Zhen are all related. The article's assertion that Joshua LIANG worked with his father at Vanderbilt University matches Joshua and LIANG Peng's work history timelines.[234] According to Joshua LIANG's self-reported information on LinkedIn, he has been affiliated with Clover Biopharmaceuticals since 2016, starting as the Chief Strategy Office and Board Director and later becoming the company's CEO in June 2020.[235]

Figure B1: An image uploaded onto social media by Joshua Liang. Front row- Guo Zhen (second from the right). Back row- Liang Peng (second from the left); Joshua Liang (fourth from the left) (30 May 2014).[236]

Trimer-Tag Technology

According to GenHunter's website, several of the company's products and services, such as the cytokines used at GenHunter, were identified by Liang's research group at Vanderbilt University.[237] While employed at GenHunter, in 2007, LIANG was issued patent US7268116 for Trimer-Tag, a novel drug development technology that realizes the trimerization of secreted proteins.[238] Several years later in 2011, LIANG was listed as the principal investigator for an SBIR grant issued by the NIH (contract number 1R43AI091286-01A1) to develop trimeric tumor necrosis factor (TNF) receptor decoys to treat

[232] Information accessed at https//pubmed.ncbi.nlm.nih.gov/18385383/ on 11 March 2021.
[233] Information accessed at https://s3.amazonaws.com/pastperfectonline/images/museum_445/042/2018089-2.jpg and https://www.facebook.com/liangj10 on 9 February 2021.

[234] Information accessed at https://s3.amazonaws.com/pastperfectonline/images/museum_445/042/2018089-2.jpg; https://s3.amazonaws.com/pastperfectonline/images/museum_445/042/2018089.jpg; https://alumnius.net/university_of_pennsy-9330-221#id110249943; and https://www.facebook.com/peng.liang.507?_fb_noscript=1 on 9 February 2021.

[235] Information accessed at https://cn.linkedin.com/in/joshua-liang-073b0a30 on 25 March 2021.
[236] Information accessed at https://www.facebook.com/liangj10 on 9 February 2021.

[237] Information accessed at https://www.genhunter.com/immunology-antibodies-and-cytokines/?sort=featured&page=1 on 23 December 2020.
[238] Information accessed at https://webcache.googleusercontent.com/search?q=cache:9knY_LMP2lkJ:https://www.biopharminternational.com/view/genhunter-receives-us-patent-trimerization-secreted-protein+&cd=1&hl=en&ct=clnk&gl=us&client=firefox-b-d on 8 March 2021.

autoimmune diseases.[239] By nature, biologic TNF receptor decoys to date have had dimeric structures, although TNF-1, the chemical that the receptor decoy is designed to intercept, has a trimeric structure. LIANG's research grant was to artificially replicate a trimeric structure in TNF receptor decoys to create a more potent blocker via GenHunter's Trimer-Tag. According to the grant document, GenHunter was awarded US$224,700 to develop Trimer-Tag from preclinical deployment to field use.[240] It is unclear from the grant document whether Trimer-Tag was developed in-part while Liang was employed at Vanderbilt University or whether its origins lie solely with GenHunter. Further examination of the origins of Trimer-Tag and outcomes of SBIR grant no. 1R43AI091286-01A1 may shed light on this issue.

In 2017, Clover Biopharmaceuticals acquired global in-licensing rights to GenHunter's proprietary Trimer-Tag technology and its affiliated patents for the development of novel drug candidates.[241] Specific details, monetary amounts, licensing agreements, or signatories were not found in public records. Media reporting and news reporting from Clover Biopharmaceuticals' website are suggest that state Trimer-Tag is Clover Biopharmaceuticals' propriety platform technology, but lacked details about its 2017 IP acquisition from GenHunter.[242]

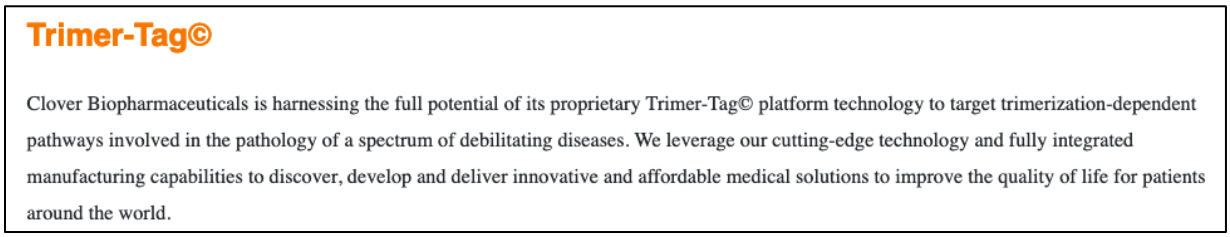

Figure B4: Example from Sichuan Clover Biopharmaceuticals Inc. on Trimer-Tag (Image dated March 2021).[243]

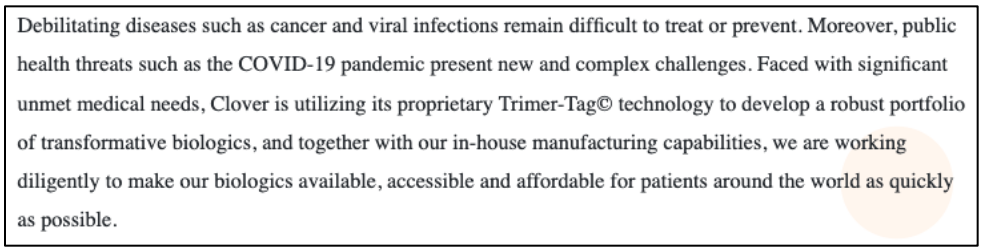

Figure B5: Another example of Sichuan Clover Biopharmaceuticals Inc.'s verbiage regarding Trimer-Tag (Image dated March 2021).[244]

It is unclear what LIANG's exact role and influence was at GenHunter in 2017 as well as his involvement with the IP transfer. What is known, however, is that he was the inventor and patent holder of Trimer-

[239] Information accessed at https://grantome.com/grant/NIH/R43-AI091286-01A1 on 23 December 2020.
[240] Information accessed at https://www.sbir.gov/sbirsearch/detail/378958 on 24 January 2021.
[241] Information accessed at http://www.cloverbiopharma.com/index.php?m=content&c=index&a=lists&catid=45; and at https://adisinsight.springer.com/drugs/800050973 on 23 December 2020.
[242] Information accessed at https://www.prnewswire.com/news-releases/clover-biopharmaceuticals-raises-230-million-in-oversubscribed-series-c-financing-301232943.html and https://www.cloverbiopharma.com/science/ on 3 March 2021.
[243] Information accessed at https://www.cloverbiopharma.com/technology/science.html on 19 March 2021.
[244] Information accessed at https://www.cloverbiopharma.com/about/note-from-ceo.html on 19 March 2021.

Tag, the Chairman of Clover Biopharmaceuticals, the founder of GenHunter, and used his GenHunter affiliation (with his email linking to Clover Biopharmaceuticals) in 2017 and 2018 publications.[245]

> Sci Rep. 2017 Aug 21;7(1):8953. doi: 10.1038/s41598-017-09518-1.

