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CHINESE NUCLEAR COMMAND, CONTROL, AND COMMUNICATIONS

Prepared by BluePath Labs

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ABBREVIATIONS

ALBM	Air-launched ballistic missile
AR	Autonomous Region
BMD	Ballistic Missile Defense
C2	Command and control
C3I	Command, Control, Communications and Intelligence
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
CAE	Chinese Academy of Engineering
CAS	China Academy of Sciences
CCP	Chinese Communist Party
CETC	China Electronics Technology Company
CMC	Central Military Commission
CNSA	China National Space Administration
COMINT	Communications intelligence
DF	Dongfeng (missile series)
EDD	Equipment Development Department
ELINT	Electronic Intelligence
EW	Early Warning
FYP	Five Year Plans
GAD	General Armament Department
HF	High frequency
ICBM	Intercontinental Ballistic Missile
ISR	Intelligence, Surveillance, and Reconnaissance
JIDS	Joint Integrated Data Link
JOCC	Joint Operations Control Center
JSLC	Jiuquan Satellite Launch Center
LOW	Launch on warning
LPAR	Large Phased-Array Radar
OPFOR	Opposition force
MCF	Military-Civilian Fusion
MOST	Ministry of Science and Technology
MUCD	Military Unit Cover Designation
NC3	Nuclear command, control and communications
NDU	National Defense University
NFU	No-First-Use
PLA	People’s Liberation Army
PLAAF	People’s Liberation Army Air Force
PLAN	People’s Liberation Army Navy
PLARF	People’s Liberation Army Rocket Force
PRC	People’s Republic of China
PSC	Politburo Standing Committee
SAF	Second Artillery Force
SAM	Surface-to-air missile
SIGINT	Signals intelligence
SLBM	submarine-launched ballistic missiles
SSBN	nuclear-powered ballistic missile submarines
SSA	Space Situational Awareness
SSF	Strategic Support Force
TSLC	Taiyuan Satellite Launch Center
VHF	Very high frequency
VLBI	Very Long Baseline Interferometry
UHF	Ultra high frequency
XSCC	Xi’an Satellite Control Center
XSLC	Xichang Satellite Launch Center

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KEY FINDINGS

The People's Liberation Army Rocket Force (PLARF) and China's Nuclear Deterrence Capabilities Have Grown Considerably in the Past 15 Years

Originally, the PLARF was constructed as purely a delivery force for China's nuclear weapons. However, that role has expanded dramatically in recent decades to include conventional missile launch and nuclear co-mingling. The PLARF has also increased in size, with the number of launch brigades increasing from 22 to 41 since 2005. In 2021, China began construction of at least three large ICBM silo fields, which will increase the number of silos under the PLARF's command. Further, the PLA has diversified its delivery systems for nuclear deterrence. These systems now include mobile launch options, silo-based missiles, submarine-launched ballistic missiles, and possibly air-launched nuclear ballistic missiles.

Although the PLARF Will Contribute to Conventional Campaigns, Nuclear Authority Rests with the Central Military Commission

The PLARF follows a "dual deterrence, dual operations" mission requirement that creates two differing lines of command. Regarding conventional campaigns, the PLARF is being integrated into China's nascent joint command structure. In these situations, commands would pass from the Central Military Commission (CMC) to the Joint Campaign Command and then down to the relevant conventional PLARF elements. However, in a nuclear campaign, command would most likely flow from the CMC directly to the nuclear launch units, bypassing Joint Campaign Command and ensuring swift launch capabilities.

Communications and Command Decisions are Disseminated Through a Series of Command Posts

The facilities involved in nuclear command and control typically revolve around a number of command posts that pass communications down the chain of command. At the top is the Joint Operations Command Center in Beijing, with theater-level and service command posts below. However, as mentioned above, in a nuclear scenario, the CMC will presumably bypass joint and theater commands, passing commands directly to launch units. To improve survivability, command posts are typically located in either hardened underground facilities, road-mobile command posts, or airborne command posts.

China is Fielding an Increasingly Capable Layered Network of Sensors

To identify nuclear threats from a variety of vectors, China is developing sophisticated strategic early warning systems. These include over-the-horizon radars, counter-lower-observable radars, and satellite early warning systems, as well as radar systems designed to detect low-flying cruise missiles. The information gathered by these systems is most likely to be collected, analyzed, and disseminated at joint theater command posts.

Introduction

A Note on Terminology: *In 2016 the Second Artillery Force (SAF) was reorganized into the PLA Rocket Force (PLARF). Throughout this report the authors use both terms depending on the date of the sources used. In particular, most authoritative sources on Chinese nuclear operations predate the reorganization, so "Secord Artillery" or SAF is used when translating materials or discussing specifics from these sources.*

The unique arrangement of China's strategic missile forces (chiefly the SAF/PLARF), wherein conventional and nuclear-armed missiles are deployed side by side in the same base and even on the same launcher, and the ambiguity surrounding its nuclear policy, strategy, and deterrence theory, represent significant barriers to a clear-eyed assessment of China's nuclear command, control and communications (NC3) arrangements.

Writing in 2012, John Lewis and Xue Litai provided a framework for understanding China's conceptual approach to nuclear weapons in the form of a six-tier hierarchy of guidance and policies. This framework provided increasing granularity, from high-level grand strategy down to specific guidance for units during a nuclear conflict.[1] Tiers 1-4 are directly referenced in China's defense white papers, albeit in abbreviated form. Tiers 5 and 6 involve more direct discussions about China's NC3 arrangement, and can be inferred from PLA doctrinal writings, including those reviewed for this study. The secrecy and perhaps intentional ambiguity surrounding tiers 1-4 casts doubt on the trustworthiness of some PLA publications that are often deemed authoritative and restricts the types of analysis that can be performed on the specifics of China's plans set forth in tiers 5 and 6.

China's Conceptual Approach to Nuclear Weapons*		
1	Military Strategic Guideline [军事战略方针]	"active defense" [积极防御]
2	Nuclear Policy [核政策]	"…no first use of nuclear weapons at any time and under any circumstances, and not using or threatening to use nuclear weapons against non-nuclear-weapon states or nuclear-weapon-free zones unconditionally."
3	Nuclear Strategy [核战略]	"self-defense" [自卫防御]
4	Nuclear deterrence theory [核威慑理论]	"having both nuclear and conventional capabilities and deterring wars in all battlespaces" [核常兼备、全域慑战]
5	Applied Strategic Principles [战略运用原则 or 战役基本原则]	
6	Operational Regulations [作战条令]	
*Based on Lewis and Xue's six-tier hierarchy and updated using official translations from the 2019 PRC Defense White Paper[2]		

According to the 2006 Defense White Paper, China's nuclear strategy is subject to the national nuclear policy and military strategy. An anonymized Chinese source also states that the SAF's strategy falls under national military strategy and that the specific objectives, approaches, and methods of its force building, and employment must be designed in accordance with the overall national military strategy.[3] As a result, grasping Tiers 5 and 6, Applied Strategic Principles and Operational Regulations, requires a clear and timely understanding of Tiers 1 through 4. Chinese researchers have raised issues with western scholars who use books like the *Science of Second Artillery Campaigns* (SSAC 2004) to deduce China's nuclear strategy.[4] According to Wu Riqiang [吴日强], a nuclear and arms control expert at Renmin University in Beijing, China's senior political leaders formulate nuclear strategy and policy, with the SAF solely responsible for implementation.[5]

While China's defense white papers outline the contents of Tiers 1 to 4, official descriptions are short, vague, and open to interpretation. Although outside the scope of this study, the uncertainty and confusion over the fundamental pillars of Chinese nuclear thinking risks inadvertent or unintentional escalations with disastrous results.[6] Unfortunately, this approach appears to be largely by design. Some sources claim that successful strategic nuclear deterrence by China takes three forms, one of which is if the enemy cannot predict the PLA's exact strategic intention and the form of counterstrikes it will carry out, it will not dare to launch a nuclear war.[7] The 2013 edition of the PLA Academy of Military Sciences' *Science of Military Strategy* (*SMS 2013*) echoed this approach, stressing that a prudently-crafted nuclear deterrence strategy [核威慑策略] is important for improving the effectiveness of China's nuclear deterrence. *SMS 2013* offered two principles to follow in the formulation of such a strategy:[8]

> *"First, (make the strategy) moderately ambiguous* [适度模糊]*. ... Maintaining a moderate degree of ambiguity on the issue of nuclear deterrence and allowing the other side to guess at China's nuclear strength, timing and scale of nuclear counterstrikes will increase the difficulty level of the other side's decision-making process and help enhance the effectiveness of deterrence of China's limited nuclear forces.*
>
> *Second, think expansively* [拓展思路]*. Formulate the nuclear deterrence strategy around the goal of instilling genuine fear in the strategic opponent's mind. Consistent messaging from top leadership and down can usually enhance deterrent effectiveness, but sometimes different people sending out different messages can achieve a better deterrence effect."*

This type of "uncertainty as deterrent" tactic permeates the hierarchy. China's no-first-use pledge (Tier 2) is the most important and widely promulgated element of China's nuclear policy and forms the starting point for understanding China's approach to nuclear weapons. However, critical uncertainty surrounds this idea, which Fiona Cunningham and Taylor Fravel examine in detail in their 2015 *International Security* article assessing China's nuclear posture in the context of U.S.-China strategic stability.

In their paper, Cunningham and Fravel described how China fosters "limited ambiguity" over its no-first-use (NFU) policy to deter the United States from launching conventional attacks against

China's nuclear forces.[9] Western analysts such as Thomas Christenson have described the scenario of U.S. conventional attacks on missiles and related assets being mistakenly viewed by China as an attack on its nuclear retaliatory capability.[10] Interlocutors from the Chinese strategic community who were interviewed by Cunningham and Fravel suggested that Beijing has decided on how to respond to a conventional attack on China's nuclear forces, but has chosen not to make that decision public to both deter through uncertainty, while also preserving the integrity of its NFU policy. To complicate the issue further, the *SMS 2013* included references to a potential shift to a launch-on-warning posture,[11] and recent editions of the Department of Defense *China Military Power Report* indicate that the PLA is in fact moving to launch-on-warning.[12] Cunningham and Fravel also note that Chinese concerns about U.S. capabilities, most notably its ballistic missile defense and conventional prompt global strike (CPGS) capability, are likely to further consolidate China's stance on this issue.[13]

Ambiguity also surrounds China's nuclear strategy (Tier 3). Officially described as "self-defense" [自卫防御], Chinese scholars have labeled this strategy in different ways based on their own interpretations, ranging from "first-strike uncertainty" to "counter nuclear coercion," among others.[14] While analysts agree on the rough contour of the strategy, characterized by Cunningham and Fravel in their paper as "assured retaliation,"[15] details about the management, direction, and employment of weapons and forces have not been made clear.[16]

There is also a lack of consensus between Chinese and international scholars regarding China's nuclear deterrence theory (Tier 4). Lewis and Xue's analysis highlights the longstanding uneasiness of the Chinese leadership with the western concept of "deterrence," which was absent from China's strategic lexicon until the latter half of the 1990s, and did not make its official debut until the 2006 Defense White Paper.[17] Wu Riqiang also underscores China's hesitation in accepting the western concept of "deterrence," warning that there is a different set of logic and terminology at work within China's strategic lexicon.[18] According to Wu, China's eventual reluctant acceptance of the term "deterrence" into its lexicon inadvertently created further confusion on both sides over essential concepts such as deterrence and coercion.[i]

According to Lewis and Xue's framework, the deterrence theory is a rough equivalent to the force strategy of the SAF/PLARF that is currently framed as "having both nuclear and conventional capabilities and deterring wars in all battlespaces" [核常兼备、全域慑战]. The term *he chang jianbei* [核常兼备], which literally means "having both nuclear and conventional," has been in use since the early 2000s. Consistent with "moderate ambiguity," this term is inherently vague and can shift its meaning depending on the context. In earlier doctrinal and other PLA reporting (perhaps due to weapons system constraints), the term is used to refer to the existence of

---

[i] For a more detailed discussion of the etymology of these terms, see Gregory, Kulacki, "Chickens Talking with Ducks: The U.S.-Chinese Nuclear Dialogue," *Arms Control Association*, Accessed 17 November 2020, https://www.armscontrol.org/act/2011-09/chickens-talking-ducks-us-chinese-nuclear-dialogue.

both nuclear and conventional weapons on PLARF bases, meaning geographically distinct brigades under the same base with two types of missile systems.

PLARF he chang jianbei unit[19]

However, the term took on additional shades of meaning when it was used to specifically refer to DF-26-equipped PLARF brigades capable of launching nuclear or conventional warheads.[20] PLARF personnel have more recently been observed training for both nuclear and conventional missions in *he chang jianbei* brigades, with drills involving conventional precision strikes immediately followed by nuclear counter strikes.[21]

As the current strategic requirement [战略要求] is for the PLARF to "have both nuclear and conventional capabilities and deter wars in all battlespaces,"[22] this configuration may be adopted more widely throughout the force. The *Science of Military Strategy 2017 (SMS 2017)*, published by the PLA National Defense University, also illustrated this trend in stating that "the higher stage of development of *he chang jianbei* is 'nuclear-conventional unity'" [核常一体 (*he chang yiti*)], which refers to the organic integration [有机融合] of nuclear counterstrike capabilities with conventional strike capabilities. [23]

In summary, China's conceptual approach to nuclear weapons remains ambiguous by design, at least to outsiders, making high-confidence assessment difficult. The point in *SMS 2013* on using both consistent and inconsistent messaging to enhance deterrence further complicates the analytical process, casting doubt over the value of PLA doctrinal writings. As Larry Wortzel noted in 2012, the number of "secret" PLA documents, particularly the 2004 Science of Second Artillery Campaigns (*SSAC 2004*), also raises red flags.[24] According to Wortzel:

> *An alternative explanation to the existence of so many highly classified documents leaking out to the West in so short a time is that the PLA is involved in a major perception management and disinformation campaign. Could what many of us have accepted, this writer included, as established PLA doctrine because of these books be part of a more nuanced effort designed to reinforce the effort in the United States to reduce the size of our nuclear forces and to rethink the scope and deployment of U.S. efforts on ballistic missile defenses?*

Consequently, while these publications on the one hand represent the best insights available to analysts in the open-source domain, they should also be regarded with a degree of skepticism and contextualized with additional materials. As will be discussed in later sections, this report attempts to contextualize observations of these materials with observed developments regarding other aspects of Chinese NC3.

China has the third-largest nuclear arsenal in the world, and according to the DOD is on track to roughly double the size of its stockpile.[25] Moreover, China is making major investments in the size and survivability of its nuclear forces. China's 2015 Defense White Paper, for example, noted that:

> *China will optimize its nuclear force structure, improve strategic early warning, command and control, missile penetration, rapid reaction, and survivability and protection, and deter other countries from using or threatening to use nuclear weapons against China*.[26]

While the 2000 DOD report to congress on China's military concluded that "China's C4I infrastructure, including the command automation data network portions, is not capable of controlling or directing military forces in a sophisticated, western-style joint operating environment […]," this is no longer the case for nuclear operations.

Discussion of China's nuclear capability is overwhelmingly skewed toward its nuclear strategy or deployed missile forces. As with many of the other gaps in Chinese military studies, this is as much a function of the lack of sources as of inattention to the topic. As a result, the literature on Chinese nuclear command authority, much less the national command and control system, is very small and largely based on outdated sources.

These difficulties persist, but by using new documents and a combination of untapped sources, including authoritative Chinese teaching and military education publications, along with declassified U.S. intelligence reports and commercially available satellite imagery, this study attempts to bridge the gap in the literature to provide readers with a snapshot of China's evolving nuclear command, control, and communications.

SECTION 1: FORCES, PROCEDURES AND PROCESSES

1.1 CHINA'S NUCLEAR FORCES

China first tested a nuclear weapon in 1964. The Second Artillery Force (SAF) was founded in July 1966 to provide a delivery system for the new weapon, and while China has been involved in the development of nuclear-powered ballistic missile submarines (SSBNs) since the 1960s, its maritime nuclear forces only recently began to go on deterrence patrols and field missiles capable of striking the United States. This means that, until recently, the SAF and PLARF were essentially synonymous with China's nuclear deterrent. As the following section will explain, not only is the PLARF an increasingly capable force, but the nascent naval and airborne components of China's nuclear triad are growing as well.

PLA Rocket Force

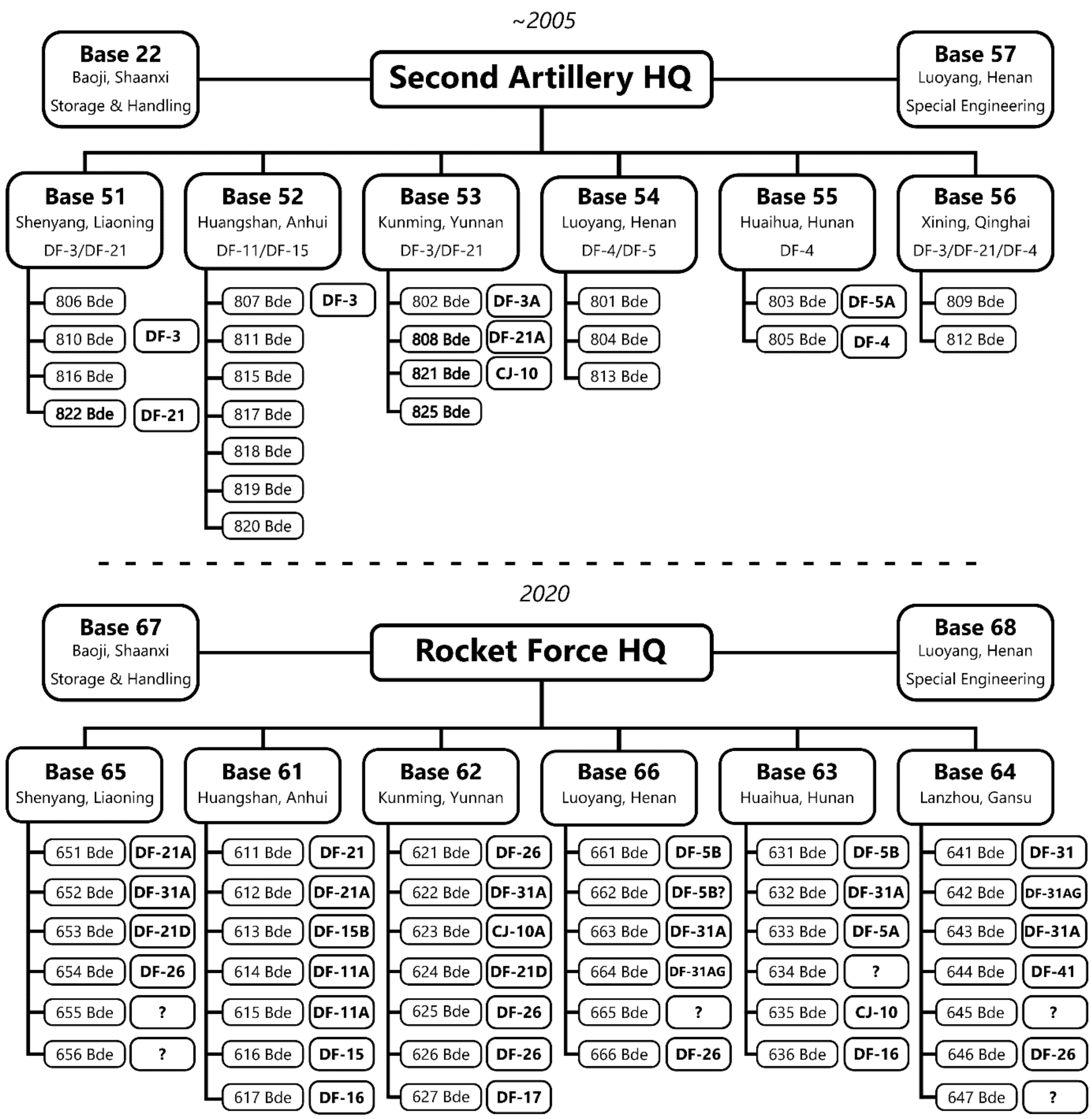
As the primary operator of China's ballistic missile force, the PLA Rocket Force (PLARF) has grown dramatically in the past 15 years, despite relative peace in China's neighborhood. This section will touch upon the drivers of that growth, contextualizing the expansion and modernization of these units with China's threat environment.

In September 2016, CCP General Secretary and senior civilian leader of the Chinese military Xi Jinping summarized the significance of the Rocket Force and China's ballistic missiles, describing them as the "core force of China's strategic deterrence, the strategic pillar of China's status as a major power, and an important cornerstone of safeguarding national security…the Rocket Force has played an irreplaceable role in containing war threats, creating a favorable strategic posture for our country's security, and maintaining global strategic balance and stability."[27] The ballistic missiles of the PLARF are not only China's primary nuclear deterrent but also play a vital role in the conduct of the PLA's main campaigns, which include joint firepower strikes [联合火力突击] and joint blockades [联合封锁] as well as the nuclear counterstrike campaign and joint nuclear counterstrike campaign [联合核反击战役].

