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Enabling Information-Based System of System Operations: The Research, Development, and Acquisition Process for the Integrated Command Platform

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The development of the integrated command platform (ICP) not only represents a significant improvement in the Chinese military's ability to conduct joint operations, but also a sea change in the way that information technology development programs are conducted. The development of information systems, especially software development programs, is often characterized by huge cost overruns and long delays. In the development of the ICP, the People's Liberation Army (PLA) set out to overcome these challenges by instituting a system focused on identifying requirements at the beginning of the process. This includes establishing a team of military experts to define operational requirements, technical experts to develop hardware and software, and test units to validate results. The Chinese military also sought to incrementally upgrade its existing information technologies rather than create a completely new system. This disciplined and risk-averse approach has resulted in the development of the Chinese military's first command system capable of fostering true inter-service operability.

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Since 1999, the PLA has been on a quest for true inter-service interoperability. However, despite gradual doctrinal reform, intermittent organizational reform, and limited technological change, the PLA remains largely stovepiped and riddled with inter-service rivalry. In 2003, the General Staff Department's 61st Research Institute (GSD 61st RI) embarked on a program to provide a comprehensive information sharing and processing platform that would remedy the technical component of the PLA's joint operations deficiencies. Their six-year effort resulted in the development of the integrated command platform (ICP), an enterprise-level architecture intended to facilitate the storage and transmission of information between units and across services.

THE INTEGRATED COMMAND PLATFORM

The ICP is a military computing platform connecting information systems from multiple services, combat arms, and units to enable the transmission, processing, and storage of information in a shared environment. With an ICP, military units can simultaneously receive and process tens of thousands of data from a variety of sources for the purpose of supplementing and implementing command decision-making. With these systems, users from multiple units can input and access information to provide common situational awareness across military services, operational domains, and levels of command hierarchy.

According to Chinese sources, the PLA has been moving toward developing information-utilization capabilities analogous to those provided by the U.S. Department of Defense's Global Information Grid (GIG). GIG provides a "globally interconnected end-to-end set of information capabilities for collecting, processing, storing, disseminating, and managing information on demand to warfighters, policymakers, and supported personnel" with the goal of empowering users to access information any time, any place, and under any conditions.

ICP RDA STAGES AND EVENTS

In the Chinese defense RDA literature, the RDA process for command automation systems or command information systems is often referred to using the product development term "life cycle" (生命周期). Authors describing the process agree on most individual steps but sometimes organize steps into different stages.

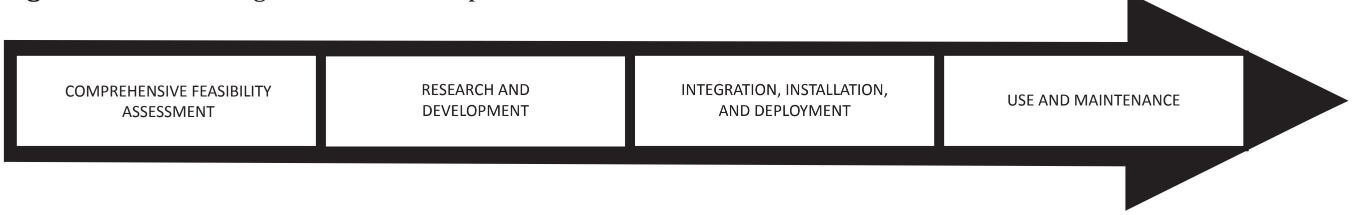
We coalesced these varying versions of the RDA process into a single framework consisting of four stages—comprehensive feasibility assessment (总体论证), research and development (项目研制), integration, installation, and deployment (集成联设), and use and maintenance (适用于维护). These stages are defined as follows (see Figure 1):

1. C***omprehensive feasibility assessment*** is the first stage of the RDA process for information systems and includes the completion of the top-level design and requirement formation process.
2. The ***research and development stage*** involves project design, development, and testing.
3. The ***integration, installation, and deployment stage*** involves the final integration of system capabilities and the initial installation and deployment of the system to end-users for testing and evaluation.
4. The ***use and maintenance stage*** includes formal delivery of the finished system, as well as training on its proper use and operation.

It should be noted, however, that different command information systems may follow their own distinct RDA patterns. For example, one source states that the timeline for complete delivery of large-scale projects is less than five years, medium-scale projects is less than three years, and small-scale projects is less than one year. In addition to differences between time lengths for development, deliverables may also differ between systems, units, and command information system subparts. Regardless of how the stages are broken down, each stage of the RDA process must be performed under supervision of the relevant department, which conducts a rigorous review and approval process before the system progresses to the next stage.

Although the limited available information on the ICP program makes a detailed narrative impossible, information is available on the motivations underlying the ICP's development, major decisions made during the RDA process, and the overall development approach for the project, allowing for an informed exploration of how the PLA developed this crucial component of its next-generation C4ISR (command, control, communications,

Figure 1. The four stages of the ICP RDA process



computer, intelligence, surveillance, and reconnaissance) architecture. Since publicly available accounts of the ICP program neither break out specific activities according to the previously discussed development stages nor provide an exact chronology of events, one must make subjective and potentially imperfect judgments as to how each disclosed activity fits into the ICP program's overall RDA process.