Improvement of Pharmacokinetic Profile of TRAIL via Trimer-Tag Enhances its Antitumor Activity in vivo

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Figure B6: Liang Peng's affiliation to both Clover Biopharmaceuticals and GenHunter in a 2017 publication.[246]

Shortly after COVID-19 began spreading, Clover Biopharmaceuticals combined trimeric SARS-CoV-2 spike proteins with the company's Trimer-Tag technology to create S-Trimer, the company's novel technological approach in COVID-19 vaccine development.[247] Clover Biopharmaceuticals' S-Trimer has been lauded by press releases as a promising tool in developing an effective vaccine and according to the company induced neutralizing antibody titers in 100 percent of participants in both adult and elderly groups when formulated with GSK and Dynavax's adjuvant systems.[248] Unlike some of the other vaccine candidates, S-Trimer can be stored in standard refrigeration, thus improving its distribution and eliminating the need for specialized refrigeration storage.

[245] Information accessed at https://pubmed.ncbi.nlm.nih.gov/28827692/ and https://pubmed.ncbi.nlm.nih.gov/29743640/ on 19 March 2021.
[246] Information accessed at https://pubmed.ncbi.nlm.nih.gov/28827692/ on 22 March 2021.
[247] Information accessed at https://pipelinereview.com/index.php/2020092575994/Vaccines/Clover-Biopharmaceuticals-Announces-Positive-Preclinical-Data-and-Updates-on-Phase-1-Study-for-its-Adjuvanted-S-Trimer-COVID-19-Vaccine-Candidate.html on 23 December 2020.
[248] Information accessed at https://www.europeanpharmaceuticalreview.com/news/135667/covid-19-s-trimer-vaccine-candidates-show-promise-in-early-trials/ and https://cepi.net/news_cepi/cepi-extends-partnership-with-clover-to-fund-covid-19-vaccine-candidate-through-global-phase-2-3-study-to-licensure/ on 4 January 2021.

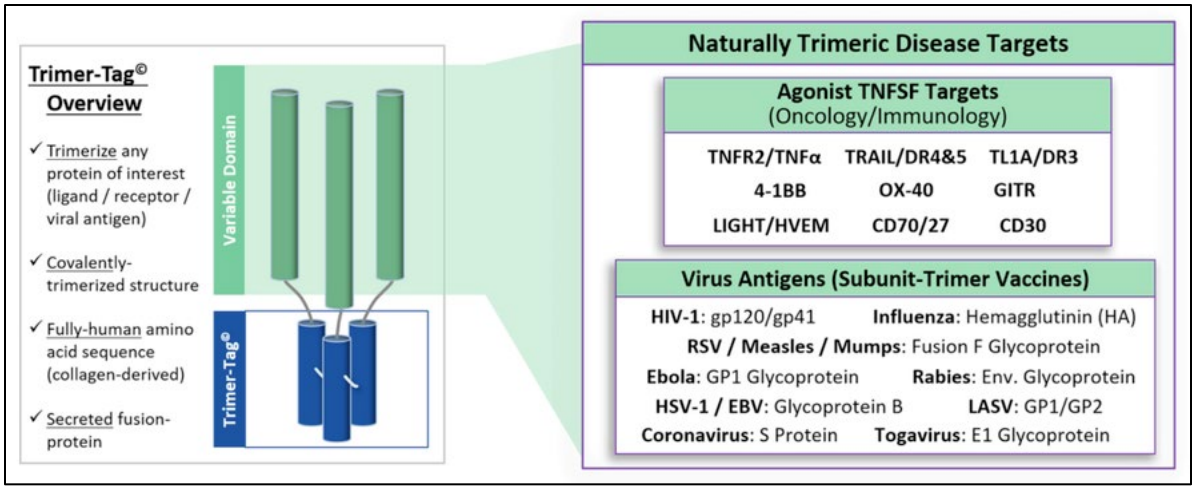

Figure B7: An overview of Sichuan Clover Biopharmaceuticals Inc.'s Trimer-Tag Technology (undated image accessed from Clover Biopharmaceuticals' website).[249]

PRC Grant Funding

Clover Biopharmaceuticals' LIANG is known to have worked on at least three PRC government funded projects funded by the Ministry of Science and Technology (MOST). One of these were part of the 863 Program and two were 973 Program projects.[250] LIANG also worked on a National Natural Science Foundation of China (NNSFC / 国家自然科学基金) grant from 2012-2015.

863 Program Funding

The earliest date of LIANG's involvement with PRC government funding is in 2013. From 23-25 October 2013, Clover Biopharmaceuticals held a strategic planning and execution board meeting for an antibody R&D 863 Program project. LIANG, co-founders/ CAB members WANG Xiaodong and ZHU Jianwei, McGill University professor Gordan Shore, and UCLA professor Patrick Harran participated in the project's discussions.[251] Specific details of their discussions and the outcome of that meeting were not found.

While employed at Sichuan University, LIANG co-authored a paper published in 2016 that was funded by 863 Program grant 2012AA02A305 and MOST Grants 2012ZX09103301 and 2011ZX09401005.[252] His author affiliations on the paper were GenHunter Corporation (Nashville, TN), Clover Biopharmaceuticals (Chengdu), and Sichuan University's Laboratory for Gene and Cell Therapy

[249] Information accessed at https://www.cloverbiopharma.com/technology/science.html on 3 March 2021.
[250] While MOST's 863 and 973 Programs have both historically and recently funded defense related dual-use projects, not all of the projects have military industrial-base applications. It is unclear whether Liang's research had any dual-use applications.
[251] Information accessed at https://webcache.googleusercontent.com/search?q=cache:2Vvhyr1GVaAJ:www.cloverbiopharma.com/index.php%3Fm%3Dcontent%26c%3Dindex%26a%3Dshow%26catid%3D11%26id%3D21 on 25 January 2021.
[252] Information accessed at https://www.jimmunol.org/content/jimmunol/early/2016/09/10/jimmunol.1600399.full-text.pdf on 30 December 2020.

(Chengdu).[253] It is unclear whether LIANG's 2013 863 Program strategic project meeting is related or separate to this 2016 publication.[254]

A Broad Blockade of Signaling from the IL-20 Family of Cytokines Potently Attenuates Collagen-Induced Arthritis

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Two heterodimeric receptors consisting of either IL-20R1 or IL-22R1 in complex with a common β receptor subunit IL-20R2 are shared by three of the IL-20 family of cytokines: IL-19, IL-20, and IL-24. These proinflammatory cytokines have been implicated in the pathogenesis of some autoimmune diseases, including rheumatoid arthritis (RA), psoriasis, and atopic dermatitis. Although mAbs against IL-19 and IL-20 have each been shown to modulate disease severity of collagen-induced arthritis in animal models, and anti–IL-20 therapeutic Ab has exhibited some efficacy in the treatment of RA in clinical trials, benefits for a complete blockade of these functionally redundant cytokines remain to be explored. In this report, we show that recombinant human soluble IL-20R2-Fc fusion protein binds to IL-19, IL-20, and IL-24 with similar high affinity and blocks their signaling in vitro. In DBA/1 mouse collagen-induced arthritis model, recombinant human IL-20R2-Fc exhibits comparable efficacy as TNF blocker etanercept in the treatment of established arthritis, whereas the combined use of both biologics manifests little synergistic therapeutic effects. In situ ligand–receptor functional binding analysis shows that a large amount of immune infiltrates expressing high levels of TNFR and IL-20 subfamily cytokines congregate within the inflamed disease tissues. Colocalization experiments reveal that signals from IL-20R2 and TNF transduction pathways seem to converge in macrophages and function in tandem in orchestrating the pathogenesis of RA. Elucidation of this interaction provides a better understanding of cytokine cross-talk in RA and a rationale for more effective biologic therapies that target IL-20R2 instead of individual cytokines from IL-20 family. ***The Journal of Immunology*****, 2016, 197: 000–000.**

Rheumatoid arthritis (RA) is a chronic and systemic inflammatory disease with cartilage destruction, severe synovitis, and leukocyte infiltration (1). The pathogenesis involved in the development of RA has been widely studied, yet the precise molecular mechanism underlying the disease remains to be fully elucidated (2). Previous studies have revealed pathogenic roles of proinflammatory cytokines such as IL-6, IL-17, TNF-α, and the IL-20 subfamily cytokines in RA (3–8). Although biologic drugs targeting TNF-α have been in clinical use in treating RA for >15 y, nearly one-third of the RA patient population become refractory to the drug class (7).