While China's conventional missiles have assumed greater prominence in potential strikes on U.S. carriers or Taiwan, this role is relatively recent. Despite having a ballistic missile program since the 1950s, Chinese leaders did not seriously envision employing these weapons for tactical use until the 1980s.[28] Nevertheless, China's conventional ballistic missile force has grown considerably since 1993, when the SAF was given a role in conventional missile strike operations.

The PLARF has six operational Bases and three support Bases (a central storage and handling Base for nuclear warheads, an engineering Base responsible for supporting infrastructure and hardened facilities, and a new Base responsible for both testing and advanced training). The Base structure has been renumbered based on the new protocol order following the 2016 shift from Military Regions (MR) to joint Theater Commands (TC). The new numbering scheme may also symbolize a change in strategic priorities, with Eastern China (formerly Base 52, now Base 61) first, rather than the Northeastern area bordering Russia and North Korea (formerly Base 51, now Base 65) that was the focus of the past. Otherwise, these Bases remain largely the same following the 2016 reforms. The most dramatic shift has been the rise in the number of positively identified launch brigades from 22 to 39 between 2005 and 2020.[ii] This growth is set to continue, as further brigades will need to be created to operate the three large ICBM silo fields under construction since 2021. The following graphic provides a sense of the growth of the Chinese missile forces, based on available public information from both periods.

Growth of Chinese Missile Forces 2005-2020



[ii] Since 2020, the PLARF has added at least two more brigades, bringing the total to 41.

Nuclear Launch Brigades	
6 launch battalions per brigade	**12 launchers per brigade**
2 launch companies per battalion	
1 launcher per company	
Conventional Launch Brigades	
6 battalions per brigade	**24-36 launchers per brigade**
2 launch companies per battalion	
3 launchers per launch company	

Typical estimates of the makeup of nuclear-equipped PLARF launch brigades include an average of six launch battalions per brigade, two companies per battalion, and one missile launcher per company.

Beyond the six main operations Bases, the PLARF has a central warhead storage facility in Taibai County, Shaanxi Province. At lower levels, warheads are parceled out to each of the PLARF's six operational Bases' Equipment Inspection Regiments [装检团] that are responsible for maintenance, storage, and transportation.[29]

Base 61 HQ, Huangshan, Anhui
1 Brigade 611, Chizhou, Anhui, DF-21A
2 Brigade 612, Leping, Jiangxi, DF-21A
3 Brigade 613, Shangrao, Jiangxi, DF-15B
4 Brigade 614, Yong'an, Fujian, DF-11A
5 Brigade 615, Meizhou, Guangdong, DF-11A
6 Brigade 616, Gangzhou, Jiangxi, DF-15A/B/C
7 Brigade 617, Jinhua, Zhejiang, DF-16A

Base 62 HQ, Kunming, Yunnan
8 Brigade 621, Yibin, Sichuan, DF-26
9 Brigade 622, Yuxi, Yunnan, DF-31A
10 Brigade 623, Luorong, Guangxi, DF-10A
11 Brigade 624, Danzhou, Hainan, DF-21D
12 Brigade 625, Jianshui, Yunnan, DF-26
13 Brigade 626, Qingyuan, Guangzhou, DF-26
14 Brigade 627, Puning, Guangzhou, U/I

Base 63 HQ, Huaihua, Hunan
15 Brigade 631, Jinzhou, Hunan, DF-5B
16 Brigade 632, Shaoyang, Hunan, DF-31AG
17 Brigade 633, Huitong, Hunan DF-5A
18 Brigade 634, Tongdao, Hunan, U/I
19 Brigade 635, Yichun, Jiangxi, DF-10
20 Brigade 636, Shaoguan, Guangdong, DF-16A

Base 64 HQ, Lanzhou, Gansu
21 Brigade 641, Hancheng Shanxi, DF-31
22 Brigade 642, Datong, Qinghai, DF-31AG
23 Brigade 643, Tianshui, Lanzhou, DF-31A/AG
24 Brigade 644, Hanzhong, Shaanxi, DF-41
25 Brigade 645, Yinchuan, Ningxia, U/I
26 Brigade 646, Korla, Xinjiang, DF-26
27 Brigade 647, Xining, Qinghai, U/I

Base 65 HQ, Shenyang, Liaoning
28 Brigade 651, Dalian, Liaoning, DF-21A
29 Brigade 652, Tonghua, Jilin, DF-21D
30 Brigade 653, Laiwu, Shandong, DF-21D
31 Brigade 654, Dalian, Liaoning, DF-26
32 Brigade 655, Tonghua, Jilin, U/I
33 Brigade 656, Laiwu, Shandong, DF-100

Base 66 HQ, Luoyang, Henan
34 Brigade 661, Lushi, Henan, DF-5B
35 Brigade 662, Sundian, Henan, DF-4
36 Brigade 663, Nanyang, Henan, DF-31A
37 Brigade 664, Luoyang, Henan, DF-31AG
38 Brigade 665, Xinxiang, Henan, U/I
39 Brigade 666, Xinyang, Henan, DF-26

Base 67, Nuclear Warhead Storage Facility, Taibai, Shaanxi

Mobile Forces

In the past 15 years, the PLARF has fielded increasingly capable mobile ICBMs, as well as shorter-range regional ballistic missiles with nuclear warheads. These missiles are transported and prepared for launch by a specialized vehicle called a transporter-erector-launcher (TEL). These launchers can move to a new location after firing and reload in the field using canisters and cranes.

The first of the mobile ICBMs was the DF-31, introduced in the early 2000s. The DF-31 is a three-stage solid-propellant missile with an estimated range of 10,000 km, which is mounted on an eight-axle vehicle capable of mobile deployments as needed. Further improvements have allowed it to launch a multiple independently-targetable reentry vehicle (MIRV) payload.[30] According to the CSIS Missile Defense Project, the DF-31 has an accuracy of 150-300 meters circular error probable.[31]

The DF-31 was followed by the DF-41 in 2019. The DF-41 features a three-stage solid-propellant missile with an extended range of 15,000km, and is capable of carrying MIRV warheads.[32] A silo-based variant of the DF-41 is also believed to be under development.

While Chinese missile units have used prepared launch sites for training, during wartime they are expected to use a separate, much harder-to-identify group of "field" launch positions. This would significantly increase their survivability and credible second-strike capabilities against opponents.

Example of a prepared training launch site for DF-31 missiles.[33]

Silos and Roll-out Missiles

The PLARF may still field around 10-15 roll-out DF-4 missiles, though these are in the process of being phased out (if they have not been already).[34] These models are a two-stage, single warhead, liquid propellant ICBM, with an estimated range of 5,500km.

China's largest missile with the greatest deliverable payload capacity is the DF-5. The DF-5 and its later variants are liquid-fueled, meaning they take longer to prepare for launch, but feature an extended range of 12,000-15,000 km.[35] At the same time, the pattern of steady improvements in missile capabilities has continued. An improved variant of the silo-based liquid-fueled DF-5, the DF-5B, was displayed at a military parade in 2015 for the first time. It is believed to be equipped with MIRVs.[36] A further upgrade, the DF-5C, is believed to be under development[37]

Ongoing experiments with silo configurations of the DF-41 indicate that the solid-fueled missiles may complement or even replace the DF-5. For example, a 2021 report for the Federation of American Scientists detailed silo expansion at the Jilantai [吉兰泰] site in Inner Mongolia and found that, while initial construction appeared to favor the DF-5, later silo construction looks to have been sized for the newer DF-41.[38] The author hypothesized that this change in size, along with the large number of new silos being constructed, indicated that the PLARF may be experimenting with which missile or combination of missiles best suits its needs.

China now appears intent on developing a significant silo-based ICBM force. Prior to 2021, the PLARF operated only approximately 20 ICBM silos. However, in 2021, the PLARF began constructing three new silo fields, in Gansu, Inner Mongolia, and Xinjiang UAR; a buildup that will collectively increase the number of ICBM silos under the PLARF's command to approximately 260.[39] This development is consistent with recent Department of Defense estimates that the PLA is set to double its stockpile to over 1,000 nuclear warheads by 2030.[40] However, recent revelations about corruption in the PLARF acquisitions process have included allegations of poor build quality for these new silos, suggesting their introduction into active duty may be significantly delayed.[41]

To operate silos and other equipment, PLARF Bases contain many specialized organizations. In addition to launch brigades, PLARF Bases each have training, communications, operational support, and comprehensive support regiments. Communications regiments [通信团] function as the basic link between levels of command and between nuclear units and higher echelons, including the Central Military Commission. These organizations are discussed in Section 2.

PLARF Training for Nuclear Scenarios

To prepare for conventional and nuclear conflicts, the SAF and now the PLARF have participated in several joint and interregional exercises to test interoperability and command and control. Likely, the most important of these are the annual *Sky Sword* [天剑] exercises held since 2012.

Few details are available, but the *Sky Sword* exercises include both nuclear and conventional forces in order to enhance the PLARF's strategic capabilities and deterrence. The 2018 *Sky Sword* exercises took place in early summer in the Gobi Desert and forests in Northeast China.[iii] A major feature of the exercise was the use of both planned and unannounced simulated launches.[42] The exercise also featured opposition-force (OPFOR) combat training with the blue force (the enemy in Chinese military contexts) employing technical reconnaissance, electronic countermeasures, and changing tactics that included information suppression, electromagnetic interference, and attacks by special forces.[43]

[iii] Given the dates of the articles reporting on the exercises we can infer a date at or before 30 May 2018.

According to official news service Xinhua, 100 percent of PLARF brigades have participated in the *Sky Sword* exercises, with nuclear missile units practicing unannounced missile assaults, electronic offense and defense, and interception.[44] Reportedly, these measures were practiced to enhance deterrence and combat capabilities.[45]

Other large-scale exercises involving the SAF/PLARF over the past decade include the now-discontinued *Joint Action* [联合行动] exercises. The 2015 iteration featured strategic early warning, intelligence and reconnaissance, command and control, and electromagnetic spectrum control.[46]

To improve the realism of these exercises, the PLARF established a dedicated "blue force" [蓝军] OPFOR unit. The group is led by Colonel Liu Shaoguang [刘晓光],[47] identified as commander of a Rocket Force Training Base Blue Force Regiment [火箭军某训练基地蓝军军团团长]. Contextual information indicates this unit is likely affiliated with the Training Area in Jingyu County [靖宇], Jilin Province.

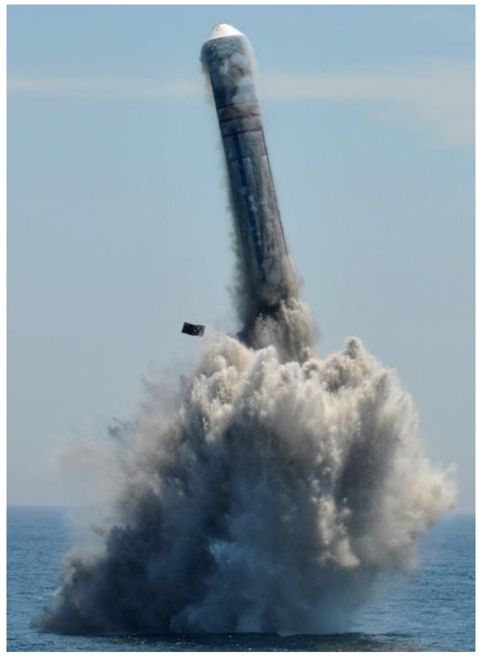
Insignia of PLARF OPFOR "Blue Team" Regiment[48]

PLA Navy Nuclear Ballistic Missile Submarine Force

While the PLARF is the "core" of China's nuclear deterrent, the PLA Navy and eventually the PLA Air Force are also set to play key roles.[49]

After the PLARF, the second-largest component of China's nuclear forces is its growing force of nuclear-missile equipped submarines. Until relatively recently, Chinese submarine-launched ballistic missiles (SLBMs) had limited range and were only able to threaten China's direct neighbors from protected areas close to its shores, forcing older SSBNs to transit closely monitored waterways to participate in potential strikes on the continental United States. However, in September 2020, commander of the U.S. Strategic Command Admiral Chas Richard stated that "China now has the capability…to directly threaten our homeland from a ballistic missile submarine."[50] This statement aligns with apparent breakthroughs in missile propellant technology that would allow for longer-ranged solid-propellant missiles.[51] Each SSBN is capable of carrying 12 of the JL-2 SLBM, and in recent years, the newer JL-3 SLBM has reportedly entered service, allowing the PLAN to target portions of the continental United States from littoral waters for the first time.[52]

The size of the submarine force has also grown significantly. Six Type 094 SSBNs are believed to be in operation as of 2023,[53] with a total of eight submarines projected to be in operation by 2030.[54] A new SSBN, the Type 096, is slated to enter service by the late 2020s, further enhancing the sea-based leg of China's nuclear triad.[55]



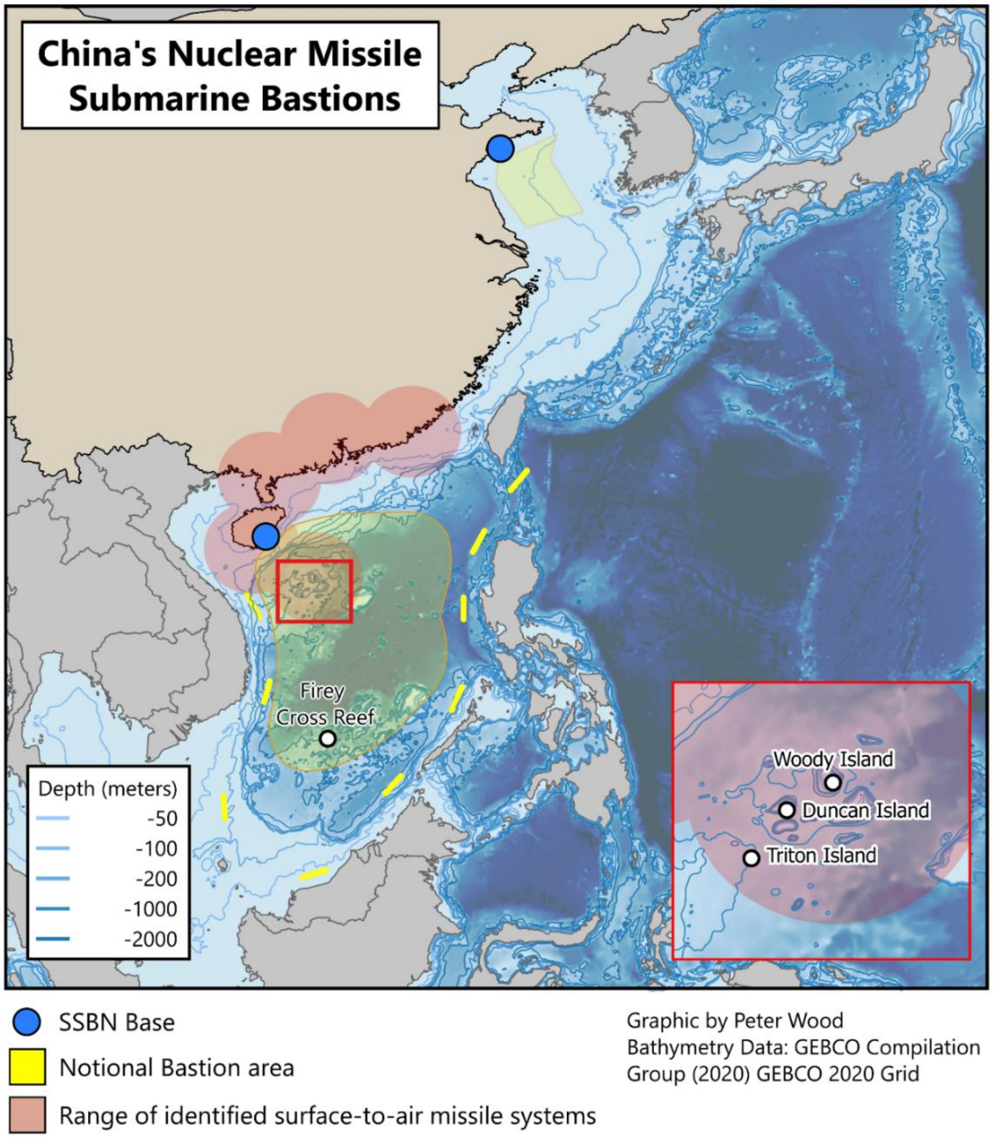
JL-2 SLBM Launch[56]

Operational employment

These submarines have multiple crews (believed to be three groups) to allow for higher operational tempos. The PLAN has sent its submarines on long patrols in tandem with its missions to the Gulf of Aden, and, according to then-Vice Admiral Joseph Mulloy, Deputy Chief of Naval Operations for capabilities and resources, kept submarines on patrol for as long as 95 days.[57]

Despite advancements in quieting technology, Chinese SSBNs remain at risk from peer competitors and appear to be deployed in protected areas, called bastions. The Yellow Sea has been mentioned as a possible bastion area, and is proximate to SSBN bases at Qingdao, Shandong Province and Dalian, Liaoning Province.[58] However, despite protection from shore-based aircraft, surface-to-air missiles (SAMs), and antiship missiles, the relative shallowness of the Yellow Sea (44m on average and 152m in its deepest parts) and high traffic make it a less secure area. The Bohai Sea, which is sometimes mentioned as an option, is even shallower, and most submarines would be unable to transit the area submerged (see map below). These submarines' deployment at the base in Yulin, Hainan Province, as well as favorable geography and bathymetry, make the South China Sea the safest area. Yulin appears to offer an ideal position as the coastal shelf drops off dramatically close offshore, likely allowing SSBNs to make a faster transit to safer depths more quickly. However, the far southern location of the South China Sea significantly limits the effective range of the PLAN's SLBMs.

China's expansion of reefs and shoals into extensive military bases dotting the South China Sea supports air and surface monitoring of the SSBNs' likely patrol areas, and SAMs and fighter aircraft have been deployed to the bases and used to intercept U.S. maritime patrol aircraft flying in international airspace over the area. The graphic below shows the bathymetry of the seas surrounding China and notional bastion areas, giving a sense of how shore- and island-based SAMs, based on identified sites, could contribute to air defense of the area.



Paralleling China's construction of hardened structures to protect its nuclear forces and command centers, as well as its fortified islands in the South China Sea, China is also building an "Underwater Great Wall" [水下长城] of layered anti-submarine defenses. Described as similar to the U.S.'s passive acoustic Sound Surveillance System (SOSUS), this network includes buoys, fiber-optic hydrophones, and passive sonars. The systems are intended to defend against enemy submarines and probably also to protect China's own fleet of SSBNs. This National Seabed Scientific Observation Network [国家海底科学观测网] will feature a monitoring and data center in Shanghai collecting data from the East and South China Seas, and has an investment of over 2.1 billion RMB over 5 years.[59] While less data is available, it is possible that some of this sea-bed infrastructure includes devices to provide communications with submarines hiding in the depths, providing another communications link to supplement the low-frequency transmitters that will be covered in section 3.2.

It is worth noting that the development of this force has been decades behind early estimates. For example, the CIA estimated in 1981 that "up to five SSBNs could be operational by the early 1990s."[60] Technical difficulties with the Type 092 Xia-class meant that the single completed example of that type apparently never went on a deterrence patrol. Other factors, including the limited capability of the JL-1 SLBM, combined with a shift in China's strategic environment in the late 1980s, contributed to the reprioritization away from SSBNs.[61] In some ways, China's more rapid deployment of a large number of submarines in the past 20 years represents a return to its earlier trajectory.

PLA Air Force Nuclear Component

The 2020 DOD report to Congress on Chinese military developments noted that "China is pursuing a 'nuclear triad' with the development of a nuclear capable air-launched ballistic missile" and "upgrading its aircraft with two new air-launched ballistic missiles (ALBM), one of which may include a nuclear payload."[62] This follows speculation that China was developing an ALBM capability, based on the appearance of grainy images on Chinese social media over the past several years that look like test flights of an ALBM carried aboard an improved variant of the H-6 bomber (see below). The missile, which currently lacks a formal designation, appears to be one meter in diameter, and according to one source, is on track for deployment by 2025.[63]

Unidentified Chinese ALBM[64]

Roderick Lee has identified Neixiang Airbase outside Nanyang [南阳] in southwest Henan Province as a probable base for the aviation leg of China's nuclear triad.[65] Renovations at the base indicate that hardened shelters capable of accommodating the H-6N bomber, which entered service in 2020, have been built.[iv]

It is likely that China did not previously develop an air-dropped or -launched nuclear deterrent due to a lack of the necessary high-performance aircraft needed to deliver a nuclear weapon against one of its probable adversaries, with the modified H-6 probably serving as a temporary solution.[66] A new Chinese dual-capable stealth bomber, the H-20, is under development. The bomber has an estimated range of at least 8,500 km and is expected to enter service before 2030.[67]

The communication systems to connect this unit to higher authorities outside Beijing or the alternative command posts are currently unknown. While it is possible to speculate that the PLAAF's existing theater/corps-level communications system, including perhaps two main communications stations [通信总站] in northwest Beijing, could play a role or supplement wired communication networks, due to the newness of the unit and the great secrecy surrounding the new capability, no other details are currently available.