INNOVATION FACTORS

Several innovation factors have contributed to the successful development of ICP by the GSD 61st RI. Multiple sources report that individual information technology systems used by the Chinese military are quite capable in their own right, but were less effective in practice due to a lack of interoperability with other platforms and equipment. The main challenge was in the integration of these systems into a joint architecture. In building a platform that could facilitate communication across units and services, the GSD 61st RI adopted the following practices.

1. Defining Requirements

The lack of sufficient and proper software requirements was the main hindrance in developing previous command automation systems. Software developers did not know the needs of their clients and clients did not fully understand the needs of joint operations to properly communicate them to industry. The GSD 61st RI resolved this challenge by integrating technology developers with military end-users to determine military and technical requirements beforehand and tasking the services and branches with determining how the ICP is applied within their respective force structures.

In order to ensure that the ICP met operational requirements, the GSD 61st RI followed a model consisting of military and technical experts and test units in which military experts proposed requirements, technical experts developed the technology, and test units verified the technology. This model had been advocated in Chinese R&D literature, but the ICP project appears to be the first known example of its successful use on a large-scale project. In developing the ICP, the GSD 61st RI created a "Requirements Assessment Center," brought in a range of experts for consultation, and utilized more than 1,000 military requirements documents to fully understand the needs of users and establish technical parameters before development began.

2. Extensive Research and Development Partnerships

Drawing on the experience of the "two bombs and one satellite" programs, the institute forged a military-industry team made up of more than 300 military units and research organizations and defense industry and civilian research institutes. In total, 8,000 personnel were involved, including communication experts, security information specialists, and primary combat troop programmers, and frontline units.

This team was led by the GSD 61st RI, which served as a type of prime contractor for the project. The GSD 61st RI oversaw the work of a variety of military and defense industry organizations, with military organizations appearing to take the lead at the system level. Among these, the Nanjing Military Region appears to have played a prominent role in defining military requirements. Military technical academic institutions also appear to have played an important role, with the Logistics Command College (后勤指挥学院) winning an award for its involvement. Partners from civilian industry joined military units in ICP development, though the full extent of their role is difficult to gauge. The North China Institute of Computing Technology (华北计算技术研究所/NCI/CETC 15th RI) is thought to have played a major role. Other companies were also involved, working in varying capacities with the GSD 61st RI on initial designs, pre-research, prototyping, technical requirements, selection of equipment (including servers and terminals), and design finalization prototyping.

3. Separating Core Platform Development from End-User Applications

Two of the fundamental challenges facing the ICP project were successfully securing the buy-in of the services and scoping the project in a manageable way such that it would avoid encountering the same problems that had led to failure in prior large-scale command information systems engineering projects. Early on in the ICP's development, chief designer Wang Jianxin developed a design principle designed to fulfill both of these objectives: "Everyone Builds the System, The System Has a Unitary Foundation, Everyone Develops Their Own Applications" (系统大家建、基础统一建、应用各自建).

Under this principle, the GSD 61st RI focused on the more manageable task of building the ICP's interoperable core functionality, with development of specialized fit-for-purpose software falling to the services to pursue according to their own objectives. In keeping with this, individual services and branches had their own targets, milestones, and tasks for bringing their respective ICP configurations to fruition, with this development taking place under GSD 61st RI's overall leadership and guidance.

4. Reliance on Proven Technology and Open Systems Architecture

In order to save time, money, and reduce the level of technical difficulty, the GSD 61st RI modified and built upon existing systems using common standards and software whenever possible. This practice is in keeping with the recommendation that 80 percent of the software used in an R&D program already be mature and 20 percent of the software be developmental. Although the precise percentage of new software in ICP is unknown, there appears to have been a heavy emphasis on the adaptation and integration of legacy software into the platform. However, when necessary, the GSD 61st RI did develop its own software, for example, when it was determined that the network security software initially used in the ICP was incapable of meeting security standards.

The project also relied on open systems architecture. Open systems architecture offered enhanced performance by promoting open design standards, lessening the military's reliance on proprietary systems and data formats, and encouraging interoperability with other open system designs and modularity in development.

5. Human Resources

The final innovation factor that played a role in the success of ICP is a commitment to hiring and retaining high-quality personnel. When initially faced with a stagnant work force and searching for greater efficiency and development output, the GSD 61st RI leadership set out to replace older workers with a younger workforce. These younger workers were in turn put through a competitive evaluation process with potential replacements. This process, particularly cutthroat by Chinese government standards, appears to have played a role in driving 61st RI personnel to uncommon success.