IL-19, IL-20, and IL-24 are members of the IL-20 subfamily of cytokines (8). These three cytokines share a common β receptor subunit IL-20R2 with all three being able to signal through IL-20R1/IL-20R2, whereas IL-20 and IL-24 can also signal through IL-22R1/IL-20R2 heterodimeric receptor complex (9–11). Such significant receptor sharing among these cytokines has raised questions about whether the three cytokines have redundant biological functions in vivo or whether they may use the same receptors for different biological endpoints in a tissue-specific or temporally regulated manner (12). Substantial evidence supports the linkage between the development of autoimmune diseases—such as RA, psoriasis, osteoporosis, and atopic dermatitis—and the abnormal overexpression of IL-19, IL-20, and IL-24 (8, 13, 14), with synovial tissues having been identified as a major source of the three cytokines in patients with RA (8, 13–15). A neutralizing Ab against IL-20 was shown to be able to attenuate disease severity of collagen-induced arthritis (CIA) in rats (16). Similar efficacy was also reported for anti–IL-19 mAb in the same animal model (13), with IL-24–specific blockers yet to be tested. Although in these studies, both anti–IL-20 and anti–IL-19 mAbs exhibited similar efficacy to that of etanercept in reducing disease symptoms in a rat CIA model, combination therapy for simultaneously blocking IL-20 and anti–IL-19 signaling has yet to be studied and would be expected to result in a better outcome. In contrast to complete failure for treating psoriasis in human clinical trials (17), anti–IL-20 mAb has demonstrated some moderate therapeutic effect against RA in a phase 2 clinical trial, although seen as inferior to anti-TNF biologics (18). Given the promiscuous nature of receptor sharing for the IL-20 subfamily of cytokines, it would be clearly advantageous to develop a biologic therapy that could simultaneously block signaling of all three cytokines that signal through IL-20R2.

Previous studies from our laboratory showed that IL-24 had overlapping functions with IL-20 and IL-22 in the epidermis (19), and IL-20R2 was directly involved in ligand binding (9, 19). Partially purified and characterized recombinant soluble IL-20R2-Fc

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Abbreviations used in this article: AP, alkaline phosphatase; CHO, Chinese hamster ovary; CIA, collagen-induced arthritis; PVDF, polyvinylidene difluoride; RA, rheumatoid arthritis; rh, recombinant human; SEC, size-exclusion chromatography.

www.jimmunol.org/cgi/doi/10.4049/jimmunol.1600399

Figure B8: A 2016 article listing Liang Peng as a co-author with affiliations to Sichuan University, Clover Biopharmaceuticals, and GenHunter. Article also acknowledges PRC government funding and links Liang's email addresses to Sichuan University and Clover Biopharmaceuticals. Red boxes were added to highlight key article metadata information.[255]

[253] Information accessed at https://www.jimmunol.org/content/jimmunol/early/2016/09/10/jimmunol.1600399.full-text.pdf on 30 December 2020.

[254] Due to the dual-use nature of some 863 Program projects, it is probable possible that a classified report of Liang's work was published and submitted to an appropriate PRC department.

[255] Information accessed at https://www.jimmunol.org/content/jimmunol/early/2016/09/10/jimmunol.1600399.full-text.pdf on 30 December 2020.

973 Program Funding

In 2012, Liang was one of several Chinese scientists who participated in a 973 Program grant on "Function and Regulation of Key Proteins in Tumor Development" (肿瘤发生发展中关键蛋白的功能与调控). The project was undertaken by scientists from Sichuan University, Peking University, Shanghai Institute of Material Medicine, the Chinese Academy of Medical Sciences, Chinese Academy of Sciences (CAS) Institute of Biophysics, and the Chinese Academy of Military Medical Sciences.[256]

In 2012, Liang was the project manager (课题负责人) for a Sichuan University 973 Program grant on "Studying Molecular Regulation Mechanism of Tumor Suppressor Protein P53 Family and New Upstream Regulatory Proteins and Downstream Targets on Tumorigenesis and Development" (研究抑癌蛋白p53家族及新的上游调控蛋白和下游作用靶点对肿瘤发生发展的分子调控机制). The period of performance was from January 2012 to August 2016. Sichuan University, Chinese Academy of Medical Sciences, and CAS Institute of Biophysics were involved as supervisory entities (承担单位).[257] No information about the project's outcome were found.

Article metadata analysis suggests that LIANG was supported by 973 Program grant 2012CB910700 for several articles.[258] These articles can be linked to the 2012 973 Program grant and are likely the public results of his research.[259]

NNSFC Funding

In 2012, LIANG was listed as the principal investigator for National Natural Science Foundation of China (NNSFC) grant no. 81171955 to study "The Biological Function of Killin in P53 Mediated Tumor Inhabitation" (Killin□ p53□ 导肿□ □ □ □ □ □ □ 学□ □). The 600,000 RMB (US $96,000) study was conducted at Sichuan University and resulted in three publications.[260] This research may have built upon LIANG's work while employed at Vanderbilt University. Examples include a 2008 articled entitled, "Killin is a p53-regulated Nuclear Inhibitor of DNA Synthesis," funded by the NIH, and a 2011 article on "S-phase-coupled Apoptosis in Tumor Suppression," which did not list any funding source.[261]

Shareholders and Investors

According to a Chinese corporate records database, Clover Biopharmaceuticals' shareholders include Hong Kong-based companies, a Cayman Islands company, PRC state-owned enterprises, and indirectly, several municipal governments and the State Council.[262] The largest shareholder is Hong Kong-based

[256] Information accessed at https://news.bioon.com/article/6545453.html and https://liangpenglab.weebly.com/ on 10 March 2021.

[257] Information accessed at https://doc.mbalib.com/view/af210e9366e1d3db76ce68eef32aea5b.html on 10 March 2021.
[258] Information accessed at https://www.nature.com/articles/gene201613#Aff1 and https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4614363/ on 15 March 2021.

[259] Information accessed at https://fenzhi.csbmb.org.cn/fenhui/admin/HXEditor/UploadFile/2016618204710428.pdf and https://webcache.googleusercontent.com/search?q=cache:VuFVhZJGN4QJ:https://wenku.baidu.com/view/8ad7ef69561252d380eb6e44.html on 16 March 2021.

[260] Information accessed at https://app.dimensions.ai/details/grant/grant.7018331 on 15 March 2021.
[261] Information accessed at https://www.docin.com/p-1651340677.html and https://europepmc.org/article/pmc/pmc2291080?javascript_support=no on 15 March 2021.
[262] Information accessed at https://www.qcc.com/firm/339c4c3bdb5f320dbd02b2c9881fdd14.html on 17 December 2020.