1.2 Posture

China's overall nuclear force has changed dramatically and is adopting increasingly survivable basing modes as well as developing a command and control architecture to match. The DOD's 2023 report on Military and Security Developments Involving the People's Republic of China noted that China's nuclear posture is changing:

> *Launch on Warning (LOW).[v] The PLA is implementing a launch-on warning posture, called "early warning counterstrike" (预警反击)...PLA writings suggest multiple manned C2 organs are involved in this process, warned by space and ground based sensors, and that this posture is broadly similar to the US and Russian LOW posture. The PRC probably seeks to keep at least a portion of its force, especially its new silo-based units, on a LOW posture, and since 2017, the PLARF has conducted exercises involving early warning of a nuclear strike and launch on warning responses.[68]*

[iv] Coordinates: 32.973889, 111.884444.

[v] Launch on Warning (LOW) and Launch Under Attack (LUA) have been used interchangeably, most commonly with LUA used to describe U.S. postures. One public assessment of survivable nuclear architecture for a LUA posture in the United States noted that ICBMs gave leaders roughly 30 minutes to act, but that submarine-launched ballistic missiles shortened this timeline to 5-10 minutes. While these numbers represent an assessment of a Soviet-US confrontation, they act as a baseline for understanding the faith that must be placed on early warning systems and the pressures to respond put on leaders to react in a timely manner. See "MX Missile Basing" Office of Technology Assessment, September 1981, https://ota.fas.org/reports/8116.pdf, 150. Highlighting these problems, the report also notes, "The risks of LUA arise not from technically difficult problems, but from the uncertainties of the interface between men and machines."

The DOD's 2019 report noted that "PLA writings express the value of a "launch on warning" [基于预警发射] nuclear posture, an approach to deterrence that uses heightened readiness, improved surveillance, and streamlined decision-making processes to enable a more rapid response to enemy attack. These writings highlight the posture's consistency with China's nuclear NFU policy, suggesting it may be an aspiration for China's nuclear forces. China is working to develop a space-based early warning capability that could support this posture in the future.[69]

The table below overviews some major developments in China's nuclear basing modes. In the 1960s, China's small force of roll-out nuclear missiles was unlikely to be survivable and would have relied largely on concealment to ensure that a retaliatory weapon was launched. Even then, the limited range and accuracy of China's systems meant that only a few counter-value targets could be targeted. The fielding of the DF-5 in a silo configuration in the early 1980s gave China a true ICBM capability, but limited numbers made this a highly vulnerable capability. In the early 2000s, the introduction of small numbers of road-capable ICBMs improved the survivability of the nuclear forces, but given the increasing sophistication of sensors to detect these missiles, China's overall capabilities likely remained insufficient to be considered a reliable deterrent. Breakthroughs in missile technology and improved SSBNs along with a rapid increase in the overall number and capability of mobile ICBMs have markedly improved China's deterrent in recent years.

Changes in Chinese Nuclear Basing Modes

Date of Introduction	Basing Mode or R&D Effort	Representative System
Late-1960s	Transit from hardened shelter to launch site	DF-3
Mid-1970s[70]	Roll-out from hardened shelter	DF-4
1981-Present[71]	Silo basing	DF-5
Mid-1980s	Beginning of shift toward mobile solid-fueled systems[72] and submarine launched missiles	JL-1, DF-21, DF-31
Early 2000s	Road-mobile, transit from garrison to launch position	DF-31
~2016[73]	Beginning of SSBN deterrence patrols	Type 094 SSBN
~Mid-2020s[74]	Mixed mobile, silo, rail deployment	DF-41
~2030	SSBNs able to target U.S. from littoral areas including South China Sea bastion	Type 096

Chinese missiles have previously been described as being kept with their warheads de-alerted, de-mated, and unfueled.[75] However, the technical aspects of certain missiles, such as the nuclear DF-21A, make it unclear if that is possible for all missile types.[vi]

[vi] The DF-21A's canister configuration may require a more complex warhead mating process, though this is speculative based on available images of the system and comparisons to other missile architecture.

China and the United States de-targeted each other in June 1998, and have established a direct phone connection between senior leaders.[76] According to then-Secretary of Defense Robert Gates, as of 2010, U.S. missiles are targeted at the ocean during peacetime in case of an accidental launch.[77] The Chinese side is less clear, but according to authoritative Chinese sources the PLARF generally advises on, rather than directly selects, targets for nuclear strikes. Presumably, the Supreme Command [最高统帅], the CMC Joint Operations Command Center (JOCC), headed by Xi Jinping, selects nuclear strike targets.

	Alert & Launch Order Sequence[78]
1	Standing War Preparedness Alert
2	Class 3 Alert
3	Class 2 Alert
4	Class 1 Alert
5	Preparatory Order [预先号令]
6	Formal Order [正式命令]

Chinese nuclear forces have been described as following a six-stage sequence, consisting of a standing war preparedness alert, followed by alerts of increasing intensity. This is followed by a preparatory order in which forces review intelligence and ensure that it is up to date and begin organizing forces for battle. Finally, forces are given a formal order to launch against targets with nuclear weapons.

1.3 Second Artillery/ PLARF Campaign Command Arrangement

'Dual Command'

This section lays out what is known about the PLA's command and control of its nuclear forces. Given that the maritime and airborne legs of China's nuclear triad are still emerging, few details regarding their command arrangements are known. Therefore, this section focuses on the PLARF, by summarizing information regarding the SAF's command arrangement according to PLA doctrinal writings. It is presented using the PLA's discourse system and terminology.

Although the reorganization of the SAF as the PLARF, a separate co-equal service [军种], has led to many changes, key aspects of its campaign command arrangement [战役指挥体制], especially concerning command authority [指挥权限], have not been altered significantly. While the PLARF's organization and force structure continue to evolve, and the command and communication systems are being modernized, its core mission set has remained the same.

In the 1990s, the CMC ordered the SAF to carry out "dual deterrence and dual operations" [双重威慑、双重作战] to adapt to the new military strategic guideline of winning high-tech localized wars [高技术局部战争].[79] To fulfill the "dual deterrence" requirement, the SAF was to use "conventional missile weapons to effect conventional deterrence against the enemy [对敌实施常规威慑] and strategic nuclear weapons to carry out counter nuclear deterrence [反核威慑]."[80] To fulfill the "dual operations" requirement, the nuclear missile force's mission set included nuclear deterrence and nuclear counterstrikes, while the conventional missile force is responsible for conventional deterrence and long-range firepower strikes in joint operations.[81]

According to recent PLA papers, the PLA's mission set remains similar to those articulated in the 1990s, including the enhancement of the SAF/PLARF's credible and reliable capabilities of nuclear deterrence and counterattack, and the strengthening of intermediate and long-range precision strike forces.[vii] [82]

The *SSAC 2004* delineated two types of campaigns undertaken by the SAF based on the types of weapons employed: nuclear counterstrike campaigns [核反击战役] and conventional missile strike campaigns [常规导弹突击战役].[83] A nuclear counterstrike campaign can be executed alone, or jointly with the nuclear forces of other services. As Cunningham and Fravel have pointed out, the PLA's doctrinal writings consistently describe the nuclear counterstrike campaign as the only type of campaign conducted by Chinese nuclear forces.[84] A conventional missile strike campaign is often carried out as part of a joint campaign but can also be executed independently. The below chart overviews the types and composition of missile campaigns envisioned for the SAF.

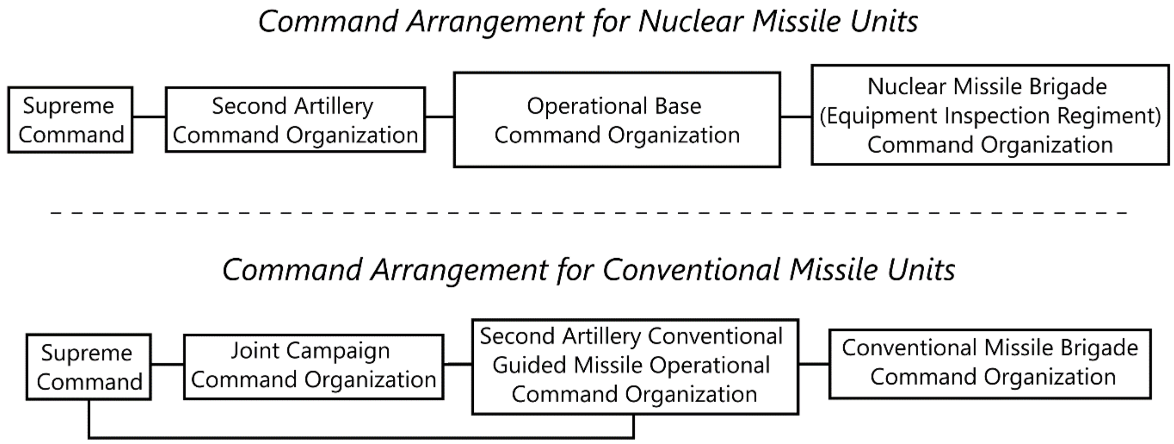
Second Artillery Campaigns[85]		
	Nuclear Counterstrike Campaign	Conventional Missile Strike Campaign
Campaign Formation/*Juntuan*[viii] [战役军团]	"Composed of Nuclear Missile Units, Nuclear Equipment Inspection Units and relevant support units and sub-units"	Composed of Conventional Missile Units, relevant support units, and sub-units
Basic Campaign Unit [基本战役单位]	Missile Base and Equipment Inspection Base [导弹基地和装检基地]	N/A
Basic Operational Unit [基本作战单位]	Missile brigade [导弹旅]	Conventional missile brigade [常规导弹旅]
Basic Firepower Unit [基本火力单位]	Missile battalion [导弹营]	Launcher [发射架]

According to *SSAC 2004*, to fulfill its nuclear-conventional "dual deterrence, dual operations" mission requirement, the SAF adopts a campaign command arrangement [战役指挥体制] of "nuclear-conventional unity, two lines of command" [核常一体、双线指挥].[86] This phrasing is confusing, and the book provides no detailed explanation as to the meaning of "nuclear-conventional unity." The "two lines of command" arrangement is illustrated in the graphic below.

[vii] Although it appears the PLARF no longer clearly distinguishes between nuclear and conventional roles

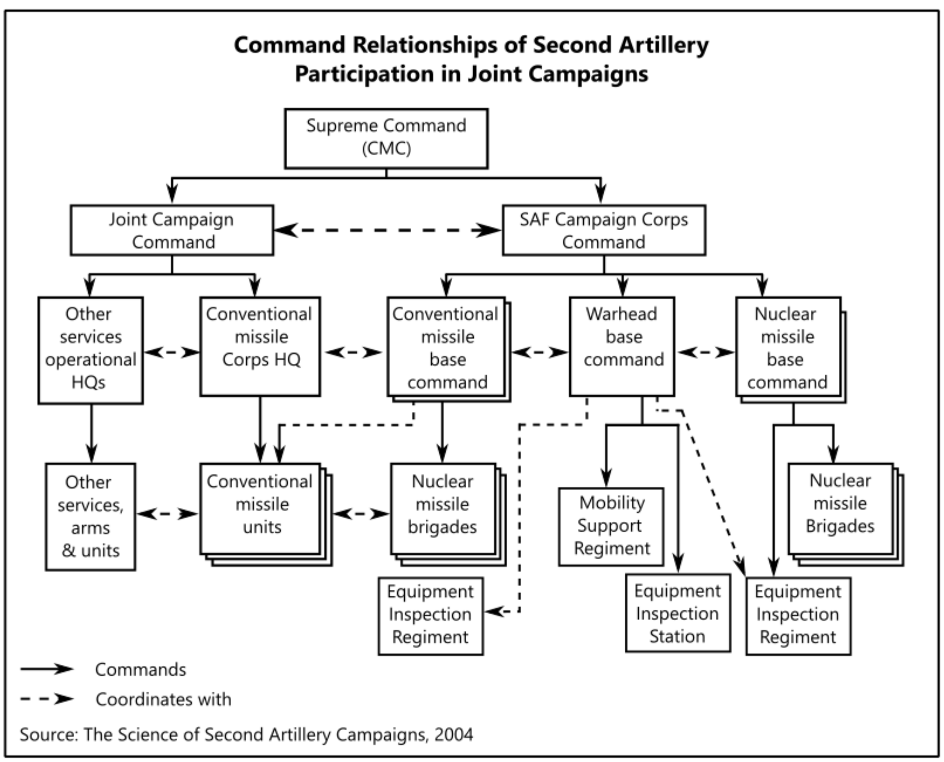
[viii] There does not appear to be a consensus on how to translate *Juntuan* [军团], though it has previously been given as "large formation." See Kenneth W. Allen, "Introduction to the PLA's Organizational Reforms: 2000-2012" in *PLA as Organization 2.0*, Defense Group Inc, 2016, 53.

SAF Campaign Command Arrangement [战役指挥体制]



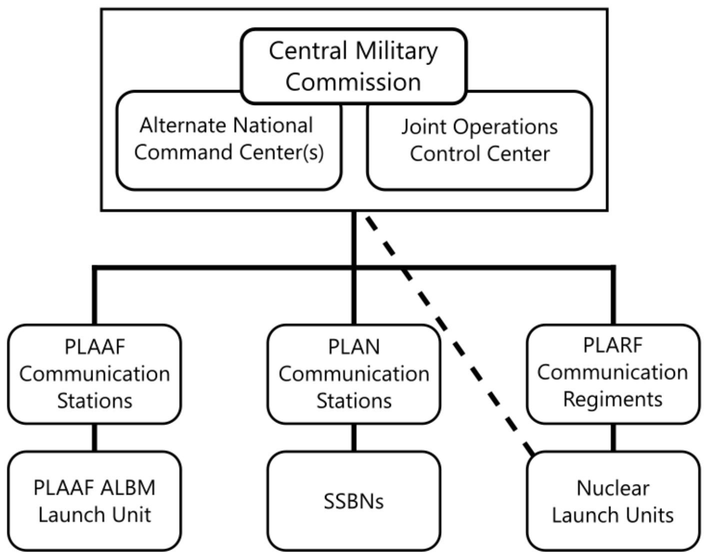
Science of Second Artillery Campaigns p.161 (2004)

SSAC 2004 clarifies that under normal circumstances the joint campaign command organization does not exercise command over the nuclear missile force. Further, in normal situations, the conventional missile campaign formation [战役军团] is commanded by the joint campaign command organization, but under certain special circumstances, the "supreme command" can take over command, as shown in the graphic above.



PLA references from the early 2000s take into account the need for both the SAF's nuclear and conventional forces to carry out joint campaigns with other forces. This command arrangement appears to fit well with recent English-language analysis that PLARF conventional missile Bases are being integrated into PLA theater commands under the new joint command structure to conduct joint operations.[87] A PLA media article from September 2018, for example, noted that Base 63 has worked to integrate into the local Theater Command's joint operations system of systems [战区联合作战体系] and has participated in the trial run of the theater command joint operations command arrangement [战区联合作战指挥体制运行试点].[88]

Estimated Chinese Nuclear Command & Control System



It is worth noting that while theater command JOCCs might have command authority over at least some of the PLARF's conventional force, *SMS 2013* stressed the critical role of the CMC in the decision-making process for not only the nuclear forces, but also the conventional forces. Its authors note:

> *"Although Second Artillery conventional missile forces also conduct campaign-level or even tactical-level combat operations, the impact of their actions is often global and strategic in nature. [As a result], the scale and timing for the employment of the Second Artillery's conventional missile forces during actual combat are also decided by the Central Military Commission."*[89]

Command Arrangement for Nuclear Counterstrike Campaigns

The CMC's direct command authority over nuclear forces has been emphasized across AMS and NDU publications and in PRC defense white papers.

The *SSAC 2004* used the generic term "supreme command" [统帅部], but the *SMS 2013* replaces this wording with CMC. According to *SMS 2013*, "all major nuclear deterrence operations or nuclear counterattack operations of any size are undoubtedly major strategic operations. The decision-making authority for the operational use of the SAF's nuclear missile forces can only belong to the Central Military Commission. The form of deterrence [威慑方式] and the scale, timing, and targets, along with any major issues related to nuclear counterstrike operations, must be decided by the Central Military Commission."[90]

Some analysts assert, however, that it is the CCP Politburo Standing Committee (PSC) that ultimately makes the call. According to Lewis and Xue, "By the time a Class I Alert is issued, the Standing Committee of the Chinese Communist Party Politburo would have made its decision for a nuclear response and transferred the national command authority to the military commission."[91] One way to reconcile the difference, according to Kulacki, is that ultimate authority rests with the chairman of the CMC, who is typically also the highest-ranking official of the CCP,[ix] and therefore would most likely consult with both the Politburo Standing Committee and the CMC.[92] Further, according to the Constitution of the PRC, ultimately, the CMC is answerable to the Politburo Standing Committee.[93]

In practice, the highest level of leadership in the Chinese system is (normally) vested in one person with three positions. Xi Jinping currently holds the titles of President of the People's Republic of China, General Secretary of the Communist Party of China, and Chairman of the Central Military Commission. However, each of these positions has a separate line of succession.

According to Chapter 3, Section 2, Article 84 of the Constitution of the People's Republic of China, the President is succeeded by the Vice President.[94] If the position of PRC Vice President is also vacant, then the National People's Congress (NPC) is to hold an election to choose a replacement. Further, between the time of the position opening and an election being held, the Chairman of the NPC Standing Committee is to temporarily act as President.

Likewise, within the PSC, the line of succession follows the order of seniority. As of 2023, the order of seniority in the Standing Committee is as follows: Xi Jinping, Li Qiang, Zhao Leji, Wang Huning, Cai Qi, Ding Xuexiang, and Li Xi. Thus, one can assume that if tomorrow Xi Jinping were no longer the Chairman of the Standing Committee, then leadership of the body would pass to Li Qiang.

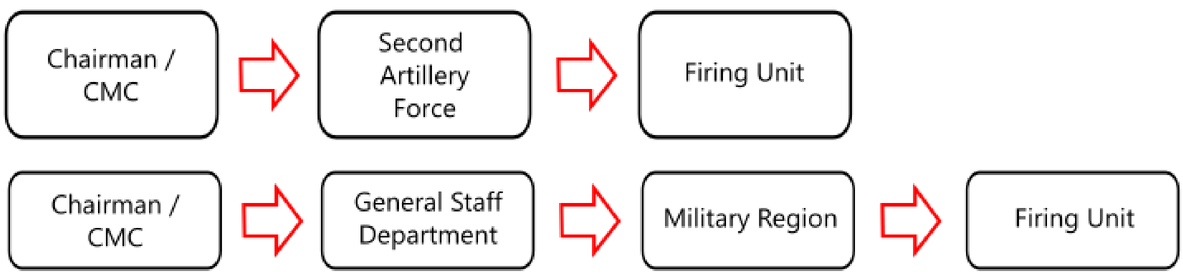
Finally, within the Central Military Commission (CMC), the line of succession is less clear. Of the two CMC vice-chairmen, PLA Generals Zhang Youxia and He Weidong, the former holds seniority and would presumably lead the CMC if Xi Jinping were no longer in a position of leadership. However, this is not certain, as the CMC is ultimately answerable to the PSC.[95] Moreover, according to the Constitution of the Communist Party of China, members of the Party CMC are decided on by the Party Central Committee.[x][96] Thus, it seems most likely that Zhang Youxia would assume immediate or temporary control of the CMC while a new President and General Secretary of the CCP is chosen. However, this is not certain, as it is also likely that the leadership of the CMC would immediately be given to the new head of the PSC, the Premier. If this was the case, then it is not clear what role the vice-chairmen of the CMC serve in terms of leadership succession.

[ix] This is not always the case, however. Hu Jintao became CCP General Secretary in 2002 but did not head the CMC until 2004. It is unclear what happens in instances where this is the case.

[x] The state CMC is officially elected by the National People's Congress but is identical to the Party CMC.

According to Cunningham, “there is no evidence that Chinese leaders have pre-delegated authority to use nuclear weapons down the chain of command in the event that its leadership is decapitated.”[97] While open sources do not provide confirmation one way or the other, the development of extensive hardened facilities, including multiple alternate national command centers with the necessary communications facilities needed to direct campaigns (see Section 3.3), suggests that plans exist for continuity of government and command and control in a nuclear conflict.