ICP PERFORMANCE

Only a limited number of data points are publicly available regarding the initial deployment of the ICP, but some anecdotal evidence indicates that problems and challenges did arise. Problems arose over the merging of existing databases with the ICP while at the same time conforming to database standards. Interfacing between the servers of internal databases and those of the ICP were also cited as a problem. Some command and operational units have also voiced complaints about the ICP during the testing process. ICP used by logistics units have been faulted for having a low level of automation and a lack of specialized software. In addition, the ICP is said to suffer from inadequate information collection, search, and analysis capabilities. Other complaints fault the deployment of end-user nodes rather than the central architecture, such as a lack of field communication equipment and back-up transmission lines, which limit the ability to conduct mobile command.

Overall, however, ICP has been called a success. The Shenyang Military Region has reportedly achieved results in 26 areas, including battlefield awareness, combat operations data, air-ground coordination, tactical airspace management and control, and digital combat operations command.

LESSONS LEARNED FROM THE ROLE OF GSD 61ST RESEARCH INSTITUTE

The ICP project's success in combining the efforts of technology developers and military end-users appears to have been facilitated by the GSD 61st RI being a military organization. The GSD 61st RI, a major center of the PLA's information technology research, served the role as the primary contractor for the ICP. As the prime contractor, the GSD 61st RI was ultimately responsible for the program's outcome, and as such, they played a leadership role in overseeing the work of other units and in ultimately deciding the direction of the project and the technology involved. It organized the ICP's overall research and development effort, and provided troubleshooting for the system after deployment. Historically, it has played a large role in developing software for the military, including the development of software-related procedures and standards, an effort which may have expanded with the opening of a dedicated Software Center in 2012. Positioned within the GSD's Informatization Department (formerly the Communications Department), the GSD 61st RI has been identified as a key organization responsible for developing operational and technical requirements for a variety of PLA platforms and systems. In fact, the Institute has a history of developing command automation systems and C3I (command, control, communications, and intelligence) systems prior to the start date of ICP development in 2003.

Although the leading role played by the GSD 61st RI in information system development is not entirely new, and thus may not solely signal a lack of confidence in the electronics industry, it is unclear whether China's electronics industry could have succeeded in the task. GSD 61st RI's industry partners were resistant to building ICP indigenously, based on their belief that it could not be done without substantial foreign technology. In addition, the deputy commander of the Nanjing Military Region has stated that the local electronics industry was incapable of understanding ICP's military requirements, which required researchers from the GSD 61st RI to help guide the process. This may reflect broader difficulties faced by the electronics industry in supplying military-use software adequate for evolving PLA needs and increasingly complex use cases.

The prominence of the GSD 61st RI as the prime contractor also appears to diminish the role of the General Armament Department (GAD) in the development of information technologies. All accounts state that the Central Military Commission and the GSD were responsible for approving the ICP through each RDA stage. In fact, no mention is made of the GAD in descriptions of the ICP RDA process. One possible reason for this is that the GSD ranks above the GAD in the institutional hierarchy of the four general departments, thus making it bureaucratically impossible for a GSD organization to seek permission from the lower-level GAD.

As a military-run program, the acquisition process for the ICP appears to be different from weapons programs led by the defense industry. A major characteristic of the deployment of ICP is its decentralized nature. Unlike in other development programs, ICP was not handed off to an industry partner at some point for final development and manufacture. Instead, military units had to engage with their own IT teams and industry to build a system suitable to their needs. This would explain the reliance on open source software in the development of ICP, as it has better compatibility with many different types of application than proprietary operating systems.

The role of the GSD 61st RI as the prime contractor would suggest that the ICP program is an outlier from how the PLA normally develops technologies. Its role in developing previous command information systems suggests that information technology development programs, especially those promoting the integrated information systems, may well be the purview of the GSD 61st RI in much the same way that organizations such as SPAWAR act as a systems integrator for the U.S. Navy. Further research is needed, however, to clarify this question.

CONCLUSION

The deployment of the ICP is potentially a watershed moment in the PLA's ongoing efforts to be able to fight and win wars under informationized conditions. Although the PLA has developed previous command information systems that achieved some limited degree of jointness, the ICP appears to be the first information technology capable of fostering jointness across all services at any level of command as well as with civilian government organizations. As a result, 12 years after the PLA first issued its regulations on the building of command automation systems, it appears to have successfully developed the technology necessary to carry out truly joint operations.

As a result, the ICP is not intended as support for a single system, but rather a distributed system-of-systems. Under this construct, the services are supposed to act as providers of their own weapons and equipment, which are then integrated together by an operational command through command and control, early warning and reconnaissance, communications, logistics, and fire control networks in a manner similar to the U.S. military's use of the Global Information Grid (GIG), or what the PLA calls "information-based system-of-systems operations" (基于信息系统的体系作战).

Information-based system of systems operations involve the interaction of numerous information systems within each combatant force, and these systems in turn form a system greater than the sum of their parts, with victory in warfare boiling down to a contest between opposing systems-of-systems. Viewed through this lens, the quality of interlinkages (such as ICPs) between individual systems is just as important—perhaps even more important—for a military's overall warfighting capacity than the quality of the component systems themselves. As a result, ICP not only represents an improvement in the approach to command information system RDA; it also represents the PLA's conceptual approach to joint operations.

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