Clover Biopharmaceuticals (Hong Kong) Co., Ltd., which holds 40% equity at the time of the writing of this report.[263] Limited information was found about the company's shareholders and business activities.[264]

PRC state-owned enterprises hold a minority stake in the company via layers of subordinate entities. In some cases, they are minority shareholders of said subsidiaries.[265] In other cases, government entities are the majority shareholders of Clover Biopharmaceuticals' minority shareholders. For example, in Figure 7, minority shareholder Beijing Lapam Health Medical Investment Center (L.P)'s majority shareholders can be traced back to the PRC government.[266]

A detailed investment network graphic of Clover Biopharmaceuticals' shareholders can be found in Appendix 2.

[263] Information accessed at https://www.qcc.com/firm/339c4c3bdb5f320dbd02b2c9881fdd14.html on 17 December 2020.
[264] Information accessed from icris.cr.gov.hk on 16 December 2020.
[265] Information accessed at https://www.qcc.com/firm/339c4c3bdb5f320dbd02b2c9881fdd14.html on 17 December 2020.
[266] Information accessed at https://www.qcc.com/firm/339c4c3bdb5f320dbd02b2c9881fdd14.html on 4 March 2021.

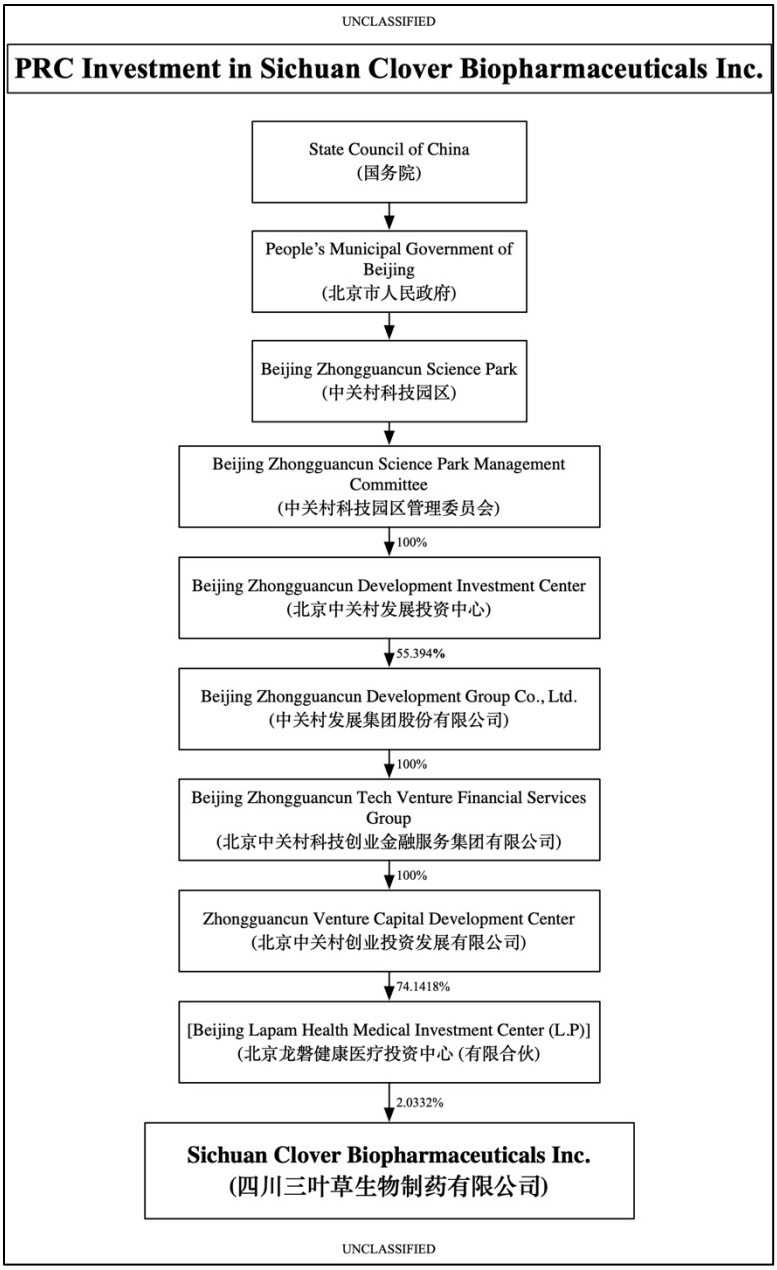

Figure B7: Example of PRC Investment / Ownership in Sichuan Clover Biopharmaceuticals Inc.[267]

According to the company, Clover Biopharmaceuticals has reportedly raised over US$400 million in the past 12 months.[268] However, an approximate estimate suggests that Clover Biopharmaceuticals has raised at least US $600 million from investors.[269] A majority of this funding comes from Oslo-based Coalition for Epidemic Preparedness Innovations (CEPI), an international public - private philanthropic institution.

[267] Information accessed at https://www.qcc.com/firm/339c4c3bdb5f320dbd02b2c9881fdd14.html on 4 March 2021.
[268] Analysts were unable to source the exact breakdown of Clover Biopharmaceutical's reported 400 million USD receipt in investments. Information accessed at https://www.fiercebiotech.com/biotech/clover-raises-230m-as-covid-19-vaccine-nears-phase-3-multi-variant-prospect-gets-going on 24 February 2021.
[269] This figure accounts for CEPI's $328 million, the company's $230 million C round investment among other investment rounds.

CEPI has invested US$328 million in Clover Biopharmaceuticals.[270] This figure includes CEPI's $3.5 million investment into the Clover Biopharmaceutical's Australia subsidiary and $66 million for COVID-19 vaccine trials from July 2020.[271] Clover Biopharmaceuticals also raised US$230 million during a C Round investment in February 2021.[272] Additional details on this investment round is outlined below.

According to Crunchbase, Clover Biopharmaceuticals completed four investment rounds in June 2017, November 2019, June 2020, and February 2021.[273] These investment rounds are summarized in Table 1 below.

Table B-2: Sichuan Clover Biopharmaceuticals Inc. Investment Series Rounds[274]

Date	Investment Series	Amount	Investors
2/23/2021	C	$230 million[275]	• Temasek Holdings • OrbiMed • Oceanpine Capital (海松资本) • GL Ventures (高瓴资本 / AKA Hillhouse Capital) • Delos Capital
6/7/2020	B	$25 million[276]	GL Ventures
11/27/2019	B	¥304 million (US$43.4 million)[277]	• Zhongguancun Venture Capital Development Center (北京中关村创业投资发展有限公司) • Sichuan Province Healthy Pension Industry Equity Investment Fund (四川省健康养老产业股权投资基金) • Lapam Capital (龙磐投资) • Jinlong Group (金龙集团) • Delos Capital (康禧全球投资基金) • Betta Biomedical Industry Fund (杭州贝欣股权投资基金合伙企业 (有限合伙)
12/14/2017	A	¥62.8 million (US$9.66 million)[278]	Tianhe Life Sciences Venture Fund (四川天河生物医药产业创业投资基金)

In December 2017, Tianhe Life Sciences Venture Fund (四川天河生物医药产业创业投资基金) provided an A Series investment in Clover Biopharmaceuticals.[279] Tianhe Life Science Venture Fund is a PRC state-backed investment fund that invests in biomedical technologies, chemical- and natural-based