It is worth noting that descriptions of the lines of authority for conducting nuclear counterstrike campaigns are not always fully consistent. A Chinese participant to the U.S.-China Strategic Dialogue held in June 2014 outlined the lines of authority for nuclear and conventional forces as two tracks of commands given from the CMC to both the then SAF and General Staff Department. The following graphic depicts these tracks (nuclear above, conventional below):[98]



This differs from Cunningham’s 2019 analysis, however, which likely incorporates organizational changes made since 2016. Outlined below, the launch authority appears to have become more formalized.[99] Cunningham writes:

> *CMC orders to alert or use nuclear weapons are likely transmitted to the CMC Joint Operations Command Center, then to the Rocket Force Headquarters, then to missile bases and down the chain of command to launch companies. Alternatively, orders may be transmitted directly from the Rocket Force Headquarters to missile brigades, battalions, or launch companies, making use of the skip-echelon function of the automated command system.*

Further, according to a confidential source (dubbed Source 2), SAF campaign guidelines [战役方针] can be decided three ways: 1) by the CMC; 2) by the CMC after consultation with SAF commanders; 3) submitted to the CMC for approval by the SAF commander(s) according to the CMC’s intentions.[100] The source clarifies that under normal circumstances, the SAF can only make suggestions [一般只有建议权] regarding the targets for nuclear counterstrike campaigns.[101]

Source 2 specified that the command authority of the SAF and the missile bases is as follows.[102] The SAF, according to the orders and instructions of the Central Military Commission, has the authority to:

- Set up command posts.
- Develop campaign plans [战役计划] to determine the division of labor between operational units, number of strikes, strike order, and timing of launches.
- Determine the employment of campaign reserves [战役预备队].
- Determine the number, timing, and manner of delivery of nuclear warheads from warhead bases to missile bases.
- Determine methods of communications [确定通信联络组织方案].
- Organize campaign coordination [组织战役协同].

Missile bases, according to the orders and instructions of the Central Military Commission and SAF, have the authority to:

- Set up command posts.
- Organize communication methods [组织通信联络].
- Determine the time for the missile brigade to pick up or receive missile bodies and warheads.
- Determine concealment areas [确定部队的隐蔽地域].
- Prepare and execute anti-air raids, counter paratrooper assaults, counter electronic interference, and organize ground defenses.
- Organize campaign coordination.
- Organize campaign operational support.
- Execute nuclear strikes.

Nuclear-Conventional Co-mingling

One of the key debates among U.S. and Chinese scholars involves the co-mingling of nuclear and conventional command and control infrastructure, which creates risks for inadvertent escalation. For example, Lewis and Xue argue that in the event of a Chinese "self-defensive" preemptive conventional attack, China's adversary (and its allies) might not be able to pinpoint the exact nature of the attack and could justifiably respond with retaliatory measures against all Chinese missile assets and command and control infrastructure, greatly increasing the chances of escalation to nuclear war.[103]

Western scholars holding the view that China's nuclear and conventional co-mingling applies to their command-and-control infrastructure and systems often cite Lewis and Xue's findings from 2012 stating that despite China's no-first-use policy, "conventional missiles can be fired first from bases that also contain nuclear missiles, using the same command-and-control infrastructure as would be used for a nuclear launch."[104] They appear to have made this assertion based on a remark by a SAF commander in the late 2000s that the strategic rocket force exercises, in their translation, "double command" [双重指挥/*shuangchong zhihui*], although they note that researchers know very little about this concept, which is "most complex and unpredictable."[105]

Chinese scholars have raised issues with this assertion. Wu Riqiang argues that there is scant information about the SAF's command and control systems and no clear evidence of nuclear and conventional units sharing command and control infrastructure. Additionally, Wu notes that the Chinese term *shuangchong zhihui* could mean two completely separate systems.

Interestingly, the Chinese term *shuangchong zhihui* that Lewis and Xue cited is missing from PLA doctrinal texts reviewed for this report. Instead, as explained earlier, *SSAC 2004* references "Dual Command" [双线指挥], or "two lines of command," which carries entirely different meanings and seems to prove Wu's point about separation rather than collocation.[106]

According to the Phase VIII Report of the U.S.-China Strategic Dialogue held in June 2014, the issue of Chinese co-mingling/collocating of conventional and nuclear weapons was raised by U.S. participants, but the Chinese side "flatly denied that co-mingling occurred."[107] In addition, "the co-mingling of C2 for nuclear and conventional forces was also denied," writes the report.[108] As of the writing of this report, there is still no clarity on this critical issue, nor is there widespread agreement among scholars. For example, the Union of Concerned Scientists' analysis from 2017 states that "China has separate command and control systems for conventional and nuclear missiles, and missiles and warheads are stored separately under different commands."[109] Cunningham, writing in 2019, argues that "China's conventional and nuclear missiles share infrastructure, including command and control systems, for bureaucratic reasons, the overlap in C3I systems has diminished over time."[110]

Due to the difference in key nuclear vocabulary in use in the United States and China, however, it is often unclear what scholars are referencing exactly when they use the term "command and control infrastructure" or "command and control systems." The authors of this study are not privy to previous conversations among Chinese and western nuclear experts on these issues, and therefore have no knowledge of what exact terms and translations were used during these strategic dialogues. However, it is worth noting that there is a difference in the basic lexicon of nuclear-related terms, both between the DOD and the PLA and between the PLA and Chinese academia that might have contributed to miscommunications between China and the United States.

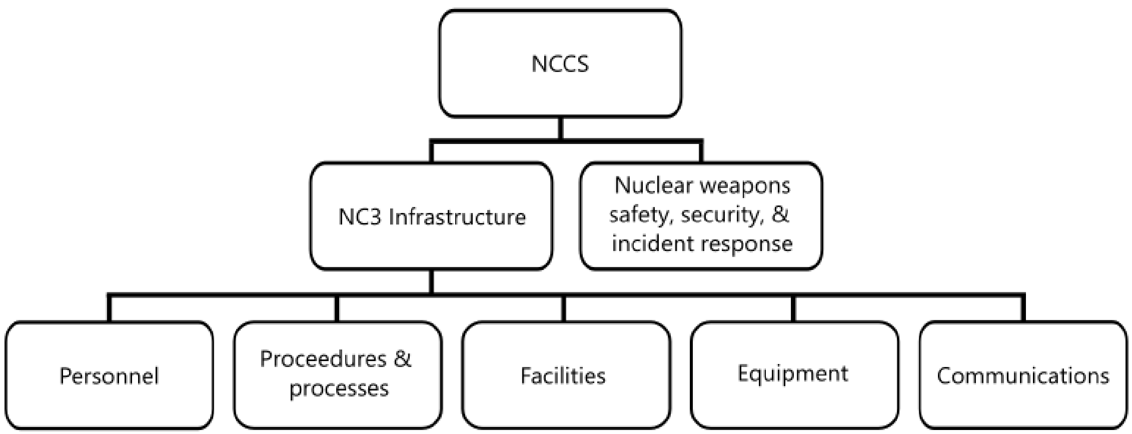
While this report, which is intended for English-speaking audiences, uses the term "NC3," the PLA does not have a precise analog to this term regarding arrangements for direction of nuclear forces. References to terms such as NC3, C3I, or C4I texts in PLA doctrinal writings and authoritative reporting are either generic, conceptual discussions, or used to describe practices of other nations, such as the United States. While U.S. and Chinese arms control experts have made extensive efforts to bridge this gap and reached an agreement on around 1,000 terms related to nuclear security, there are still key concepts that lack a mutually acceptable definition.[111] Experts from Chinese academia, on the other hand, are much more familiar with western terminologies and are comfortable using them in their writings and discussions with western counterparts.[112] As Li Bin explains, there has been a divergence in the nuclear lexicons adopted by the SAF and academia:[113]

> *…whereas the Second Artillery and most parts of the PLA (for example, PLA's National Defense University and Academy of Military Science) use native words to describe strategic nuclear issues, the nuclear establishment* [academic

community studying nuclear issues] *uses words directly translated from Western literature and United Nations documents. This results in serious confusion about the meaning of some terms, with perhaps the best example being the term "deterrence." The nuclear establishment uses the term "weishe" [威慑] for the meaning of "deterrence." However, for the PLA, "weishe" means "coercion."*

On the issue of command-and-control infrastructure sharing, it may be useful to examine the set of terms adopted by the DOD and the PLA for discussions on this issue. Based on descriptions from the DOD's *Nuclear Matter Handbook 2020*, the U.S. nuclear lexicon relies on the following key terms to define the NC3 arrangements:

Main Components of U.S. Nuclear Command and Control System



Nuclear Matters Handbook 2020 15, 22-26

PLA doctrinal publications such as *SSAC 2004* did not offer as clear a framework of reference, but there is a group of frequently used terms on the same subject. The book dictates that the "campaign command system" [战役指挥系统] is an organic whole that exercises command functions and consists of the agent, object, and means of command [指挥主体, 指挥对象, and 指挥手段, respectively]. The term used to dictate the configuration of organizations for operational command, their functions, and the relationship between various command levels is referred to by PLA sources as a "command arrangement" [指挥体制], an umbrella term that involves discussions about the following topics:

- Command authority [指挥权限]
- Command organization [指挥机构]
- Command relationship [指挥关系]
- Command activity [指挥活动]
- Command and control procedures [指挥控制程序]

At the same time, a separate term, "command means and tools" [指挥手段和工具] exists to describe the technological tools enabling C2, such as the command-and-control network [指挥控制网] and the automated command system [指挥自动化系统].

Due to this difference in lexicons, it is difficult to identify immediate equivalents of these key terms in either vocabulary system. For example, DOD's *Nuclear Matter Handbook 2020* describes the United States' Nuclear Command and Control System (NCCS) as a combination of capabilities comprising two main components: nuclear command, control, and communications (NC3), which encompasses personnel, procedures, and processes, facilities, equipment, and communications, as well as nuclear weapons safety, security, and incident response. But in Chinese, the term NC3 is frequently reserved for the smaller-in-scale idea of command-and-control technical systems, i.e., software and applications. PLA doctrinal writings do not use the term "infrastructure" [基础设施] to describe its NC3 arrangements, and the elements included in the U.S. version of the term such as personnel, procedures, and processes fall under different umbrella terms.

As Li Bin has noted, exchanges between Chinese and U.S. nuclear experts remain "difficult and inefficient" due to critical differences between Chinese and U.S. thinking about nuclear weapons and deterrence concepts, which often have very different connotations.[114] As a result, umbrella terms such as NC3 infrastructure should be broken down into smaller, more substantial components to avoid miscommunications in discussions with the Chinese authorities and experts and promote understanding regarding the crucial issue of nuclear and conventional co-mingling.

Setting the differences of opinions and possible miscommunications aside, some analysts have argued that the risk posed by China's nuclear and conventional co-mingling has been somewhat overstated. According to Roderick Lee's analysis, the PLA publicly identified some PLARF conventional units that have been integrated into the theater command structure as not falling under the direct authority of the CMC during wartime conditions.[115] In addition, Lee points out that PLARF conventional systems intended for strategic targets—such as the DF-21Ds or DF-26s—and nuclear-only systems are not granted theater command access. Lee also notes that the PLA clearly defines command relationships between PLARF bases and PLA theater commands. Because the PLA clearly differentiates administrative and operational control, a nuclear-capable missile brigade may simply be assigned to a CMC-controlled operational group during wartime. Consequently, it is possible that nuclear and strategic target units may be commanded by the CMC, while other conventional units are commanded through the PLARF/joint campaign command, and thus are not co-mingled.

SECTION 2: SUPPORTING ORGANIZATIONS AND FACILITIES

2.1 SUPPORTING ORGANIZATIONS:

Section 2 describes the facilities involved in nuclear command and control, and the organizations supporting the network. This includes the JOCC in Xiangshan, Beijing; theater-level, service-command, and backup command posts; and other mobile or hardened underground facilities.[xi] This also includes airborne command posts and the organizations operating transmitters, with the specific equipment and transmitters profiled later.

PLA Rocket Force Communications Regiments

Each PLARF base has an associated communications regiment [通信团] (with the exception of the Base 64 Regiment located in Xining). Each regiment has three numbered subordinate communication battalions [通信营], and subordinate subunits [分队] may be tasked with handling a particular set of communication tasks. Some communications regiments have been identified as controlling a wide variety of communications assets, including microwave stations at the base HQ[116] and a satellite ground station associated with the Beidou navigation system.[117]

Base 66 in particular likely plays an important role in the overall nuclear command and control architecture, as it has at least four subordinate brigades equipped with nuclear weapons, an additional suspected nuclear brigade, and another brigade equipped with the dual-capable DF-26.

Prior to November 2018, the PLARF had a Communications Regiment, or Communications Command, directly subordinate to its Staff Department [参谋部通信团/通信总站]. In 2018, it was resubordinated to the Staff Department Operations Support Group.[118] This regiment was established in April 1968 as a communications hub for strategic missile units and has been referred to as the PLARF's communications "nerve center." The regiment's 5th Company was responsible for transmitting communications from PLARF headquarters to subordinate brigades and regiments.

[xi] The CMC Joint Staff Department Information and Communications Bureau (JSD-ICB) [联参信息通信局] appears to be a major component of the centralized satellite communication system See: John Costello and Joe McReynolds, "China's Strategic Support Force: A Force for a New Era," *China Strategic Perspectives* 13, National Defense University, October 2018, https://ndupress.ndu.edu/Portals/68/Documents/stratperspective/china/china-perspectives_13.pdf, 35

PLARF Communications Regiments	
PLARF Staff Department Operations Support Group Former Communications Regiment **MUCD**: 96946[119]	**Location**: Haidian District, Beijing [北京市海淀区][120]
Base 61 Communications Regiment [61 基地通信团], **MUCD:** 96812	**Location**: Tunxi District, Huangshan, Anhui [黄山市屯溪区][121]
Base 62 Communications Regiment [62 基地通信团], **MUCD:** 96822	**Location**: Guandu District, Kunming, Yunnan [昆明市官渡区]*[122]
Base 63 Communications Regiment [63 基地通信团], **MUCD:** 96832	**Location**: Hecheng District, Huaihua [怀化市鹤城区]*[123], Hunan
Base 64 Communications Regiment [64 基地通信团], **MUCD**: 96842	**Location**: Chengdong District, Xining [西宁市城东区], Qinghai[124]
Base 65 Communications Regiment [65 基地通信团] **MUCD:** 96852	**Location:** Huanggu District, Shenyang, [沈阳市皇姑区][125] Liaoning
Base 66 Communications Regiment [66 基地通信团] **MUCD:** 96862	**Location:** Jianxi District, Luoyang [洛阳市涧西区], Henan [126]
* Location Unconfirmed	

Training exercises involving these units are focused on ensuring an uninterrupted flow of communications in hostile and complex environments, as well as quickly repairing lines and other equipment.[127] Numerous reports in Chinese media emphasize preparations for deploying without prior warning, mitigating jamming, and improving the speed at which networks can be established in the field[xii] [128] in adverse environmental conditions or while under attack. [129]

Generally, Comprehensive Support Regiments [综合保障团] provide additional equipment transport, storage, and maintenance support. Operations Support Regiments [作战保障团] provide support through specialized functions such as survey and mapping, meteorology, chemical defense, security, and engineering. Finally, Equipment Inspection Regiments [装检团] are responsible for storage, management, and distribution of the nuclear warheads assigned to each Base.[xiii]

2.2 Facilities

Due to the larger nuclear arsenals and limited early warning that Chinese leadership would likely receive in the event of an attack, the PRC and the PLA rely heavily on hardened facilities to protect civilian and military leaders, associated command, control, and communications functions, critical defense industrial facilities, weapons storage and handling, and other assets and activities. China has gone to great lengths to prepare for nuclear and conventional war, apparently engaging in several large-scale efforts to build hardened bunkers, command posts, storage facilities, and

[xii] One regiment under Base 62 for example, has claimed to have decreased its deployment times for a C2 platform by 33 percent.
[xiii] For more information on PLARF force structure, see Ma Xiu, "PLA Rocket Force Organization," China Aerospace Studies Institute, 2022, https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/PLARF/2022-10-24%20PLARF%20Organization.pdf

even aircraft hangers since the 1950s. These facilities, including command posts, nuclear forces, and supporting facilities, are designed to be resilient against surprise attacks, including missile, air, chemical, and biological strikes, or special forces raids. They are extensive, concealed, hardened, and linked through modern communications networks. China began building nuclear bomb shelters in earnest in the late 1960s, following the bombing of cities by the Republic of China (ROC) throughout the 1950s, and the PLA's experience dealing with UN airpower during the Korean War.[xiv] Chinese writings treat the ability to weather a nuclear strike and remain capable of mounting retaliatory strikes as a central role for the PLARF, which has continued to expand and modernize these facilities.[xv] This section will briefly examine China's system of command posts, the network of underground facilities (UGFs), and their respective roles in a nuclear conflict.

Historical Examples

Date	Name	Purpose
May 1964	Third Front Construction [大三线建设]	Many projects and investments in national defense and industry
1965	Project 6501 [6501 工程]	Massive, three-level Army base
1966	Project 816 [816 工程]	Build an underground nuclear reactor to produce nuclear weapons
December 1967	Zhuhai Baili Island Naval Base [珠海白沥岛海军基地]	Hardened underground naval base
January 1969	Project 131 [131 工程]	Established underground command and control centers
1969	Chifeng Airbase [赤峰机场]	Hardened underground airbase
August 1973	Project 7381 [7381 工程]	Protect and evacuate Harbin in case of Soviet invasion

In the 1960s and 1970s, the Sino-Soviet Split was a major source of concern for Chinese defense planners. Chairman Mao Zedong issued a call for China to "Dig deep, store grain, and not seek hegemony."[130] Subsequently, massive projects were carried out to fortify China against a possible Soviet invasion. During the Second World War, both the CCP and Nationalist Party made extensive use of China's mountainous interior to mount a strong defense against invasion. Thus,

[xiv] On 25 November 1951 for example, the "Chinese Volunteers Army" command post was struck by U.S. bombers, killing Mao Anying, Mao Zedong's eldest son, and narrowly missing Peng Dehuai, commander of Chinese forces in Korea at the time. Peng would go on to play a major role in the PLA's modernization until his fall from political favor in 1958. See: Wang Yan [王焰], Ed. *Official Chronicle of Peng Dehuai* [彭德怀年谱], Beijing: People's Daily Press, 1998. 450

[xv] China's armed forces place continued emphasis on improving cities' abilities to withstand various types of attacks including air attack, and many cities have annual air-attack drills using militia and civilian assets to organize both defenses and protective measures such as evacuations.

when fear of Soviet aggression reached an apex, digging into rural mountains was again the defense of choice.

In general, facilities built during this period can be characterized by their concern with an invasion from the Soviet Union, and their high costs in terms of resources, manpower, and construction time. Called the Third Front [大三线], these civil defense projects made use of extensive manpower to carve out spaces for munitions factories, missile storage, and command and control centers.[131] In 1967, Zhou Enlai personally ordered construction of facilities capable of withstanding nuclear attacks. One of these facilities, Project 6501 (a massive, three-level army base with both road and rail access), was the first installation described as part of China's "Underground Great Wall" [地下长城].[132]

However, another use for the underground facilities was for storing and, in one case, creating China's nuclear arsenal. Project 816 was started in late 1966 as a means of continuing to prosecute nuclear war beyond the first strike. This massive, underground nuclear reactor would not only be impervious to external nuclear attacks, but also allow the PLA to produce nuclear warheads in a secure location without fear of the Chinese arsenal being annihilated.[133] However, the project was discontinued in 1984 due to cost concerns and a changing strategic environment. Another such facility is the Lop Nur Nuclear Storage Testing Facility, where China first detonated a nuclear bomb. Built in 1964, the facility is still in use today. Near the testing site is a ridge where multiple tunnels have been drilled into the mountainside.[xvi] Nuclear materials are believed to be stored at this facility,[134] which is likely under the command of the PLA Strategic Support Force's (SSF) China Nuclear Test Base (Base 21), headquartered in the village of Malan 100km to the northwest.[xvii] Due to the highly classified and remote nature of these facilities, little information is available in the public sphere.

Considerations for Modern Underground Facilities

Today, the PLA's renewed interest in underground facilities comes primarily from two concerns, one doctrinal and the other technological. The PLA maintains a No-First-Use doctrine regarding nuclear warfare. To maintain credible deterrence, the PLARF must have a survivable nuclear stockpile that can rapidly retaliate against an aggressor with enough power to ensure unacceptable losses on the attacking force. Thus, in the face of this necessity, hardened underground facilities are regarded as a key guarantee of China's retaliatory abilities.

The second reason for the PLARF's interest in underground facilities comes from technological considerations. The 1991 Gulf War is widely regarded as a turning point for the PLA's understanding of contemporary warfighting. The SAF, especially, took note of the American military's use of precision missiles and ground-penetrating bombs. According to a Xinhua article from 2019, it was in response to these developments that Qian Qihu [钱七虎], a

[xvi] Coordinates: 41.703999, 88.367963.

[xvii] Uxxaktal Airbase to the west of the village has been previously identified as having a weapons storage UGF. See: 42.203028, 87.153722

military engineer and member of the Chinese Academy of Engineering, put forward the concept of building deep, resistant underground facilities specifically to weather a nuclear first strike and maintain a credible retaliatory capability.[135] This opinion is echoed by other prominent academics in Chinese military circles, including Yang Xiumin [杨秀敏] of the China Academy of Engineering, who also considers underground facilities as the most logical method for ensuring proper nuclear deterrence against an outside force.[136]

Construction Considerations

To address the possibility of a nuclear war, China's military planners placed its DF-5 missiles in underground, reinforced silos starting in 1979. In order to deceive the sophisticated reconnaissance and precision delivery systems of would-be belligerents, decoy silos were also utilized.[137] However, despite reinforcement and the deployment of decoy silos, the likelihood of missiles being damaged beyond use in an attack remained high. However, technological limitations meant that mobile launch platforms were prone to unacceptable inaccuracy issues.

Thus, the resulting plan, called Deep Deployment [深埋部署], sought to combine the survivability of underground facilities with the accuracy of fixed, above-ground positions.[138] The underground facilities house the missiles, delivery platforms, and the crews to man them. When the time comes, the platforms will be properly set-up and prepared in the safety of the underground facility, and then deployed to hardened concrete pads where the launch will take place.[139] This mixed method improves both survivability and accuracy but requires massive investments to hollow out tunnels and prepare the concrete pads for launch.

Unidentified Nester Unit[140]

Construction of underground facilities, frequently referred to in Chinese media as "Underground Dragon Lairs" [地下龙宫], is undertaken primarily by the PLARF's "nester" [筑巢人] engineering units, responsible for national defense, combat support, and non-war military engineering projects.[141]

The labor requirements for constructing "Dragon Lairs" has changed significantly over the decades. The building of underground facilities is a significant resource commitment, with one construction site requiring at least 8,000 cubic meters of sand, 4,000 bags of cement, and over 300 steel bars.[142] Another facility is said to use the electrical power of a small city.[143] In the early 1990s, construction relied on "crowd tactics" with picks, shovels, and little machinery.[144] These projects took upwards of ten years to finish, with constant danger of cave-ins and on-site injuries.[xviii] [145]

According to Ren Qingcheng [任庆成], a senior PLARF nester engineer, the use of heavy tunneling machinery and improved conditions have caused a huge change in both the pace and safety standards of nester work in recent years.[146] Sources report both that the use of machinery has doubled efficiency and that projects that could span a decade or more now typically take two years to complete.[147] One engineering subunit under an operations support regiment was downgraded from a battalion to a company, hinting at reducing manpower. However, despite its decreased personnel, the source claims that its workload has increased.[148] This suggests that there is both an increase in construction efficiency as well as the number of construction projects.

"Nester" Drilling Machine[149]

[xviii] One account mentioned the build-up of radioactive dust in the missile storage sections and blisters and rashes appearing on the skin of workers in the area. Reportedly, more than 4,000 personnel became disabled due to workplace injury, and 512 died outright, though a timeframe for these injuries was not mentioned.

In addition, these tunneling projects are regularly described as examples of military-civil fusion [军民融合], due to partnerships between the units and local civilian tunneling companies. Further, many PLARF engineers pursue certificates and qualifications while still employed by the PLA, presumably for the purpose of transitioning to a civilian career after leaving the PLARF.[150]

The PLARF Institute of Engineering Design [火箭军工程设计研究所] in Beijing is responsible for developing requirements for physical infrastructure. Established in 1958, the institute consists of at least six research divisions and at least eight offices [室]. The institute's scope includes general design of underground facilities, geological assessments, tunnel boring technology, materials, camouflage, launch site surveying and design, and military load classification analysis for transportation networks and bridges. As of September 2017, it has been resubordinated to the PLARF Research Academy and is now called the PLARF Research Academy Institute of Engineering Design.[151]

The establishment of Base 68, a corps deputy-grade engineering command, also highlights the centrality of physical infrastructure in PLA operations. This unit was formed through the merger of the 308 Engineering Command and Engineering Technology Group. Today, it oversees six engineering brigades, as well as two regiments tasked with building out and maintaining the PLARF's secure communications infrastructure.[152]

Survivability

Survivability is of utmost importance to the PLARF's underground facilities. In addition to reinforcement with concrete and rebar around the tunnels themselves, the facilities benefit from compartmentalization and monitoring. Multiple thick blast doors separate different sections of the facility, allowing a segment to be sealed off in case of nuclear, biological, or chemical attack.[153] Likewise, the underground facilities have started integrating information technology systems into construction designs to allow for more robust monitoring within the base. Reportedly, this allows for support to be rapidly dispatched to vital points in the facility should the need for repair arise.[154] It can be inferred that during an attack, the command and control elements of the facility would be able to rapidly assess inflicted damage and determine the best course of action to ensure a retaliatory strike. Thus, training activities at these facilities revolve around a combination of simulated system failures (destroyed ventilators, cave-ins[155], water contamination[156], hunger, and chain-of-command disruption), and initiating retaliatory strikes.

However, steps to ensure the survivability of underground facilities are moot if there is no way to get the delivery systems above ground to the launch sites. Thus, an important aspect of these facilities is the maintenance of access roads, as well as training focused on road maintenance, obstruction clearing, and disassembling and relocating launch sites.[157] Further, to ensure that the launch system is not struck before it can deliver its payload, training for the launch teams also focuses on properly applying camouflage. One PLARF brigade trained for countermeasures and camouflage application against simulated enemy satellite reconnaissance and electromagnetic jamming. The training focused on establishing communications and engaging in a launch thereafter.[158]

Reports on training regularly mention mitigating jamming, and some PLARF launch brigades have dedicated electronic countermeasures battalions.[159] Regarding the effectiveness of these measures, an analysis in 2011 by Zhao Tong found that China's theater nuclear forces (including DF-31 missiles and Type 094 submarines) would likely survive a U.S. strike using conventional precision-guided weapons.[160] It further found that the U.S. would be unlikely to detect if China put its forces on alert during a crisis.

While underground facilities are in mountainous or more remote areas, the PLARF's garrisons are largely concentrated in cities. Mobile units are expected to disperse to areas sometimes hundreds or thousands of kilometers from these initial locations, but they would still be likely targets in a conflict. The decision to build garrisons in urban areas, rather than in remote areas that would be less likely to incur civilian casualties, apparently dates to 1985, when the PLA decided that better living conditions for personnel and improved access to communications systems outweighed the potential costs.[161]

Above: DF-21A disguised as a civilian truck[162]
Below: Ballistic missile TEL decoys

In addition to hardening and mobility, the PLA is increasingly using passive and active laser, radar, and infrared defenses, including jammers and obscurants to improve the survivability of its missile forces. China has long employed decoy emplacements and inflatable systems that mimic the characteristics of a system, or even disguising TELs and support vehicles as civilian trucks, now often incorporating heat generators or radar reflecting elements (see the lower right image above) to better imitate actual equipment.

CMC Joint Operations Command Center

China uses a system of command posts [指挥所] from the national and theater levels down. At the top of the chain of command sits the CMC Joint Operations Command Center (JOCC) [中央军委联合作战指挥中心] in Beijing.[xix] The JOCC was likely established in 2013, as part of an effort to improve the jointness of the various PLA services and forces and, at the time, served as the headquarters of the General Staff Department.[163] The Command Center would likely serve as a hub for communications and information-gathering activities, and include leadership from the PLA's various services and forces.[164] The JOCC was constructed underground, specifically with the intention of surviving nuclear attacks. Reportedly, during the "Operations Mission 2013" [行动使命-2013] exercise, Xi used the Command Center to review and approve the course of the exercises.[165]

PLA Joint Operations Command Center[166]

[xix] Many members of the senior leadership maintain residences in the nearby Jade Spring Hill [玉泉山] area.

Alternate National Command Posts

In addition to the CMC JOCC in Beijing, the PLA has other back-up national command posts. Declassified documents indicate at least two other large complexes in Shanxi and Hubei Provinces.[167] The first, in Licheng County [黎城县], northeast of the city of Changzhi [长治], Shanxi, was described as the National Naval Alternate Headquarters in documents from 1983.[xx] The site has what appears to be camouflaged buildings on the surface and a tunnel entrance on the southern side, which would offer a degree of protection from nuclear strike.[xxi] However, the clarity of available satellite images makes this difficult to verify or expand upon. In the original report, the site was identified as having significant supporting communications and transport infrastructure.[xxii]

The second of these complexes is located in Fang County [房县], Hubei, (a.k.a. "Fangxian") which has been previously described as home to an "Alternate National Military Command Center Complex" for the then-General Staff Department supported by a combination of microwave and LF transmitters.[168] In January 1969, China began construction of nuclear command bunkers for senior leadership in Southeastern Hubei. The 131 Project [131 工程 or 131 地下工程][xxiii] is located near Gaoqiao Town, Xianning [咸宁], Hubei, and has since been turned into a tourist attraction. Other complexes have been mentioned as possible sites, but information is less clear.[xxiv]

Theater Command Joint Operations Command Centers/Posts

Reportedly, the military reforms made in 2016 established Theater Command Joint Operations Command Centers.[169] As mentioned in the flow chart listed in Section 1.3, the decision to use nuclear weapons will come from the CMC JOCC and be passed along to the PLARF directly, bypassing the Theater Command JOCCs.[170] Thus, while the Theater Command JOCCs would play an important communications role during a conventional campaign, they are likely to be de-emphasized in a nuclear scenario.

[xx] Coordinates given in the report as the main site at 36.698611, 113.362500.

[xxi] Coordinates 36.696284, 113.346378.

[xxii] Specifically, Licheng is identified as being supported by Shahe and Changzhi Airfields and the Handan heliport.

[xxiii] Coordinates: 29.850132° 114.468529°; Also called 中国澄水洞地下军事工程.

[xxiv] Hohhot, Inner Mongolia was also previously identified as the location of another alternate command center, but this appears instead to be a widely reproduced error. For example, David Shambaugh's *Modernizing China's Military: Progress, Problems, and Prospects* (2002) gives Hohhot as home to a command center on page 169, citing FAS "China: Command and Control Facilities," which in turn cites William Arkin and Richard Fieldhouse's "Nuclear Battlefields," pages 290-291, which does not appear to provide this information.

PLA Joint Operations Command Center[171]

Mobile and Airborne Command Posts

In the field, PLARF units typically exercise command and control via mobile command posts. Their vehicle of choice appears to be a three-axle trailer pulled by a standard six-wheeled truck. As with PLA Navy vessels, these command posts appear to have numerous video terminals and elaborate consoles, as well as some version of the encrypted "red telephones" [红机],[xxv] linking field command posts with both other units and higher command.[xxvi] [172] These command posts are typically staffed with two senior colonels, likely the commander and commissar, and at least eight other officers and enlisted personnel.[173]

[xxv] These may be analogous to DOD's Defense Red Switch Network (DRSN)

[xxvi] The PLA may use a maroon color to differentiate their lines from the brighter red phones seen used by top leaders, perhaps pointing toward another set of encrypted lines.

Interior of PLARF mobile command and control vehicle[174]

Exterior of PLARF mobile command and control vehicle[175]

The PLA also uses airborne command posts [机载指挥所] (helicopters equipped with communications suites) to support theater command posts and similar operations. The PLAAF also operates at least two B-737-300 aircraft in a command, control, communications, and intelligence role.[176] One source identifies these aircraft as based at Beijing's Daxing Airport. Additional variants of the Y-8 aircraft (Y-8T), which appear to be equipped with a large communications suite, may be in service with the 76th or 78th Airborne Command and Control Regiments based in Wuxi, Jiangsu.[177]

While it is currently unclear if China has dedicated (fixed-wing) airborne command posts with specialized equipment for communications with nuclear forces (along the lines of the Russian IL-80 or U.S. E-6B Mercury aircraft), given the expanding triad and need for survivable systems, the authors consider it likely that such a system will be developed. In the past decade, China has been successful in producing a large number of domestic aircraft that would be suitable for such a role, and the PLA has substantially improved the airborne refueling capabilities necessary for extended flight.

Section 3: Equipment and Systems

The equipment utilized for NC3 includes early-warning radars and satellites to identify and characterize threats, and communication systems to link sensors to higher echelons as well as to allow headquarters to issue commands to nuclear forces.

3.1 PLARF Command and Control Information Systems

This section presents findings about the PLARF's command and control information system, as it provides an indication of the current status and direction of the sophistication of China's command and control.

The exact configuration and capabilities of the PLARF's nuclear command and control information system are difficult to assess using open-source information. As noted earlier, the degree of co-mingling between nuclear and conventional forces is unknown, making it difficult to identify information about command-and-control information systems specifically for nuclear forces. Further, *SMS 2017* clearly stated that organically integrated nuclear counterstrike and conventional strike capabilities, with dual-mission capable tactical-level operational units [战术一级的作战单位], are enabled by a unified information-enabled support and command system [在统一的信息平台保障和指挥系统指挥下].

After witnessing the revolutionary role played by information technology during the Gulf War, the SAF decided to build the PLA's first-ever automated operations command system [作战指挥自动化系统].[178] According to one source, this automated strategic command system links four levels of command posts, from the SAF (headquarters), to missile bases, missile brigades (and support regiments), and finally to missile launch battalions via a network of computers, terminals, communication facilities, and equipment.[179]

While this system might have had some degree of interoperability with systems of the other services,[180] compartmentalization was a major issue. According to one article, by 2000, the PLA's various services and branches had developed and fielded hundreds of command information systems.[181] The same article notes that these systems are based on significantly different technologies and platforms, making integration virtually impossible. In some instances, commanders had to step out of the command vehicles and rely on gestures and verbal instructions to communicate.[182] This prompted the development of a fully integrated PLA-wide command system, similar to the Global Command and Control System (GCCS) of the United States.[183] Around 2004, a research institute under the PLA General Staff Department, which focused on research into informatization [总参某信息化研究所], began to design and develop the PLA's first-generation "integrated command information system" [全军一体化指挥信息系统].

According to the same source, a total of 8,000 researchers and engineers from 300 work units contributed to the research and development of this command system, which became operational in 2012. This integrated system has been described as "the PLA's first comprehensive information system that unifies strategic, operational, and tactical command for all four military services."[184] A key figure identified by official media in the development of this system is Li Xianyu [李贤玉], director of the 4th Research Institute[xxvii] under the PLARF Research Academy [火箭军研究院].[185]

Li, a Peking University graduate who joined the PLA in 1990, has been identified in multiple media reports as the "PLA Rocket Force's first female general"[186] following her promotion to the rank of Special Technical Major General [专业技术少将军衔][xxviii] in 2015.[187] She also became an academician with the Chinese Academy of Engineering (CAE) in 2019.[188] A *PLA Daily* article from January 2016 identified Li as a member of the chief design team of the PLA-wide command information system and the deputy chief designer of the SAF sub-system.[189]Another *PLA Daily* article from December 2017 noted that Li was leading over 10 projects related to the informatization of the PLA and the PLARF, including "information/informatized system simulation demonstration and verification environment construction" [某信息化系统模拟演示验证环境建设], a "multi-level debugging of a command system" [某指挥系统多级调试], and a "joint debugging of a new missile information system" [某新型导弹信息化系统联调].[190]

Li Xianyu (back row, center) pictured with Wang Jianxin [王建新], chief designer of the PLA-wide Integrated Command Information System, and other researchers.[191]

[xxvii] Now the 6th Research Institute, also known as the Institute of Information and Special Support, following reforms to the PLARF Research Academy.

[xxviii] Li is a uniformed civilian cadre, under the track called special technical officers [专业技术军官]

Li Xianyu[192]

The *PLA Daily* article from 2017 offered no further details regarding the system upgrades Li was working on, but a documentary on CCTV Channel 7 about Li, which aired on 18 January 2013, provided additional information about the SAF's first- and second-generation command and control systems.[193]

According to the documentary, Li participated in the development of the SAF's first-generation automated command system in the 1990s. This system reportedly played a role in the Third Taiwan Strait Crisis when the SAF conducted a series of missile tests in the waters surrounding Taiwan.[194] However, with the commission of multiple conventional missile models, which relied on different command and control systems, beginning around 2003, the SAF needed a system capable of enabling integrated command and control [一体化指挥控制] of multiple brigades and missile types.

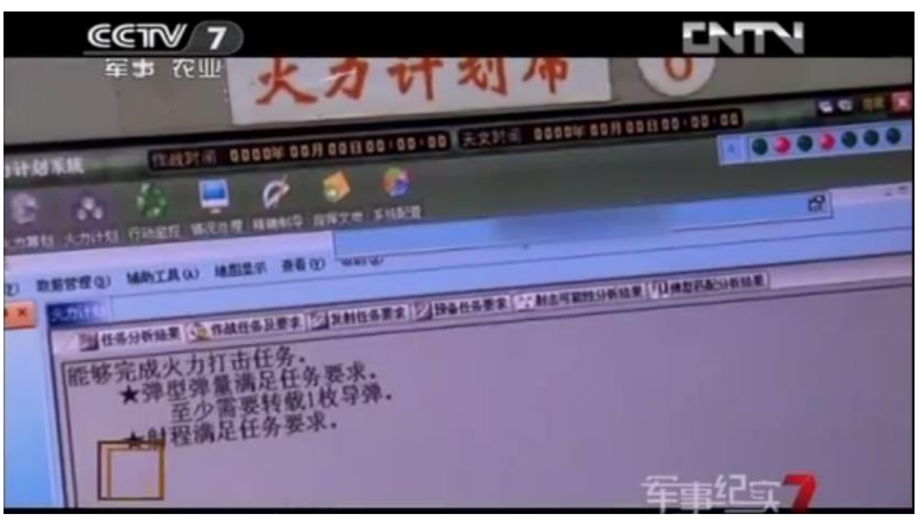
The SAF Equipment Research Academy [第二炮兵装备研究院][xxix] was ordered to upgrade the existing system, but Li Xianyu, despite opposition and criticism, insisted on developing a new software system with independent intellectual property rights. As the documentary put it, Li's "integrated command and control system" translated the "dialect" of conventional missile combat command into universally understood "Mandarin," allowing integration of different types of communication systems. The documentary described a training mission conducted by a SAF missile brigade in December 2012 that successfully tested a combat method [战法], namely, a simultaneous multi-salvo [多弹齐射] firepower attack. The narrator noted the instrumental role played by Li in designing a command-and-control system that enabled the multi-salvo attack.

The documentary laid out in great detail the features of the "missile integrated command and control system" [导弹武器一体化指挥软件系统] that Li was responsible for designing. Given

[xxix] Now the PLARF Research Academy.

that the time window coincides, it is possible that this is part of the PLA-wide integrated command information system, or "SAF sub-system," as noted earlier.

This "missile integrated command and control system" connects command posts [指挥所], missile launch units [导弹发射单元], and even launchers [发射架]. It brings together nearly all elements of missile operations, and each port [端口] can interact with real-time data [交互实时信息数据] and is even capable of automatic fire/ignition [自动点火]. According to Li Xianyu, in addition to its core command and control function, the system also connects intelligence, reconnaissance, and weapons. The system significantly enhances the commander's situational awareness regarding the status of available forces. For example, the images below indicate the system is capable of determining the appropriate missile and quantity needed for a particular mission and cross-referencing available systems with mission requirements.



Missile readiness monitoring system, part of the C2 system developed by Li[195]

Command Center[196]

According to the reporters who accompanied Li to an unidentified "informationized SAF brigade" located in southern China in January 2013, this system connects the brigade operations duty office or watch office [作战值班室] with the mobile command post, which is also called the Basic Command Post [基本指挥所].

According to Brigade Commander Shi Xiangyang [施湘阳],[xxx] "Previously, orders [作战文书] had to be printed out and handed to the appropriate person, which was inefficient, but now coded commands [代码指挥] (likely a set of pre-arranged mission orders arranged by code) are sent through our unified command platform or datalinks, so this allows us to transmit the codes to

[xxx] Shi has been identified as commander of the "1st Conventional Missile Brigade" [常规导弹第一旅], the 613 Brigade under Base 61 in Jiangxi Province. Until recently, this brigade was equipped with DF-15 missiles, which appears to match imagery in the video. See: "Demystifying the 1st Conventional Missile Brigade of the Rocket Force: Which "firsts" have been created," [揭秘火箭军常规导弹第一旅：究竟创造了哪些"第一"], Global Times [环球时报], 31 July 2020. https://m.us.sina.com/gb/china/huanqiu/2020-07-31/detail-ifzysrcs1744292.shtml

various elements [要素; which includes launch units] in real-time." In addition to the code-commands, the system also enables precision-guided weapons management [精导管理], interfacing with the weapons [武器接口], automatic information reporting [信息上报], and other functions.

Images from the brigade operations duty office and a launch vehicle. The equipment, resembling a laptop, is used to transmit launch orders[197]

Once the brigade operations duty office [作战值班室] receives a preparatory launch order [预先号令] from the Base during a nuclear counter-attack campaign, the joint duty officer [联合值班员] only needs to input a short code.[xxxi] This information is transmitted through an internet direct messaging function to launch units, which are distributed in dozens of geographic areas hundreds of miles away, in less than a minute. These units immediately go into action, and their movements can be monitored in real-time by the operations duty office.