[270] Information accessed at https://www.reuters.com/article/us-health-coronavirus-clover-cepi/cepi-to-fund-development-of-covid-19-vaccine-candidate-by-chinas-clover-idUSKBN27J05S on 25 January 2021.
[271] Information accessed at https://www.reuters.com/article/us-health-coronavirus-clover-cepi/cepi-to-fund-development-of-covid-19-vaccine-candidate-by-chinas-clover-idUSKBN27J05S on 25 January 2021.
[272] Information accessed at https://www.fiercebiotech.com/biotech/clover-raises-230m-as-covid-19-vaccine-nears-phase-3-multi-variant-prospect-gets-going on 24 February 2021.
[273] Information accessed at https://www.crunchbase.com/organization/clover-biopharmaceuticals/company_financials on 24 February 2021.
[274] Information accessed at https://www.crunchbase.com/organization/clover-biopharmaceuticals/company_financials on 24 February 2021.
[275] Information accessed at https://www.fiercebiotech.com/biotech/clover-raises-230m-as-covid-19-vaccine-nears-phase-3-multi-variant-prospect-gets-going on 24 February 2021.
[276] Information accessed at https://www.crunchbase.com/organization/clover-biopharmaceuticals/company_financials on 16 December 2020.
[277] USD amount calculated using historic exchange rates from https://www.exchange-rates.org.
[278] USD amount calculated using historic exchange rates from https://www.exchange-rates.org.
[279] Information accessed at https://www.crunchbase.com/funding_round/clover-biopharmaceuticals-series-a--771c3928 on 9 February 2021.

drug manufacturing, modern traditional Chinese medicine, medical devices and testing equipment, and biological medical services.[280]

The company's 2019 B Series investment round had several Chinese investors. The most notable investor was Zhongguancun Venture Capital Development Center (北京中关村创业投资发展有限公司). Zhongguancun Venture Capital Development Center is a joint venture between Zhongguancun Management Committee (中关村管委) and Beijing Zhongguancun Development Group Co., Ltd. (ZDG / 中关村发展集团股份有限公司).[281] Beijing Zhongguancun Development Group Co., Ltd. is a PRC state-owned enterprise that acts "on behalf of the Beijing municipal government to make investments in major projects that support the commercialization of key technologies."[282] ZDG is also known to be active in Silicon Valley in directing state-backed investments in US start-ups and supports overseas talent recruitment and technology transfer efforts. It is not known if ZDG's investment ins Clover Biopharmaceuticals were part of its US operations or technology acquisition efforts.

The company's 2021 C Series investment had two Chinese private equity investors, Oceanpine Capital (海松资本) and GL Ventures (高瓴资本 / AKA Hillhouse Capital).[283] Oceanpine Capital is a Beijing-based Chinese venture capital firm established in 2016 and invests in technology and biotechnology companies. [284] GL Ventures is Hillhouse Capital's early-stage venture capital arm[285] and focuses on long-term equity investments.[286]

Table B-3: Sichuan Clover Biopharmaceutical Inc.'s Shareholders[287]

	Name EN	Name CN	Investment Amount	State-backed Investor	Notes
1	Clover Biopharmaceuticals (Hong Kong) Co., Ltd.	N/A	40.4874%	UKNOWN	Hong Kong-based company
2	AUT-XXI HK Holdings Ltd.	N/A	10.5263%	UKNOWN	Hong Kong-based company
3	Chengdu Tianhe Traditional and Modern Medicine Technology Institute	成都天河中西医科技保育有限公司	10.1218%	N/A	
4	Elasa[288]	N/A	9.0605%	UKNOWN	Cayman Islands-based company
5	[Hangzhou Yuhang Lapam Healthy Medical Equity Investment Fund Partnership (L.P.)]	杭州余杭龙磐健康医疗股权投资基金合伙企业 (有限合伙)	7.1162%	N/A	Managed by private equity firm, Lapam

[280] Information accessed at http://public.360inno.com/bs_commonpage/shop/index/3d2557df-c7fe-4c5a-810a-eb0553d8770a on 25 January 2021.
[281] Information accessed at http://www.zgcvc.com/ on 16 December 2020.
[282] Information accessed at https://www.prnewswire.com/news-releases/telestone-receives-rmb-15-million-investment-from-zhongguancun-development-group-159821685.html on 1 November 2020.
[283] Information accessed at https://www.crunchbase.com/organization/clover-biopharmaceuticals/company_financials on 24 February 2021.
[284] Information accessed at https://www.prnewswire.com/news-releases/oceanpine-capital-hits-200mn-first-close-of-fund-ii-301062517.html on 1 March 2021.
[285] Information accessed at https://www.hillhousecap.com/zh-hans/about-2/ on 1 March 2021.
[286] Information accessed at https://www.ft.com/content/6f160a50-f5fe-11e3-a038-00144feabdc0#axzz3RtxGuzwd on 1 March 2021.
[287] Information accessed at https://www.qcc.com/firm/339c4c3bdb5f320dbd02b2c9881fdd14.html on 26 February 2021.
[288] No additional information on Elasa was found during the course of this report. Additional inquiries into the Cayman Islands-based company is advised.

					Capital (龙磐投资)[289]
6	[Beijing Lapam Health Medical Investment Center (L.P)]	北京龙磐健康医疗投资中心 (有限合伙)	5.083%	Zhongguancun Venture Capital Development Center; SASAC	Managed by private equity firm, Lapam Capital (龙磐投资)[290]
7	[Sichuan Province Healthy Pension Industry Equity Investment Fund Partnership (L.P)]	四川省健康养老产业股权投资基金合伙企业 (有限合伙)	5.083%	Sichuan Municipal Government[291]	Managed by private equity firm, Juxin Development (四川聚信)[292]; 2019 Series B Investor[293]
8	Tianhe Life Sciences Venture Fund	四川天河生物医药产业创业投资基金合伙企业	4.4334%	Sichuan Municipal Government[294]	2017 A Series investor[295]
9	[Beijing Kaiyuan Hongdao Venture Center (L.P)]	北京开元弘道创业投资中心 (有限合伙)	2.0332%	Zhongguancun Venture Capital Development Center[296]	
10	[Qianhai Equity Investment Fund (L.P)]	前海股权投资基金 (有限合伙)	1.9853%	Shenzhen Municipal Government	Fund of Funds set up by Shenzhen Municipal Government.[297]
11	[Nanjing Deaoweilan Equity Investment Management L.P. (G.P)]	南京德奥维兰股权投资管理合伙企业 (普通合伙)	1.5284%	N/A	
12	Betta Biomedical Industry Fund	杭州贝欣股权投资基金合伙企业 (有限合伙)	1.5249%	N/A	Managed by private equity firm, Pegasus Capital (贝加投资)[298]; 2019 Series B Investor[299]

[289] Information accessed at https://m.cyzone.cn/capital/1395782.html on 23 February 2021.
[290] Information accessed at https://zdb.pedaily.cn/pe/show50919/ on 23 February 2021.
[291] Information accessed at https://www.qcc.com/firm/339c4c3bdb5f320dbd02b2c9881fdd14.html on 17 December 2020.
[292] Information accessed at https://www.qcc.com/firm/314536ddd5700d57503eb8c19b5d9c96.html on 23 February 2021.
[293] Information accessed at https://www.crunchbase.com/funding_round/clover-biopharmaceuticals-series-a--771c3928 on 9 February 2021.
[294] Information accessed at http://public.360inno.com/bs_commonpage/shop/index/3d2557df-c7fe-4c5a-810a-eb0553d8770a on 25 January 2021.
[295] Information accessed at https://www.crunchbase.com/funding_round/clover-biopharmaceuticals-series-a--771c3928 on 9 February 2021.
[296] Information accessed at https://www.qcc.com/firm/7da6d12f76df84db0330a16c9880323e.html on 23 February 2021.
[297] https://www.qcc.com/firm/9b83150fb345d894a8b75266fb55b117.html
[298] Information accessed at https://www.qcc.com/firm/2138b50393d989f8f7c2760dfb55c1ca.html and https://www.cbinsights.com/investor/pegasus-capital on 23 February 2021.
[299] Information accessed at https://www.crunchbase.com/funding_round/clover-biopharmaceuticals-series-a--771c3928 on 9 February 2021.