The Commander and Political Commissar appear to sit side by side in the mobile command post (the two officers with the same rank) with the apparent commander giving the orders to carry out the mission.[198]

While the launch battalions mobilize, the brigade commander and political commissar in the mobile command vehicle begin strategizing based on data and information provided by the command-and-control system. Brigade Commander Shi notes that the new version of the operation command software [新版的作战指挥软件] assists commanders in decision-making partly by saving them from the tedious manual calculations they previously had to do. Thus, commanders can devote more energy to thinking about operational issues and have become "twice as efficient."

Eventually, the brigade commander enters the launch command [打击指令] into the computer, enabling it to transmit directly to the missile launcher for automatic ignition.

3.2 Early Warning Systems

Nuclear strikes can come from multiple vectors, including submarine-launched missiles, aircraft, and ICBMs. To identify these threats, China is fielding an increasingly capable layered network of radars. This section provides an overview of the identified systems that make up that network and examines their likely near-term development. Specifically, this includes "strategic" early warning (systems capable of detecting incoming ballistic missiles), over-the-horizon radars (which circumvent the line-of-sight limitations of traditional radars and provide some capability against multiple threats), counter-lower-observable radars (designed to detect stealthy or small targets), and satellite early warning systems (which detect the infrared signatures of missile exhaust against the cold background of space as they exit the atmosphere). This section will also examine Chinese radar systems that detect low-flying cruise missiles, a priority for its early warning and defense systems.

Early Warning System of Systems		
Altitude	*System*	*Targets*
Space / High Altitude	LPARs, early-warning satellites	Ballistic missiles
High-Medium Altitude	Air-defense radars	Ballistic missiles, bombers
Low-Altitude/Surface	OTH radars, aerostat-based IR sensors, and radars	Ballistic missiles (launch phase), cruise missiles, low-flying aircraft

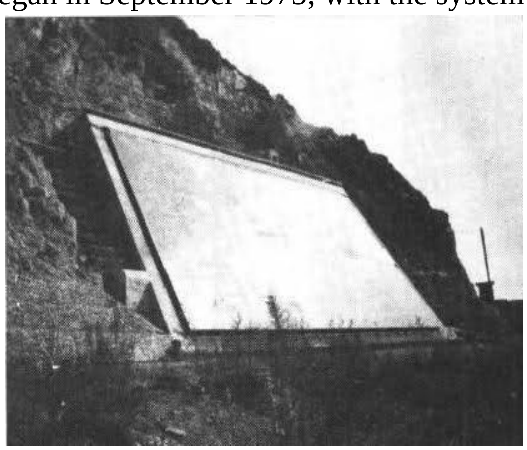
[xxxi] As shown in the video, the code typed in is 警报信号 100.

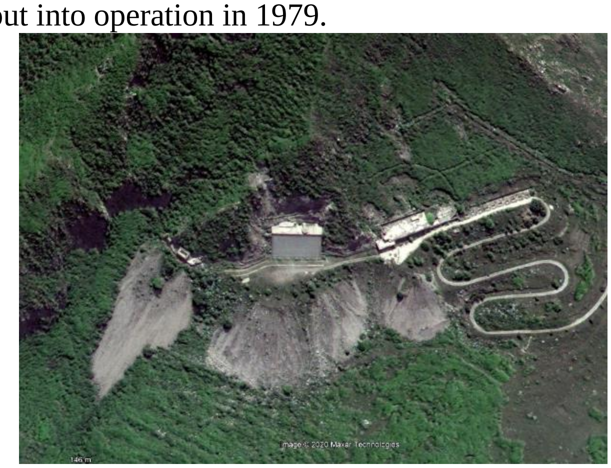
As the eyes of the central leadership going into a conflict, a growing number of sensors, such as long-range radars and satellites, will play a pivotal role in how Chinese leaders respond to an emerging crisis. The joint theater commands and their subordinate organizations are intended to help improve the collection, analysis, and dissemination of intelligence. Kevin McCauley has noted that "The new Theater Joint Commands Joint Operations Command Centers (JOCC) contain intelligence centers, as do command posts (CP) formed at each echelon down to regiment level."[199]

Strategic Early Warning Radars

The U.S. and Republic of China (Taiwan) began flying high altitude reconnaissance missions over China in the 1950s, first with the RB-57 and later with the U-2 and SR-71 and its air-launched drone, the D-20. In the 1960s, China responded by developing early warning radars to provide nationwide detection of high-altitude aircraft and satellites. These quickly began to incorporate other missions, including ballistic missile early warning and defense. In 1964, China began work on a series of interconnected development and scientific research programs called Project 640 [640 工程] during a time of rising tensions with the USSR. This included FJ (*Fanji*; 反击; counterattack) anti-ballistic missiles, lasers, anti-missile artillery (specifically a 140mm cannon), an early warning system, and related science projects. By the early 1970s, China had deployed a series of powerful early warning radars capable of providing strategic early warning, some of which have been upgraded and remain in service today.[xxxii][200]

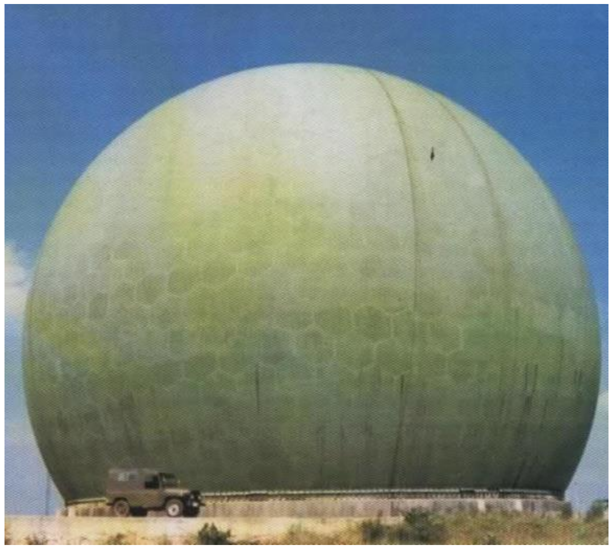
The first radar system was developed and put into use in 1976 by the 14th Institute (now CETC 14th Research Institute, also known as the Nanjing Research Institute of Electronics Technology). In May 1970, the CCP approved the development of an ultra-long-range early warning radar with the code name 7010 (also called the Xuanhua Radar Station [宣化雷达站]), built into the side of a mountain in Hebei Province, and the Type 110 radar in Zhanyi, Yunnan Province.[201] Testing began in September 1975, with the system put into operation in 1979.





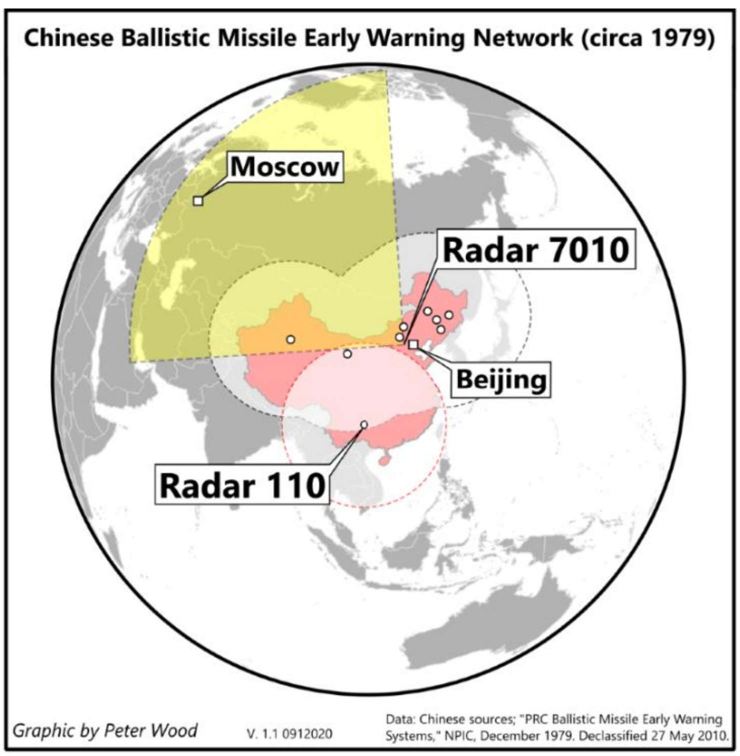
7010 Radar[202]

[xxxii] The radars were designated TREE FORK 2 and Suji D by American analysts. The inset image strongly resembles the J-14 LLQ-105 Surveillance Radar, an example of which can see seen at the China Aviation Museum outside Beijing. A review of these sites beginning in January 1971-1979 identified eight radars, with at least two sites in Heilongjiang and Jilin Provinces were still occupied as of 2020.



Type 110 Radar

A CIA assessment from 1978 noted that the Xuanhua radar/7010 was "ideally suited to detect ICBMs launched from most Soviet complexes, and will be able to give up to eight or 10 minutes of warning of missile attacks from the central and western Soviet Union."[203] The same report noted that "conventional radars provide coverage of missile launches from the Sea of Japan and eastern Siberia, but their warning time might only be 2 or 3 minutes."



To further support the development of domestic satellite communications capabilities, work began on the requisite ground segment infrastructure. In 1974, the Seventh Ministry of Machine Building [第七机械工业部], predecessor to the China National Space Administration (CNSA), China Aerospace Science and Technology Corporation (CASC), and China Aerospace Science & Industry Corporation (CASIC), launched the 450 Project [450 工程], a system of tracking and measurement radars for the Dongfanghong-2 [东方红 2 号], China's geostationary communication test satellite.[204] The first Dongfanghong-2 mission in January 1984 failed to achieve geostationary orbit (GEO), but a second test satellite, launched in April of that year, was successful.

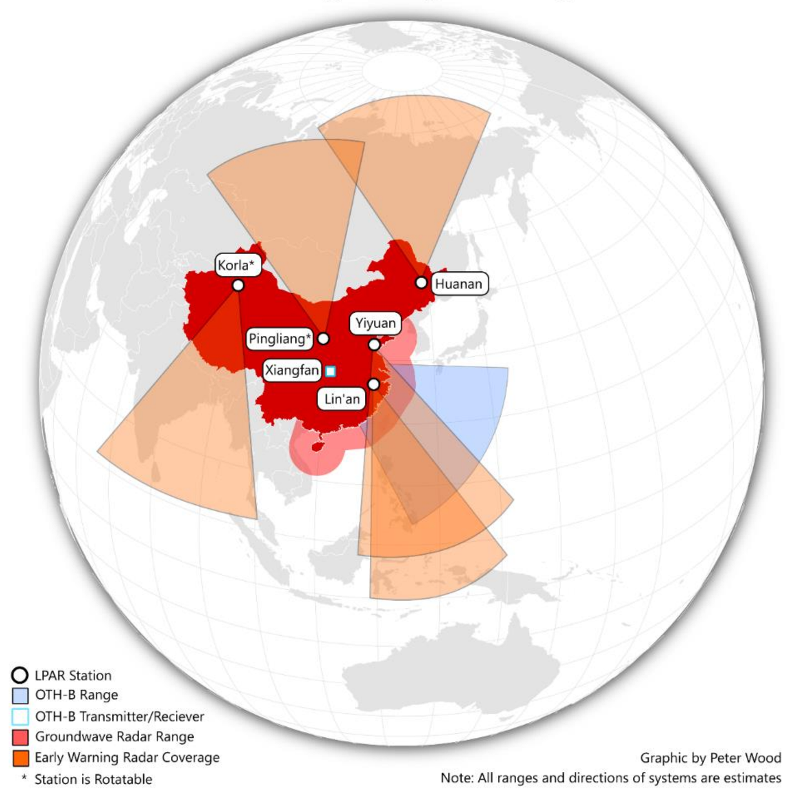
The 110 Large-Scale Single Pulse Precision Tracking and Measurement Radar [110 单脉冲远程精密跟踪雷达] was jointly developed in 1977 by the CETC 14th Institute and the Chinese Academy of Sciences Electronics Institute, along with other units. The project, which began in 1958, was a national key scientific research project [国家重点科研项目]. In 1965, the project developed a successful single-pulse test radar, laying the foundation for the development of precision tracking radar.

In the early 1970s, China developed early warning and missile tracking radars, including the large-scale 7010 radar, which began installation and commissioning of small area array antennas in 1972. In September 1975, the 7010 radar was initially tested, and an outer space target was observed for the first time. In 1976, the installation, commissioning, and operation of the full array of antennas were officially completed. After 1977, the 7010 radar completed several Chinese missile and satellite observation missions. In particular, during one mission, the radar was able to provide target indications for the 110 radar to then form an accurate identification network. While the 7010 radar has long been decommissioned, the 110 radar, operated by the PLASSF's Xi'an Satellite Control Center (Base 26), appears to still be in use.[205]

Current Strategic Early Warning Network

From the early 2000s on, China's strategic early warning network has grown considerably, adding overlapping capabilities to detect a wide range of threats.

Chinese Strategic Early Warning Radars



Large Phased-Array Radars (LPAR)

The most powerful components of this early warning network are LPARs, building-sized radars capable of imaging ballistic missiles thousands of kilometers away and high into the atmosphere.[xxxiii] The PLASSF has been identified as operating the following LPARs, mostly under its Space Systems Department's (SSD) Xi'an Satellite Control Center (XSCC) [西安卫星测控中心] in charge of the PLASSF's space tracking and satellite launch centers (SLC).

Two LPARs appear to have been built on turntables, likely to allow them to support missile testing while possibly serving in an early warning capacity as well. One is in Korla, Bayingol, Xinjiang UAR [新疆库尔勒市开发区] and appears to have an MUCD of 63615, placing it under the SSD's Jiuquan Satellite Launch Center [酒泉卫星发射中心].[xxxiv][206] This LPAR likely supports ballistic missile tests at the nearby Impact Area Test Department and the Korla Missile Test Complex.[xxxv][207] The second station, outside Pingliang [平凉], Gansu Province, was completed between early 2017 and mid-2019 and appears to have an MUCD of 63726, subordinate to the Taiyuan Space Launch Center [太原卫星发射中心].[xxxvi][208]

A third LPAR is located in Huanan County, [桦南县], Heilongjiang Province in northeastern China.[xxxvii] It may have an MUCD of 63757,[209] and appears to be under the XSCC,[xxxviii][210] which supports satellite launches with a network of tracking stations across the country.

Lin'an District, Zhejiang Province [临安区] also hosts an LPAR.[xxxix] This LPARhas been identified as associated with a PLASSF unit with the MUCD 61232[211] under a Network Systems Department SIGINT unit which may have missions involving interception of satellite communications and space-based SIGINT collection.[xl][212]

[xxxiii] Specifics for the different types of radars identified here are not available, but a brochure from the Zhuhai Airshow in 2016 depicts a Phased Array Theater Ballistic Radar designated GLC-4 developed by the Nanjing Research Institute of Electronics Technology (CETC 14th RI). The P-band radar has a min-max range of 50-3000km and is described as capable of tracking satellites in low-earth orbit as well. There do not appear to be authoritative sources with specifics of ranges and altitudes, but it is clear that these systems have an arc of greater than 60° and a range of over 4,000 kilometers. The map above uses a conservative estimate.

[xxxiv] Coordinates: 41.641194, 86.236749.

[xxxv] The Impact Area (Test) Department has been connected with the LPAR MUCD (63615). In addition, the LPAR unit, the Department and Complex have similar locations and similar MUCDs, as both the Department [落区测量试验部/落区部] (MUCD 63610) and Complex [落区部库尔勒站] (MUCD 63618) are also in Korla and under the Jiuquan SLC MUCD block, with the LPAR MUCD of 63615 falling between them. The LPAR unit may also be known as the Impact Area (Test) Department Bayingol Station [落区部巴音郭楞站].

[xxxvi] Coordinates: 35.483025, 106.571871.

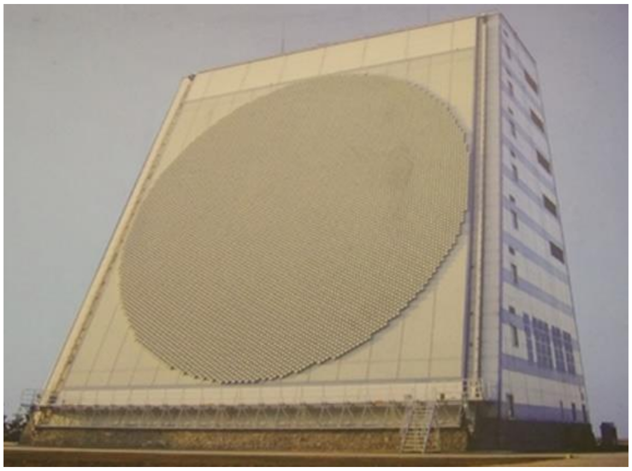
[xxxvii] Coordinates: 46.528092, 130.755276.

[xxxviii] Based on MUCD blocks (the XSCC has 63750-63780) and close physical proximity to another XSCC radar, the Jiamusi Deep Space (TT&C) Station [佳木斯深空站].

[xxxix] Coordinates: 30.286492, 119.128783.

[xl] The former General Staff Department Third Department's 12th Bureau (Unit 61486). The unit has conducted research on satellites.

The final confirmed LPAR is in Yiyuan County [沂源县], Shandong Province, attached to a former PLAAF unit with an MUCD of 95921[xli][213] that is now part of the PLASSF, most likely under its new space early-warning base (Base 37) [空间预警 37 基地].[214]



P-band long-range early warning phased array radar[215] *and Huanan, Heilongjiang LPAR*[216]

> Other types of radars described as having missile detection and early warning roles:
> - Type 390A (JL3D-90A)
> - YLC-8/8A VHF Band Long Range 2D Surveillance Radar
> - YLC-4 2D Long Range Surveillance Radar
> - JY-14
> - JY-27A CVLO (counter-very-low-observable) radar
> - JY-27 VHF Band Long Range Surveillance Radar

One additional LPAR may be present in Hui'an, Fujian Province, collocated with PLAAF and PLAN radar units, though it may just be another type of radar or electronic attack device.

In addition to the LPARs, the PLA fields a wide variety of passive and active radars likely involved in detecting cruise missile, bomber, and ballistic missile threats, including the JY-27, which has a range of 390km,[217] YLC-8B UHF 3D long-range radar, with a quoted detection range of 500km for aircraft and 700km for missiles,[218] and the JY-50 passive radar.

Over-the-Horizon Radars

OTH Radar Type	Detection Range (km)
Groundwave	10-400
Skywave	1000-4000

While the radars described in the previous section can track ballistic missiles high in their trajectory or as they descend, their detection range is limited by the horizon. To overcome this limitation, China has developed and deployed at least two types of over-the-horizon (OTH) radars, to provide layered detection capabilities close to its shores and beyond the Ryukyu Island Chain of Japan. While both types of OTH radar can be used against surface or airborne targets, they also have utility against ballistic missiles in their launch phase.[219] They may also have better results in

[xli] Coordinates: 36.024856, 118.092048.

tracking hypersonic waveriders, which can fly at much lower altitudes than ballistic missile reentry vehicles and can spend more time below the horizon and therefore outside the detection range of LPARs.

However, due to the strong influence of environmental factors on the propagation of these radars, as well as their high susceptibility to jamming, multiple redundant systems are needed for a reliable early warning system. Other countries, including Russia, have deployed these systems.[xlii][220]

Groundwave OTH radar

The shorter-range type of OTH radar, called Groundwave, has broad civilian application for monitoring maritime traffic near China, but also has the capacity to detect enemy ships or even stealth aircraft.

The most prominent figure in China working on this technology is academician Liu Yongtan [刘永坦]. According to an interview with Liu, China first successfully detected ships using its first OTH radar system in Weihai, Shandong in April 1990.[221] The system was formally approved [批准正式立项] in 1997. The test site, a program of the Harbin Institute of Technology (HIT) Institute of Electronic Engineering at its Weihai, Shandong campus [哈工大（威海）电子工程研究所], is positioned opposite Qinghuangdao, on the shores of the Bohai Sea roughly 340km away.[222]

In 2011, Liu and his team completed the development of a continuous operation, all-weather long-distance detection system.[223] The radars developed by Liu and Yu have been described as the "Coastal Defense Great Wall" [海防长城].[224] While the particulars of the system are not public, the fact that Liu and his team have twice received the National Award for Scientific Advancement, First Class [国家科技进步奖一等奖] (in 1995 and 2015) and won the Special Award for Advancements in Defense S&T [国防科技进步特等奖] (in 2014) indicates the significance of the program. Liu has also received a prize of 8 million RMB ($1.2 million) for his work.