13	Hangzhou Golden Dragon Group Corporation Ltd.	杭州金龙集团有限公司	1.0166%	Hangzhou Municipal Government[300]	Managed private equity firm, Jinlong Group (□ 龙□ 团)[301]

Clover Biopharmaceuticals' Subsidiaries

At the time of this report, Clover Biopharmaceuticals has at least six subsidiaries— four in China and two overseas. Information on these subsidiaries is detailed below.

PRC-Based Subsidiaries

Clover Biopharmaceuticals has three wholly-owned subsidiaries in China, [Keluofei Biomanufacturing (Beijing) Co., Ltd.] (克洛菲生物制药 (北京) 有限公司), [Kailuofei Biopharmaceuticals (Shanghai) Co., Ltd.] (恺洛菲生物制药 (上海) 有限公司), [Zhejiang Clover Biomanufacturing Co., Ltd.] (浙江三叶草生物制药有限公司), and [Chengdu Fuya Business Management Co., Ltd.] (成都福雅企业管理有限公司).[302] Notably, senior officers from Clover Biopharmaceuticals are these subsidiary firms' CEOs. Limited information was found about the companies beyond their business registrations.

- [Keluofei Biomanufacturing (Beijing) Co., Ltd.] is licensed to manufacture medicine, conduct medical research, testing, and development, and technology development, consulting, exchange, transfer, promotion, and services.[303] The company's legal representative is Clover Biopharmaceuticals CEO, LIANG Guo (aka Joshua LIANG).[304]
- [Kailuofei Biopharmaceuticals (Shanghai) Co., Ltd.] is licensed to conduct medical research and testing developing, including technology services, consulting, exchange, transfer, and advertisement. The company's legal representative is Clover Biopharmaceuticals CEO, LIANG Guo.
- [Zhejiang Clover Biomanufacturing Manufacturing Co., Ltd.] is licensed to conduct medical product manufacturing, retail, and exports.[305] The company's legal representative is Clover Biopharmaceuticals founder, LIANG Peng.[306]
- [Chengdu Fuya Business Management Co., Ltd.] is licensed to conduct business management consulting and social-economic consulting, conference hosting services, and goods/commodity and technology exporting. The company's legal representative is PING Zheng (平正), who used to be Clover Biopharmaceuticals' Logistics Director prior to the company's December 2020 restructuring.[307] PING's current position with Clover Biopharmaceuticals is unknown.

[300] Information accessed at https://www.qcc.com/firm/341431923c5e5856fa91f4d0b762d8c5.html and http://www.hzjljt.com/cn/about-us.asp on 23 February 2021.
[301] Information accessed at https://www.qcc.com/firm/341431923c5e5856fa91f4d0b762d8c5.html on 23 February 2021.
[302] Note names in [] indicate our translation or transliteration and no official English name was found.
[303] Information accessed from https://www.qcc.com/firm/ca96ddb17c83fd5c4a3697263df5172f.html on 23 December 2020.
[304] Information accessed from https://www.qcc.com/firm/ca96ddb17c83fd5c4a3697263df5172f.html on 23 December 2020.
[305] Information accessed at https://www.qcc.com/firm/0dc9e24de388cb4dac0be7f94eb9e8f6.html on 23 December 2020.
[306] Information accessed at https://www.qcc.com/firm/0dc9e24de388cb4dac0be7f94eb9e8f6.html on 23 December 2020.
[307] Information accessed at https//www.qcc.com/firm/851ab38db565e46ecb76db635e7c3d28.html and http://www.cloverbiopharma.com/index.php?m=content&c=index&a=lists&catid=35&langId=2 on 4 March 2021.

Overseas Subsidiaries

Clover Biopharmaceuticals has a wholly owned subsidiary in Australia called Clover Biopharmaceuticals AUS Pty Ltd.[308] Information about Clover Biopharmaceuticals AUS Pty Ltd.'s activities or personnel is limited aside from CEPI's April 2020 investment to conduct phase one clinical trials in Australia.[309] This subsidiary partnered with Perth-based Linear Clinical Research, a clinical research company, to conduct human trials of its COVID-19 vaccine.[310] As of June 2020, Clover Biopharmaceuticals was the sixth Chinese drug maker to have advanced their COVID-19 vaccine to human trials.[311]

On 30 March 2020, Clover Biopharmaceuticals established Clover Biopharmaceuticals USA, Inc. in Delaware.[312] Clover Biopharmaceuticals Global Leadership Team's Chief Medical Officer of Oncology, Philippe Bishop, is employed by this subsidiary.[313] Additional information about the company's personnel, activities, or location was not found.

Additional Engagements

Senior PRC leaders have visited Clover Biopharmaceutical's offices. In 2016, Politburo member and chief of Chengdu's Organization Department, HU Yuankun (胡元坤) , met with LIANG Peng at Clover Biopharmaceutical. Hu praised the company's innovations and advances in drug and vaccine development and pledged that the Chengdu Municipal government will continue to support the company.[314] Chengdu's Vice Mayor TIAN Rong (田蓉) visited Clover Biopharmaceuticals in May 2016 to express his support. TIAN Rong met with LIANG Peng and reportedly spoke highly of the company's achievements in drug development and pledged to support the company's next phase of commercialization.[315]

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[308] Information accessed at http://www.cloverbiopharma.com/index.php?m=content&c=index&a=show&catid=11&id=44 on 17 December 2020.
[309] Information accessed at http://www.cloverbiopharma.com/index.php?m=content&c=index&a=show&catid=11&id=44 on 17 December 2020.
[310] Information accessed at https://www.aa.com.tr/en/asia-pacific/australia-set-for-chinese-covid-19-vaccine-human-trial-/1821328 on 23 December 2020.
[311] Information accessed at https://www.reuters.com/article/us-health-coronavirus-clover-gsk/clover-launches-sixth-chinese-covid-19-vaccine-trial-idUSKBN23Q15B on 25 January 2021.
[312] Information accessed at https//icis.corp.delaware.gov/Ecorp/FranchiseTax/Filing.aspx?eId=210302174717298 on 5 March 2021.