In 2019, HIT and HIT Leixin Technology Co. [哈尔滨工大雷信科技有限公司] were awarded the China Patent Silver Award [中国专利银奖] for their "high-frequency ground wave radar weak target detection and tracking method and device," indicating the technology associated with Liu and his team is reaching maturity and likely capable of detecting weaker radar returns.[225]

[xlii] Russia's "Konteiner" over-the-horizon radars for example are described as capable of detecting cruise missiles and hypersonic weapons 2,000km away. It has a system of Voronezh-type radar stations to detect and track ballistic missiles.

HIT-Weihai Radar Test Site[226]

Chinese research institutions also appear to be developing several other OTH Groundwave projects. For example, Wuhan University [武汉大学] and Wuhan Deweisi Electronic Technology Co. [武汉德威斯电子技术有限公司] have jointly developed a portable high-frequency groundwave OTH maritime monitoring system called OSMAR-S that has a range of 200km.[xliii][227]

Further, materials shown at the 2016 Zhuhai Airshow depict a surface-wave OTH (SW-OTH) High frequency system designated LD-JHC300 able to "continuously monitor over-the-horizon maritime targets and provide sea-situation information." The materials further state that "several LD-JHC300 SW-OTH radars can be netted into an operating network as well as fuse data with those from other coastal surveillance radars."[228] The system can provide enhanced early warning at ranges of over 200km. Most importantly, from the perspective of nuclear early warning, these systems have the potential to detect low-flying aircraft, including those equipped with stealth technology, and sea-skimming cruise missiles. A second OTH system shown at the same exhibition, the "LD-JXC100" Microwave OTH radar, uses an X-band phased array.

China may also have gained access to foreign technology to speed development of this system. Unconfirmed reports suggest that China purchased three sets of the Russian Sunflower-E [向日葵

[xliii] The system has apparently been deployed on the Zhoushan and Dachen islands in Zhejiang province.

-E/Подсолнух-Э] system in 2000. The Sunflower system has a range of approximately 300km for sea-surface targets.[229]

OTH Backscatter (OTH-B) / Skywave radar

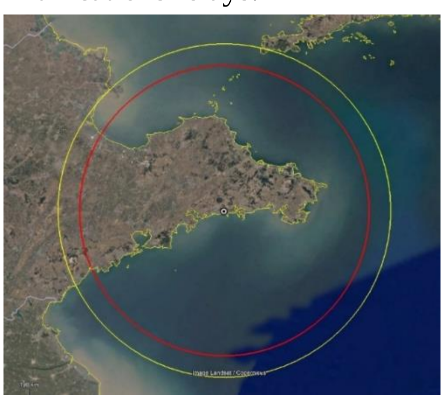
OTH Backscatter (OTH-B), also known as Skywave, is a high-frequency over-the-horizon radar that uses reflection off the ionosphere to detect air and surface objects at distances of over 2,000km. Because the system reflects off of the atmosphere, it has significant gaps in coverage closer to the transmitters, making pairing it with other types necessary. A PLAAF unit has been identified using the radar in Xiangfan, Hubei, which is likely able to observe airborne and maritime activity out to the mid-Pacific and is capable of providing some early warning of stealth aircraft.

Satellite imagery of a site in Beijing's Yanqing District [延庆区] between 2005 and 2020 suggests that a number of deployments that may be an OTH system have been tested.[xliv]

Counter-Very-Low-Observable Radars and Aerostats

China is also fielding a large number of radars to detect stealth aircraft, cruise missiles, and other so-called "low-observable air targets." Examples include synthetic impulse aperture radars, which have been identified in several sites around China and in the South China Sea.[230]

Aerostats such as the one outside Haiyang [海阳市], Shandong Province, are another platform that can contribute to layered early warning, particularly against low-flying threats.[xlv] According to information on one type, the JY-400 produced by CETC, these inflatable aircraft are capable of operating at "200-3,000 meters" while carrying tens of tons of equipment. They can stay aloft for up to 25 days at a time and can carry early warning radars, collect ELINT/COMINT, or act as communications relays.[231]



At an altitude of 3,000m, such a radar would be capable of covering much of the Shandong Peninsula (see image on left).[xlvi] These have been identified as operating in several other locations all over China.

Satellite Early Warning Systems

Space-based systems offer significant advantages over ground-based radars as they are not limited by the horizon and can detect missiles as they leave the atmosphere.

[xliv] Coordinates: 40.503892, 116.024913. This appears to be a dedicated communications or similar site, as seen by the large number of satellite communication dishes at 40.501333, 116.026226.

[xlv] Coordinates: 36.758255, 121.310091. The U.S. has tested an aerostat, the Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System, (JLENS) as part of the airspace defense network around Washington, DC to help detect low-flying targets such as UAVs and cruise missiles.

[xlvi] The line of sight at that altitude is ~195km (red) and radio horizon is just over 225km (yellow).

Beginning in 2009, China began launching infrared early warning satellites. In 2016, *S&T Daily* stated that China had built a space-based constellation of infrared early warning satellites called "Outpost" [前哨], complementing other constellations of military reconnaissance satellites.[232]

While difficult to confirm, a second system of geostationary infrared satellites, sometimes called Huoyan ("Fire Eye") [火眼], may have also been put into orbit. The constellation includes TJS-2, -5 and -6, launched in 2017, 2020, and 2021, respectively.[233] Few other details are available, though there are indications that related R&D for the system is being carried out by the Beijing Space Vehicle General Design Department [北京空间飞行器总体设计部], among others.[234]

Further driven by the intensifying race to develop more accurate and maneuverable reentry vehicles and hypersonic glide vehicles, China will undoubtedly invest in greater numbers of space-based early warning systems that are better able to detect these threats. As noted by U.S. Undersecretary of Defense for Research and Engineering Michael Griffin, in responding to hypersonic weapons, "The only way to see these things coming is from space," going on to note that hypersonic missiles are ten times dimmer than ballistic missiles, making space-based tracking an essential component of effective early warning systems.[235]

According to Li Deren [李德仁], an academician of both China's Academy of Sciences and Academy of Engineering and the central architect of China's earth observation programs, China currently has 14 high-resolution Earth observation satellites. Of these, half are for civilian applications and half are used by the military, though the system is intended to be dual-use.[236]

China's plans appear to be to develop an interconnected network of sensors, data-relays, and communication satellites interfacing with a 5G network to quickly pass data to the end user.

Naval Observation Force

The PLAN also maintains a system of "coastal observation and communications stations" [海岸观察通信站] for early warning and detection along China's coast. These stations are mainly responsible for observing naval and low-altitude targets, monitoring sea and air conditions, and providing timely information to PLA command centers and vessels.[237] These stations are tasked with observing naval maneuvers, with one article describing efforts by personnel to memorize the radar profiles of various surface vessels.[238] The article further noted that the majority of the force was deployed to Zhejiang, Fujian, and Guangdong, while another article mentions their presence in China's South China Sea installations.[239]

Radar system deployed to the South China Sea[240]

3.3 Communications Systems

China's ability to respond to nuclear attack or carry out its own strikes relies on the leadership in Beijing and elsewhere being able to successfully pass orders to units as diverse as missile silos in the mountains of Henan, mobile ICBMs on the move in western China, SSBNs hiding in the depths of the South China Sea, or airborne H-6s carrying nuclear ALBMs.

Establishing and maintaining fragile communications links with these forces is clearly both a massive undertaking and one of the most carefully guarded aspects of China's nuclear enterprise. Specifically, this communication network is primarily made up of buried cable networks, microwave relays, troposcatter systems, and satellite communication systems. Low-frequency transmitters allow contact with China's SSBNs. This section lays out what is known about the development of the various types of communication links and what is known or can be inferred about their current status.

Overview

Strategic communications connect the Supreme Command [最高统帅] with units at the corps level and above.[241] China's communication units trace their origins to the Signal Corps established to support the August 1927 Nanchang Uprising, the beginning of the PLA. Work on a national defense communications network began after May 1961, but was reliant on uninsulated wires and short-wave radio.[242] After a winter storm in January 1969 significantly disrupted the national communications network, Zhou Enlai directed the creation of a reliable buried cable network.[xlvii] Successive expansions and upgrades of this network were undercut, however, by China's lack of modern switching technology, meaning that many of the exchanges faced significant bottlenecks. Communications were one of the priorities for modernization that came out of the December 1978

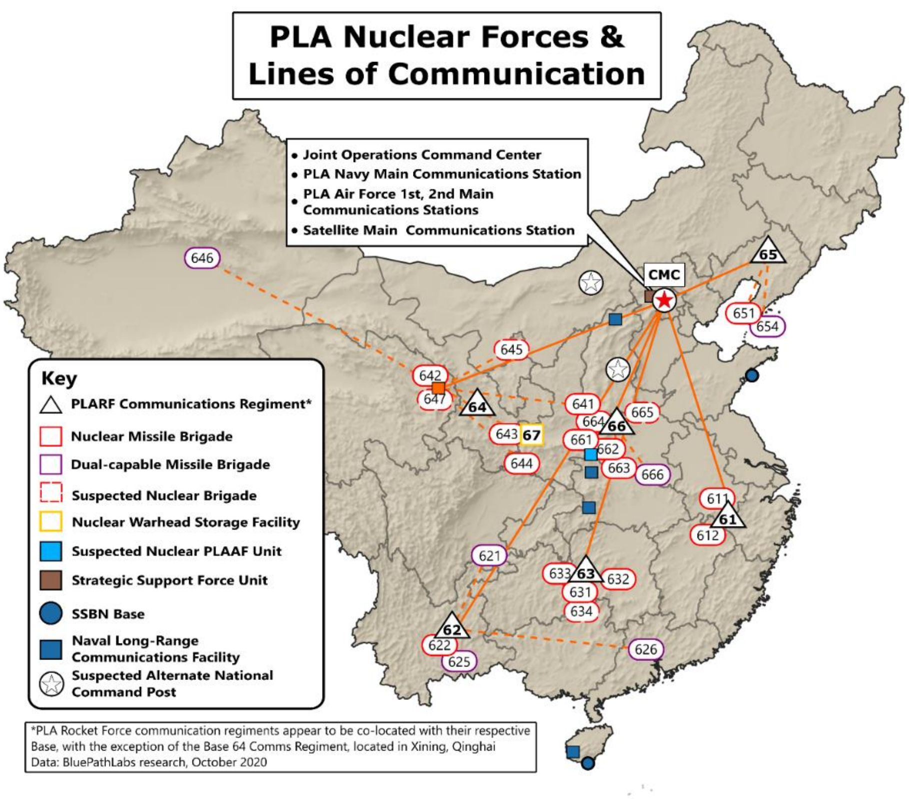
[xlvii] Called the "National Underground Cable Communication Network Construction Plan" [全国地下电缆通信网建设规划]

reforms to the PLA, but switching issues were only resolved beginning in December 1985.[xlviii] [243] Reliable ground cables were apparently not developed or sufficiently widespread for use in the national defense communications network until 1973.[244] China did not master the technology for producing the cables until at least 1980.[245] Further, the use of satellite communications has grown significantly since its introduction in the 1990s.

Having overcome many of the technological bottlenecks, the emphasis today appears to have shifted. Specifically, new and better communications technologies offer the ability to transmit greater volumes of intelligence to launch units, and improve redundancy of lines of communication, but come with their own risks and vulnerabilities inherent to electronic systems. Not surprisingly, then, there appears to be an increased focus on greater realism in training, particularly concerning cybersecurity and overcoming electromagnetic jamming, while further developing existing networks and improving processes to share information.[246]

Current Situation

The following map provides a notional depiction of the lines of communication connecting the Central Military Commission with PLARF Bases, Communications Regiments, and nuclear-weapons-equipped brigades or dual-capable brigades.



[xlviii] In 1978 the Communication Department of the General Staff proposed construction of what would become China's first real military communications network with multi-channel lines, special secure lines and integration with units in the field.

Development of the first PLAAF Automated Command System began in November 1959 as Project 1125 [1125 工程]. The first generation of the system was tested beginning in 1984, with deployments in Beijing and Guangxi, and the first complete system linking PLAAF HQ – Military Regions – Command Posts – Divisions & Regimental Commands was completed between 1986-1989. Tensions with Taiwan in the 1990s provided impetus for development of a second-generation system, an automated theater-level C4ISR system called *Qu Dian* [区电], which was developed between 1996-2003.[247] The system was intended to link together airborne sensors with satellites, buried fiber-optic cable networks, and microwave transmission nodes.[248] By 2008, this system had been deployed nationwide.

Fiber-optic Cable Network

Since the late 1970s, China has been working to deploy a national network of fiber-optic cables to improve the survivability of its military command and control systems. All research, development, and production activity relating to fiber-optics was centralized and China was eventually able to gain access to commercial fiber-optics and telecommunications switch technology from Belgium in the 1980s.[249]

While information is limited, the PLARF has recently upgraded its network of fiber-optic communications between its headquarters communications regiment (MUCD 96946) and its operational Bases.[250] Fiber-optics are also widely employed at lower levels, for communications between operational Bases and their brigades, as well as between brigades and their various elements. For example, the PLARF 613 Brigade has in recent years constructed extensive fiber-optic lines between several of its elements in the areas around its main facility in Shangrao, Jiangxi Province.[251]

The Base 68 Communications Engineering Regiment [通信工程团] (MUCD 96885) in Sanmenxia, Henan Province, is responsible for construction of the PLARF's communications infrastructure, including its fiber-optic network.[252] This regiment likely has at least two Communications Line Battalions [线路营], each with at least four component companies. Personnel typically complete 3-5 engineering projects each year, and this regiment laid down over 200 total kilometers of fiber-optic cables in 2019. Further support is provided by Base 68's Engineering Maintenance Support Group [工程维护保障大队] (MUCD 96886), which is tasked with maintenance and repair of the PLARF's communications infrastructure.

The PLARF and SSF practice wartime repair of these cable systems under a variety of circumstances, including addressing cyber-attacks (e.g., Trojan viruses) inserted into the network.[253] In a conflict, the Communications Engineering Regiment and Engineering Maintenance Support Group would be responsible for repairing damaged communications infrastructure and ensuring an uninterrupted flow of information between grassroots units and the higher command. A third Base 68 unit, the Mobile Communications Regiment [激动通信团] (in one instance referred to as the elite "special forces" of communications troops), would also be tasked with deploying and rapidly establishing field communications hubs to replace damaged or destroyed nodes.[254]

Members of a PLASSF unit undertake field repairs on a fiber-optic cable[255]

Microwave Communications

Left: SAF drill featuring microwave communications vehicle, 2012.[256] Right: PLARF comms unit.[257]

China's military radio communications network predates its buried cable networks. While careful to avoid detection, as cryptographic schemes were only introduced for some systems in the mid-1970s, these nevertheless remain an important leg of communication networks for the PLA Rocket Force and other services.[xlix]

By 1985, China had a microwave radio relay (radrel) network connecting Beijing to remote regions (except Tibet and Xinjiang) stretching over 14,000km, but this system was apparently not trusted due to fear of interception.[258] The SAF began building a microwave network in 1995, which entered service in the late 1990s, providing all-weather communications.[259]

[xlix] PLAAF units, including H-6 bombers, communicate with HF/UHF radio, but the arrangements for the newly established ALBM units are currently unknown .

The PLA also uses HF radios on truck and backpack configurations. Images of PLARF Communications units appear to show trucks equipped with the MW-1500 Microwave Communication System, which can provide line of sight communications up to 30km.[260]

Troposcatter Systems

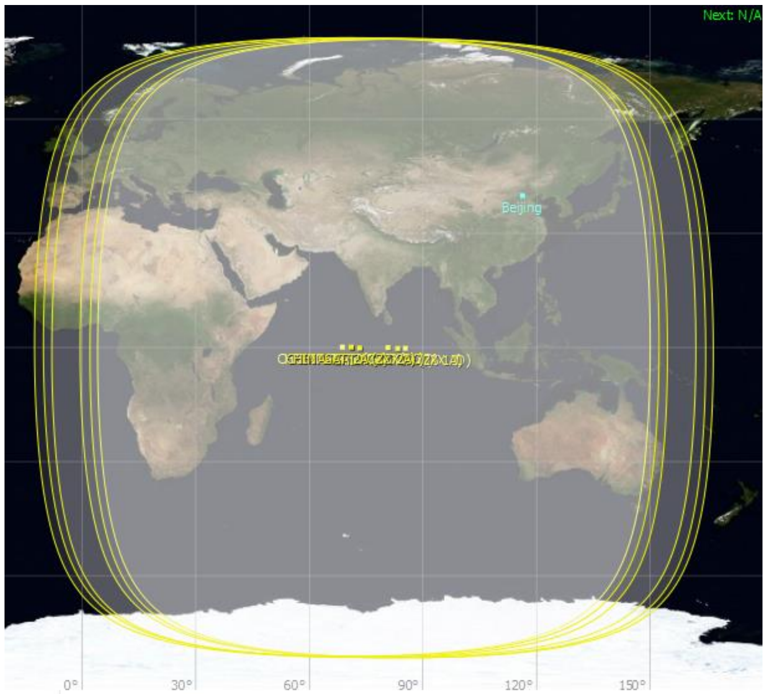
Troposcatter systems use the troposphere to reflect microwave radio signals over distances typically between 300-700km. The fact that they do not require line-of-sight or significant supporting infrastructure other than a mobile transmitter-receiver provides additional flexibility in communications and makes them useful for China's missile forces operating in remote and often mountainous areas. In the mid-1960s, the 10th Academy's 19th Research Institute [十院 19 所] and the 760 Factory developed the Type 6171 Troposcatter transmitter.[261] Encryption for the device was developed by the 10th Academy's 30th Research Institute, the 716 Factory, and Tsinghua University in the early 1970s.

By the 1980s, China had built a troposcatter network of over 20 stations for both military and civilian applications.[262] Current systems, such as the ones displayed during the various military parades in Tiananmen Square, include the TS-504 or TS-510 tropospheric scatter communications systems produced by the CETC's 54th Institute, with a range of roughly 200km.

Satellite vehicles and troposcatter Communication vehicles support a DF-31 exercise.[263]

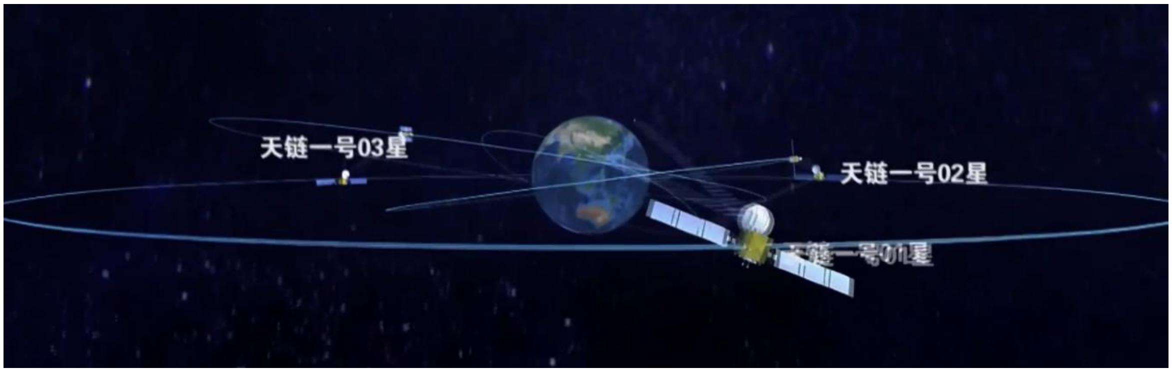
Satellite Communication Systems

Satellite communications are a growing part of China's NC3 structure. To facilitate longer-range operations and overcome the deficiencies of the existing communications network, the PLA began integrating satellite communications in the early 1990s.



The satellites believed to be part of China's military communication geostationary satellite network (ChinaSat 1A/1C/2A/2C and Zhongxing-20A) are clustered in orbits over the Indian Ocean (see image above), providing maximum coverage out to the mid-Pacific and over most of Europe and Africa.

China has also launched a series of geostationary data-relay satellites, designated *Tianlian* [天链], to pass data from the various *Gaofen* [高分], *Yaogan* [遥感], and other constellations back to the communications satellites.[264] The system reached initial global overage after launches in 2003, 2008, and 2012.[265] A second generation system, *Tianlian* 2, was launched in 2019.[266] Subsequent system upgrades have ensured the interoperability of ground stations with both constellations and global real-time information transmission.[267]



Depiction of Tianlian Satellite constellation[268]

Launched in early 2017, the Space-Earth Integrated Information Network Mega Project [国家天地一体化信息网络重大工程], managed by the Ministry of Science and Technology (MOST) and led by China Electronics Technology Company (CETC), is intended to achieve the comprehensive integration of a space-based information network, future internet, and mobile communications network.[l][269] Put another way, the megaproject is designed for the purpose of "providing information network coverage wherever [China has] national interests."[li][270] According to China Academy of Sciences (CAS) academician and CMC Equipment Development Department (EDD) researcher Yin Hao [尹浩], when completed, the information network will consist of various types of satellite systems (reconnaissance and surveillance satellites, communications satellites, navigation and positioning satellites, early-warning satellites, meteorological satellites, etc.) on different orbits, supplemented by land, sea, and space-based information systems and application terminals to form an organic, intelligent, distributed, space-Earth integrated global information network system.[271] This integrated network will support four application areas: spacecraft, guided missile and space launch centers, near-space[lii] flight vehicles, and unmanned aircraft (UAVs).