[313] Information accessed at http://www.cloverbiopharma.com/index.php?m=content&c=index&a=lists&catid=35 and https://www.cloverbiopharma.com/about-us/leadership/on 23 December 2020 and 1 March 2021.
[314] Original quote in Chinese "" Information accessed at https://web.archive.org/web/20161023172454/http://www.cloverbiopharma.com/index.php?m=content&c=index&a=show&catid=11&id=7 on 24 January 2021. 胡部长听取了梁朋博士对公司生物制药研发及产业化发展进程的介绍，高度评价了三叶草生物制药在生物制药核心技术领域所做出的努力和阶段性成果，对三叶草生物未来的发展前景给予厚望，他表示成都市政府及相关部门会继续高度关注三叶草生物的发展，帮助企业及时解决困难加快产业化进程.

[315] Original quote in Chinese "田蓉副市长高度评价了三叶草生物拥有的生物制药核心技术和取得的阶段性成果，对三叶草生物未来的发展前景寄托予厚望，表示成都市政府及相关部门将继续高度关注三叶草生物的发展，帮助企业及时解决困难加快产业化进程." Information accessed at https://web.archive.org/web/20161023170253/http://www.cloverbiopharma.com/index.php?m=content&c=index&a=show&catid=11&id=5 on 24 January 2021.

Personnel

The following tables detail Clover Biopharmaceuticals' Corporate Advisory Board (CAB) and its senior leadership. In late 2020, Clover Biopharmaceuticals restructured its leadership and advisory boards, such as renaming the Scientific Advisory Board (SAB) to (CAB) and added a Global COVID-19 Vaccine Scientific Advisory Board.[316] Notably, four of Clover Biopharmaceuticals' Corporate Advisory Board's board members are Thousand Talent Program selectees.[317] It is unclear what specific roles or duties these board members play in the company. An expanded network diagram of LIANG Peng is included in Appendix 1.

Table B-3: Sichuan Clover Biopharmaceuticals Inc.'s Global Leadership Team[318]

Name EN	Name CN	Role at Clover Biopharmaceuticals	Roles at Other Entities
LIANG Peng	梁朋		Profiled in this report
WANG Xiaodong	王晓东	Founding Advisor, Board Director, Corporate Advisory Board Director	BeiGene founder; National Institute of Biological Sciences founder; CAS
Joshua LIANG; LIANG Guo	梁果	CEO (2016-present)	Former Centerview Partners investment banker (07/2014- UKN); Global Platinum Securities (03/2012-12/2013); USB Investment Bank (06/2013-08/2013); Vertex Pharmaceuticals (05/2012-08/2012); ICBC International (07/2011-09/2011); Vanderbilt University Medical Center (09/2009-05/2010)[319]
Htay Htay HAN	UKN	Chief Medical Officer, Vaccines	Takeda Vaccines Head Early Clinical Development Programs (2016-present); GSK (2000-2016)
Philippe Bishop	UKN	Clover Biopharmaceuticals USA Chief Medical Officer, Oncology	Founder of aratinga.bio; executive leadership roles at SVP, Gilead, Genentech, Johnson & Johnson, Sanofi-Aventis, US Food and Drug Administration, US National Institute of Health.
Phillip Lee		CFO and Chief Business Officer	Former VP at 4D Molecular Therapeutics; Cytokinetics; Avalanche Biotechnologies; Centerview Partners.
David HE; HE Donggou	何东苟	CTO	VP of Technical Operations and Head of China Manufacturing at Legend Biotech; Boehringer-Ingelheim Head of Clinical Supply and Transfer and Member of Site Leadership Team
LI Xiaobing	李晓冰	Executive VP of Product Development and Portfolio Management	Voyager Therapy VP; Sage Therapeutics and Ironwood Pharmaceuticals Senior Director and Global Program Lead; former Director at Janssen
DONG Min	董敏	Executive VP, Global Clinical Development	EOC Pharma Senior VP of Clinical Development; former Director of Novartis' Global Program Team

[316] Information accessed at https://www.cloverbiopharma.com/about-us/note-from-ceo/ and https://www.cloverbiopharma.com/about-us/leadership/ on 3 March 2021.
[317] Information accessed at http://www.cloverbiopharma.com/index.php?m=content&c=index&a=lists&catid=35&langId=2 and https://web.archive.org/web/20161023170413/http://www.cloverbiopharma.com/index.php?m=content&c=index&a=lists&catid=35 on 8 December 2020.
[318] Information accessed at http://www.cloverbiopharma.com/index.php?m=content&c=index&a=lists&catid=35 and https://www.cloverbiopharma.com/about-us/leadership/on 23 December 2020 and 1 March 2021.
[319] Information accessed at https://alumnius.net/university_of_pennsy-9330-221#id110249943 on 9 February 2021.

Igor Smolenov	UKN	Vice President, Global Clinical Developments, Vaccines	Former Therapeutic Area Head at Seqirus, Head of Clinical Development at Moderna; PATH; Novartis; GSK
JIAN Ren	任健	Senior VP of Quality	Head of Quality at Boehringer Ingelheim; former Associate Quality Director at Roche, Quality Control at Merck Sharp & Dome Corp. (MSD), GSK, and Pfizer
Andy CHIN	UKN	VP of Biomanufacturing; Changxing Site General Manager	Senior Production Director at Legend Biotech; former Head of Production at Boehringer-Ingelheim
Andrew Baker	UKN	Senior VP of Global Procurement	Former senior procurement roles at GSK.
Chris Wallace	UKN	Senior VP of Supply Chain	Former global logistics function lead at Celgene; Sanofi Genzyme
Vincent Mwangi	UKN	VP of Clincal Operations/Medical Affairs, Vaccines	Head of Operational Oversight at Takeda Vaccines; GSK Vaccines
LI Ping		VP of Global Biostatistics	Former Senior Director at Pfizer; Head of Statistics Group at GSK Vaccines North America
Steven GONG; GONG Dongyi	龚东屹	VP of Business Development and Strategy	Senior Director and Business Development at Eddingpharm; Associate Director at Novartis; former Strategic Development Manager at Sanofi
Cindy MIN; MIN Xi	闵熙	VP of Public Affairs	Head of Communications at Novartis China; former Head of Corporate Communications and Public Affairs at Janssen China

Table B-4: Sichuan Clover Biopharmaceuticals Inc.'s Board of Directors[320]

Name EN	Name CN	Role at Clover Biopharmaceuticals	Roles at Other Entities
LIANG Peng	梁朋	Founder, Chairman, and President	See Table 3
Joshua LIANG	梁果	CEO, Board Director	See Table 4
WANG Xiaodong	王晓东	Founding Advisor, Scientific Advisory Board Director	See Table 3
ZHU Jianwei	朱建伟	Founding Advisor, Scientific Advisory Board Director	See Table 3
XU Guangyu		Board Director	Current Partner at Lapam Capital; former Hanergy Investment Group Investment Manager, President, and Executive Director; five years' work experience in Beijing government departments.[321]
Tim XIAO		Board Director	Current Principal at Delos Capital; former investment banker at China International Capital; Goldman Sachs Investment Banking Division.[322]

[320] Information accessed at https://www.cloverbiopharma.com/about-us/leadership/on 23 December 2020 and 1 March 2021.
[321] Lapam Capital was a Series B investor and is a minority shareholder via its subsidiaries. See Ownership and Investors section for more details.
[322] Delos Capital was a Series B and C. See Ownership and Investors section for more details.

Table B-5: Sichuan Clover Biopharmaceuticals Inc.'s Global COVID-19 Vaccine Scientific Advisory Board[323]

Name EN	Name CN	Role at Clover Biopharmaceuticals	Roles at Other Entities
Ralf Clemens	UKN	SAB Chairman	Former Senior VP/ Global Head of Vaccine Development at Takeda, Novartis Vaccines, and GSK; former member of International Vaccine Institute's Board of Trustees.
Donna Ambrosino	UKN	Research Advisor	Former CEO of Nosocomian Vaccine Corp.; former CEO of MassBiologics; University of Massachusetts Medical School Professor.
Sue Ann Costa Clemens	UKN	Clinical Development Advisor	Oxford University Visiting Professor of Global Health; Director of Vaccine Group Oxford-Brazil; Professor and Head of Institute for Global Health at the Universita di Siena; former VP of Vaccine Development (Latin America) for GSK.
Pierre Desmons	UKN	CMC Advisor	Former GSK VP and Head of R&D China, Head of Asia Strategic Partnerships.
Sam Liao	UKN	Business Development and Strategy Advisor	Former Head of Business Development and Licensing (Asia) for Novartis Vaccines; former Director of Corporate Development at Sanofi.
Michael Pfleiderer	UKN	Regulatory Affairs Advisor	Principal Consultant at Biopharma Excellence; former Head of Viral Vaccines Section at Paul-Enrlich-Institute; former Chair of the European Medicines Agency's Pandemic Task Force (2009/2010).
Peter Richmond	UKN	Medical Advisor	Head of Division of Pediatrics (Faculty of Health & Medical Sciences), The University of Western Australia; Head of Vaccine Trials Group, Telethon Kids Institute.
Antoinette Quinsaat	UKN	Project Management Advisor	Former Head of Clinical Operations (International), GSK Biologicals and Novartis Vaccines; former Head of Study Management (Asia Pacific), Sanofi.
Frank Rockhold	UKN	Biostatistics Advisor	Professor of Biostatistics and Bioinformatics, Duke University Medical Center; Managing Partner, HunterRockhold Inc; former Senior Vice President and Chief Safety Officer, GSK.
David Salisbury	UKN	Public Health Advisor	Former Director of Immunization, Department of Health (London); former Chair of Strategic Advisory Group on Immunization, World Health Organization (WHO); former Co-chair of Pandemic Influenza Group, G7 Global Health Initiative; Chattem House.
George Siber	UKN	Research Advisor	Co-founder, Affinivax; former Executive Vice President and Chief Scientific Officer, Wyeth Vaccines; former Associate Professor of Medicine, Infectious Diseases, Harvard Medical School. Member of several SABs including: COVAXX, CanSino Biologics Inc, Valneva, AdVaccine, ILiAD Biotechnologies, CureVac,, Vaxess Technologies, and Genocea Biosciences.

[323] Information accessed at https://www.cloverbiopharma.com/about-us/leadership/on 23 December 2020 and 1 March 2021.

Nelson Teich	UKN	Public Health Advisor	Former Minister of Health, Brazil; Founder and former President, Integrated Clinical Oncology Group (COI) and COI Management, Education and Research Institute.
Ann Wartel	UKN	Clinical Development Advisor	Associate Director General, International Vaccine Institute (IVI); former Senior Director of Clinical R&D, Regional Medical Expert, and Country Medical Head (Vietnam/Cambodia), Sanofi.
Nicholas Jackson	UKN	SAB Observer	Head of Programs and Innovation, CEPI; former Vice President and Head of Global Research, Sanofi.

Appendix B1: LIANG Peng Network Chart

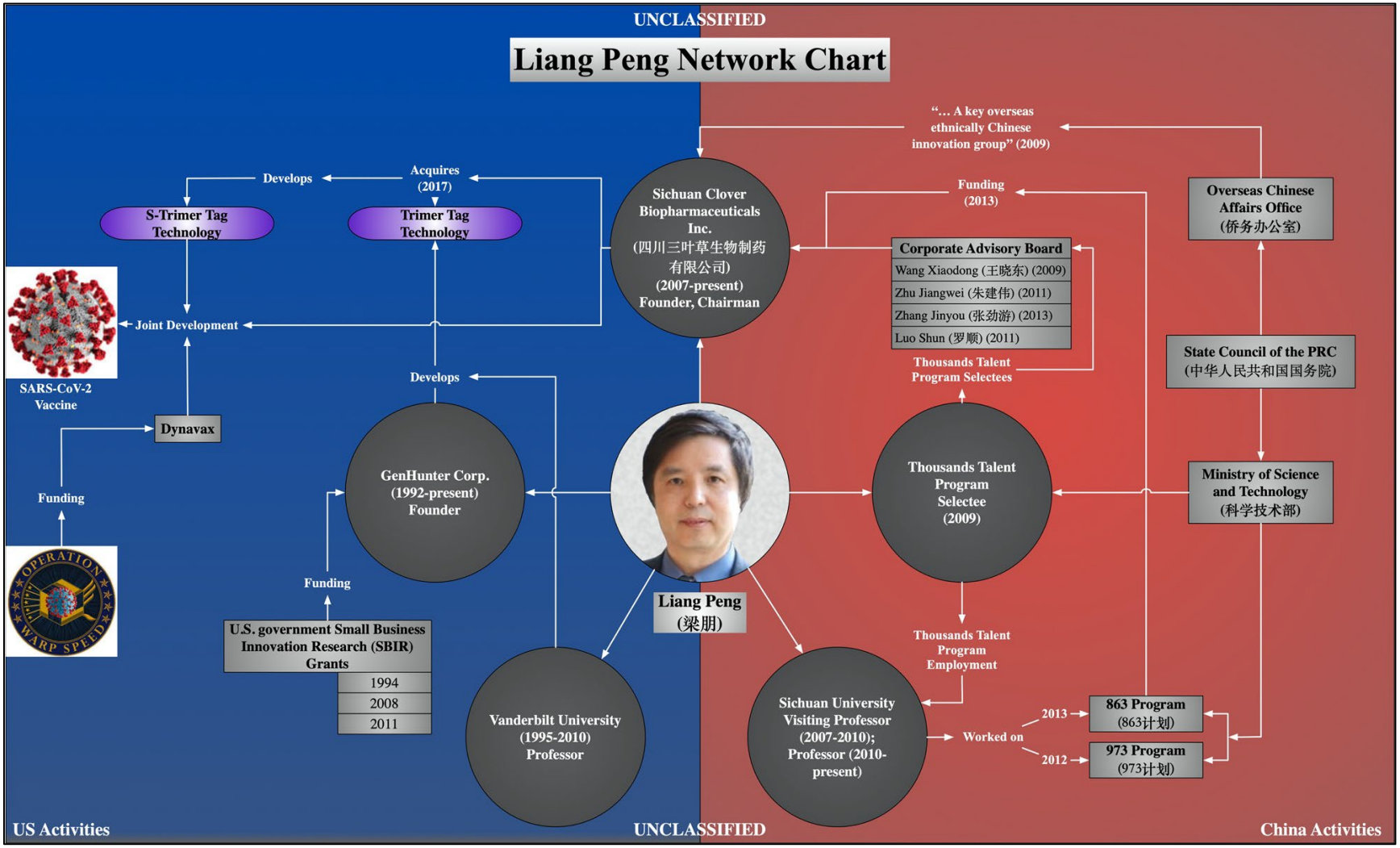

Figure 9: Liang Peng Network Chart

Appendix B2: Sichuan Clover Biopharmaceutical Inc. Investment Diagram

See attachment “Sichuan Clover Biopharmaceuticals Inc Investment Chart.”