China is also testing high-throughput satellites (HTS) that offer significant increases in transmission capacity compared to other communications satellites.[liii] [272] In the longer term, Chinese scientists envision a layered approach of satellites in high and low Earth orbits linked by datalink satellites in orbit and via high-speed 5G connections on the ground providing redundant and interconnected communications links.

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[l] The original Chinese is "天地一体化信息网络。推进天基信息网、未来互联网、移动通信网的全面融合，形成覆盖全球的天地一体化信息网络." The *National Science and Technology Innovation Plan for the 13th Five Year Period*, released by the State Council in July 2016, announced plans to launch a group of national S&T R&D megaprojects called titled *S&T Innovation 2030*, which includes the Space-Earth Integrated Information Network Mega Project. These megaprojects are designed to "reflect national strategic intentions" [体现国家战略意图], and, as the name suggests, seek to achieve significant breakthroughs by 2030.

[li] The original Chinese is "国家利益到哪里, 信息网络覆盖到哪里."

[lii] Near space is defined as the upper atmosphere above 20 kilometers and reaching the "Kármán Line" at 100 km, typically used to define the beginning of space.

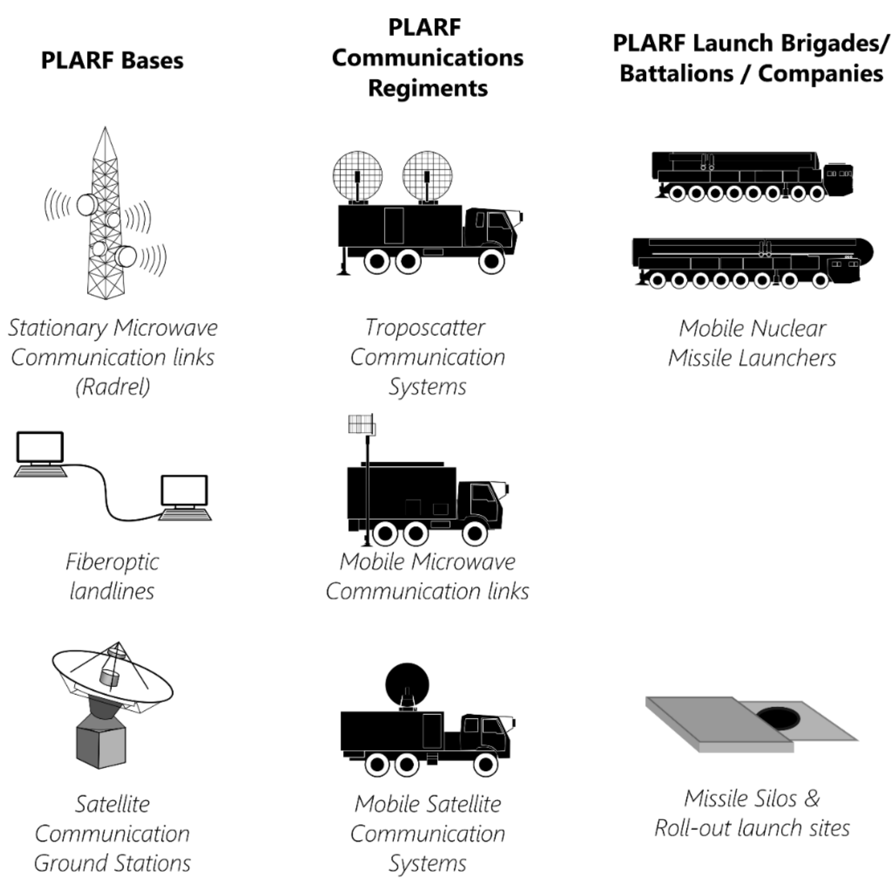
[liii] HTS satellites transmit at greater than 100 Gigabits/second, whereas conventional communications satellites typically transmit at 10 Gigabits/second or less.

China has also made significant investments in space-situational awareness, which it has directly described as supporting air and missile early warning systems.

The former General Armaments Department (GAD) developed a large ground segment to support missile testing, space launch, and space awareness, as well as satellite communication services. These stations have been transferred to the PLASSF after 2016.[273] Individual PLARF communications regiments also operate satellite communications (SATCOM) elements [分队] to support communications with mobile launch units and higher echelons. PLARF mobile SATCOM stations appear to have been upgraded, and Chinese media reporting periodically describes the integration of new equipment.[274]

The PLA's satellites are believed to be operated by the PLASSF Unit 61096, also called the Satellite Communications Main Station [卫星通信总站].[275] The unit is located in Beijing's Mentougou District [门头沟区][liv] [276] and may be part of a new PLASSF Space Applications Operations Base with MUCD 32039.[277]

Summary of PLARF Communication Links



[liv] Coordinates 39.912267, 116.094027.

Meteor Burst Communications

This technology uses the ionized air left by meteors entering the earth's atmosphere to reflect radio waves, allowing communication at distances of up to 2,250km. China apparently tested or conducted research on meteor burst communications [流星余迹通信] beginning in 1984.[278] Several patents related to meteor burst communications continue to be filed every year by a number of relevant Chinese institutions, including the CETC 54th Research Institute, PLA Rocket Force University of Engineering, and Xidian University, suggesting continued interest in the technology.

Low-Frequency Communications

Low frequency communications systems are used to communicate with ballistic missile submarines on patrol, which are typically unable to receive other types of transmissions. Receiving low-frequency transmissions requires submarines to rise to depths of about 18m and to tow long antennas.[279] Transmission of low frequency communications requires specialized facilities to generate long wavelengths. Extremely Low Frequency (ELF) systems have superior ability to pass through seawater, allowing them to be detected by SSBNs hiding in the depths of the open ocean, but carry the least amount of information in a signal and require very large facilities, often kilometers wide.

Very Low Frequency (VLF) Transmitters

To support China's nascent submarine force, in February 1950, the Soviet Union signed an agreement to transfer equipment and provide technical support for construction of very low frequency transmitters capable of underwater communications.[280] With Soviet assistance, China built three small high-frequency transmitters, in Qingdao, Ningbo, and Xiying, and a series of larger, more capable transmitters. One article from 2003 asserted that China had built 12 VLF stations, including stations in Zhanjiang, Guangdong, and Yulin, Hainan.[281] However, these stations have not been characterized in further detail. The following are some of the VLF transmitters known or suspected to still be in use.

Datong [大同], *Shanxi*

In 1959, with Soviet assistance, Chinese military planners determined Datong as an appropriate location for a VLF transmitter. The project was given the code designation Project 5901 [5901 工程]. Despite the withdrawal of Soviet support due to rising tensions, construction of the transmitter began in 1960. The transmitter was successfully tested and put into operation for communications with Chinese submarines, between 1965 and 1966.[lv] [282] As of this writing it appears to still be in

[lv] The transmitter appears to have been first identified by U.S. intelligence in June 1965 from imagery collected by the Corona imagery satellite. A more extensive report from March 1969 by the National Photographic Interpretation Center noted the identification of a large VLF communication facility in Datong.

operation.[lvi] The facility clearly resembles a Soviet design used at the VLF station outside Khabarovsk, in the Russian Far East.[lvii] These facilities are massive, covering over 10km^2 in the case of the Datong facility, with 'curtains' of long wires.

Datong VLF station[283]

Cili [慈利], *Hunan*

Likely prompted by the 1969 Sino-Soviet conflict and concerns about the vulnerability of the Datong transmitter to a strike, a second large-scale transmitter was commissioned deeper in China's central regions. This transmission station, alternatively referred to as the Lujiaping VLF Radio Communications transmitter or the "Second Transmission Station" [通信二台], is in Cili County [慈利县] in Northeastern Hunan Province. The 2MW "Ultra-long-wave" [超长波][lviii] transmitter station meant to maintain communications between the CMC and China's nuclear submarines was approved by Mao on 4 August 1969, and thereafter referred to as Project 6984 [6984 工程].[lix] The transmitter was designed by Wang Dongshan [王东山], later director of the PLA Navy's Department of Naval Communications [海军通讯部]. Construction began in 1971, with the facility completed between May 1978-1979.[284] As opposed to the Datong design, this transmitter is suspended over the Jiangya [江垭] Reservoir, three kilometers long on three sides

[lvi] Coordinates: 39.946502, 113.248151. The station appears to be active, and it is likely operated by a Navy unit with the MUCD 92325.
[lvii] Coordinates: 48.485833, 134.819067.
[lviii] Chinese media does not use the internationally accepted terms VLF, ULF, SLF, or ELF to differentiate between types of waves, and instead typically uses long-wave [长波], ultra-long wave [超长波], etc., which are not equivalent.
[lix] The project is also called "New 01 "["新 01"工程] to differentiate between the Datong facility, which had been referred to as the 01 Project.

spanning two ridges, and held up by 27-meter-high towers. A third station is believed to be present in southwestern Hunan, south of Huaihua [怀化] in Lengshuixixiang [冷水溪乡].[lx]

Dongfang [东方], *Hainan*

A group of transmitters in Hechang, Dongfang on Hainan's west coast comprise another possible VLF location. A former PLAAF unit, which has since been resubordinated to the PLASSF (MUCD 95852), is stationed in the city, but their connection to one of the transmitters, which in at least one case includes a commercial broadcaster, is unclear.[285]

Extremely Low Frequency (ELF) Transmitters

China has also invested in extremely low frequency (ELF) transmitter technology, which both the United States and Russia have used to communicate with their submarine forces. In January 2020, *S&T Daily* reported that China's Wireless Electromagnetic Method (WEM) Project [极低频探地 (WEM) 工程], which consists of an ELF transmitter and receivers, passed inspection.[286] Initial work on the project, led by CAE Academician Lu Jianxun [陆建勋], started in 2000. Formally approved by the central government in 2010, construction began in 2012. The transmitter was reportedly developed with assistance from the Russian Academy of Sciences and other unnamed foreign countries provided to China in 1999. Descriptions of the technology say it will be used for earthquake prediction and natural resource exploration, but also acknowledge the development of ELF transmitters as an outgrowth of China's military technological development.

It is unclear if this facility or others are used to support Chinese submarine operations. If so, this could provide limited communications to submarines operating anywhere on the globe.

Developers of Chinese C2 Systems

While available information is limited, CETC and its historical predecessors have clearly played a leading role in developing the PLA's command and control systems, including its nuclear C2 system. CETC's 39th and 54th Research Institutes are the main developers of the communications network used for China's ground segment, with other institutes developing technologies such as fiber-optic cables and network switches.[287] CETC 54th Research Institute and the China Electrical Power Research Institute [中国电力科学研究院 or 电科院] are the lead designers for combined military communications systems and tactical datalinks. CAE Academician Sun Yu [孙玉], a researcher affiliated with CETC 54th Research Institute, for example, has played a central role in developing civilian and defense-related and strategic communications systems, including China's first Integrated Services Digital Network (ISDN), missile control systems, and an "ultra-long-range scattering digital transmission system" [超远程散射数字传输系统].[288]

[lx] It is possible this Lengshuixiang station is the first Project 6984 transmitter. However, it is also possible that another station in Cili, some 400km north, is the 6984 transmitter.

Indigenization of the core technologies to produce these systems, or even basic technologies involved in communications systems, has been fraught with difficulties, but has resulted in breakthroughs. In 2009, for example, the CETC 14th Research Institute announced it had developed an indigenous chip, the Huarui-1 [华睿 1 号], together with Tsinghua University [清华大学].[lxi]

It is also clear that overt and covert purchases of foreign technology have played a central role in helping the PLA overcome technological bottlenecks and develop its C2 systems. This included China gaining access to Belgian-developed fiber-optics and telecommunications switching technology in the 1980s.[289] A 1986 CIA assessment noted that China had acquired mainframes, computers, and mini-supercomputers from the U.S. through covert means, in order to enhance SAF strategic command and control.[290] The 2002 DOD report on Chinese military developments suggested that China may have received help from Agat, a Belarusian company, "to produce C4I software and equipment capable of performing joint battle management."[291]

Main Developers of NC3 Equipment and Systems	
CETC 7th RI	Mobile communications
CETC 10th RI	Signal processing
CETC 14th RI Nanjing Research Institute of Electronics Technology	LPARs, other early warning radars
CETC 28th RI	Command information systems[292]
CETC 34th RI Guilin Laser Communications Institute	Fiber-optic cable and direct laser communications
CETC 39th RI[293]	Static and mobile satellite communications antennas
CETC 50th RI	Shortwave radios
CETC 54th RI[294]	Satellite communications and troposcatter systems
Beijing Beiguang Technology Co., Ltd. [北京北广科技股份有限公司] *former Factory 761*	Low-frequency transmitters for communications with submarines
China Electric Power Research Institute (CEPRI) [中国电力科学研究院]	Military communication networks

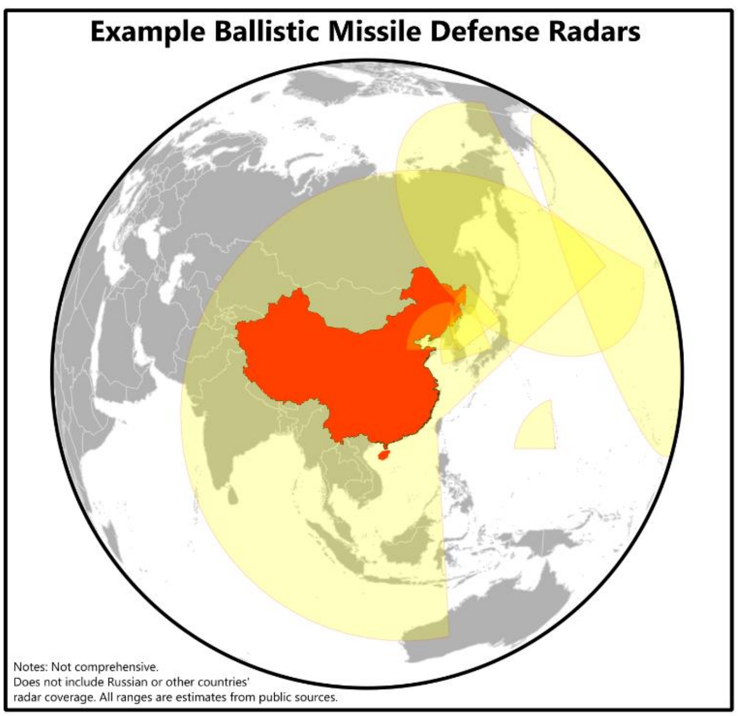
[lxi] The new chip has apparently been incorporated into various radar systems. A more recent chip developed by the 38th Research Institute, the Hunxin-1 [魂芯一号] has been incorporated into the KJ-500 early warning aircraft.

3.4 International Drivers of China's NC3 Modernization

An important piece of contextual information to understand China's views of its strategic environment is that its airspace is closely watched by its neighbors' ballistic missile defense (BMD) radars. The Soviet Union began building early warning radars soon after China successfully detonated a nuclear weapon, constructing "Hen House"-type radars at Shary Shagan and Mishelevka to cover China between 1968-1969.[295]

Radars in the continental United States and Alaska, Russia, India, and Taiwan are all capable of detecting missile launches over the PRC on a number of likely vectors. For example, the Precision Acquisition Vehicle Entry Phased Array Warning System (PAVE PAWS) radar in Hsinchu County, Taiwan "can detect a missile launched from as far away as 5,000km (3,100 miles) and track projectiles in motion in great detail, even from a distance of 2,000km (1,200 miles) – a range that covers China and the entire South China Sea."[296]

Space-based systems provide additional coverage, allowing earlier detection and better cuing of other radars. The U.S. completed its Space Based Infrared System (SBIRS) in August 2022.[297] The system features six satellites in geosynchronous orbit and two in highly elliptical orbits to ensure global coverage. An additional system based in low-earth orbit is also planned. While space-based sensors have lower precision compared to radars, they can detect a missile much earlier in its launch phase.



In addition, the U.S. Space Development Agency has contracted L3Harris and SpaceX to build and launch eight hypersonic and ballistic missile early warning satellites.[298] These satellites are equipped with optical data to be able to communicate with other satellites in the U.S. Department of Defense's Transport Layer data-transmission system. This follows awards in August 2020 to Lockheed Martin and York Space for 20 satellites to comprise the Transport Layer.[299]

Ballistic Missile Defenses

Chinese strategists are also concerned about U.S. ballistic missile defense (BMD) capabilities and have been developing their own capabilities in response. A 2020 DOD report describes China as having at least two BMD-capable missiles: the HQ-19, which is capable of intercepting medium-range ballistic missiles (MRBMs), and an unidentified mid-course interceptor with "good initial capability against intermediate-range ballistic missiles (IRBMs)."[300] The HQ-19 has been tested as a mid-course interceptor, and was expected to reach initial operational capability (IOC) around 2021, but appears to be delayed as of early 2023.[301]

Given the size and capability of U.S. and Russian radar systems, Chinese conventional and nuclear programs are designed to provide China's leaders with the greatest number of options, either in a limited conventional conflict against its neighbors or in a nuclear confrontation with a smaller nuclear power such as India. Investments in hypersonic weapons make sense in a context where an assured second-strike capability is achievable, and where it could be paired with a BMD system to mitigate a strike by an opponent with a smaller nuclear arsenal.[302] However, such a strike capability will only be truly effective when paired with a layered and persistent system of sensors to detect targets and guide these hypersonic weapons to them.[lxii]

In the near term, China's investment in hypersonics will likely succeed in its goal of putting regional actors' sensors on the back foot. In 2018, DOD Undersecretary for Research and Engineering Michael Griffin, speaking at the Center for Strategic and International Studies, said that current sensors were up to the task of detecting hypersonic weapons, but that defending against them was more of a challenge. He also stated that the DOD was looking into improving survivability for its current network of sensors.[303]

While China's fielding of hypersonic weapon systems such as the DF-17 has improved its offensive strike capabilities, it has also prompted additional U.S. investment in more capable sensors to detect these weapons, and at the same time, generated a slew of new systems that China's own smaller sensor network may find hard to detect. Meanwhile, the modernization of competing arsenals is not slowing down. The United States has announced plans to deploy a replacement silo-based ICBM, the Ground-Based Strategic Deterrent, with deployments to existing bases in Wyoming, Montana, and North Dakota in 2023, 2026, and 2029, respectively.[304]

[lxii] For more on Chinese C4ISR developments, see: Peter Wood and Roger Cliff, "Chinese Airborne C4ISR," China Aerospace Studies Institute, December 2020, https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/Infrastructure/2020-12-17%20PRC%20Airborne%20C4ISR_eBook.pdf.

CONCLUSION

In the past few years, the PLARF has expanded significantly in size and delivery options. This expansion includes not only the number of launch brigades but also mission scope, methods of delivery, and the ability to accurately track incoming threats. The mobility of PLA nuclear forces has also improved to include capable road-mobile systems, a submarine-launched ballistic missile force, and an air-launched ballistic missile in the near future. These expanded options suggest that, along with China's extensive tunneling and hardening programs, its nuclear forces would have a greater chance of survival compared with previous decades.

China has also been improving its capabilities in the information arena. Most sources on the PLARF's system of warning date to prior to 2010. In the interim, the PLA has made significant strides in improving its ISR and C2 architecture. Not only does the PLA have an extensive system of coastal radar stations, but it also possesses modern satellite communications and fiber-optic networks, along with a growing network of early warning satellites.

Although the supporting architecture and delivery methods for a nuclear campaign have expanded significantly, China's doctrine surrounding nuclear use remains opaque. China publicly maintains a no-first-use policy for its nuclear forces but may consider a conventional attack on its nuclear stockpile to be worthy of nuclear retaliation. This is particularly dangerous considering that the PLARF often stores nuclear and conventional stockpiles at the same locations, sometimes co-mingling its nuclear and conventional forces within the same units. While China maintains that its nuclear weapons are for defensive use, the Chinese concept of "active defense" only adds to the uncertainty of when China would deploy nuclear assets. From the outside, Chinese leadership appears to consider this convolution an extra layer of deterrence. Considering the determined push for nuclear development, an explicit evolution of China's nuclear doctrine may follow.

However, a number of hurdles still remain for the PLA. Regarding sensing capabilities, the development of space-based remote detection still poses significant challenges. Further, although China may have improved its "shield" in the past year, its likely opponents have also improved their spears. The U.S., for example, has tested missiles that can strike targets less than six inches across after traveling at hypersonic speeds for thousands of miles.[305] Despite this, China's progress does not appear to be slowing down or reversing. In the coming years, we may yet see China with an advanced nuclear triad, survivable facilities, and a committed strategy of uncertainty to keep its opponents on the back foot.

ENDNOTES

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