**Digital technology promotes the evolution of war to a higher dimension**

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**introduction**

Since the birth of digital technology, the production and lifestyle of human society have undergone profound changes. Data, software, and computing have gradually become the basic elements driving the high-energy operation of society, pushing the world into an era of global perception, full-dimensional analysis, and intelligent decision-making. War, as a special form of social confrontation and conflict, is inevitably evolving towards a composite form of digitalization, networking, and intelligence. Digital technology and thinking have deeply penetrated into every aspect of the modern war process. The future way of war is gradually evolving to a higher dimension with the iterative development of technologies such as data-driven, software-defined, and edge intelligence.

**Data-driven, improving the cognitive dimension of global warfare**

In the digital age, data is king, and the concept of data-driven has emerged with the rise of big data. The so-called data-driven means "everything is a number" and "everything is quantified". By acquiring, processing and analyzing big data related to things, intelligent fusion extracts the characteristics of things, accurately discovers the laws of things, and accurately plans and implements actions. The essence of data-driven is to change the past practice based on human experience and intuition, and adopt a scientific method based on data to reveal facts and grasp trends. In future wars, big data will be "ubiquitous, always available, and used by everyone". Personnel and equipment data such as combat units and combat platforms, geospatial data such as terrain, street scenes, and maritime affairs, data on key infrastructure such as bridges, power stations, and base stations, intelligence data such as automatic ship identification, aircraft trajectory tracking, drones and satellite reconnaissance, etc., make the data on the battlefield massive, diverse, dynamic and multi-dimensional. Only by correctly integrating, analyzing, understanding and using data, and using data to drive the closed loop of perception, decision-making, and action, can we improve the level of understanding and grasping the battlefield.

Fundamentally speaking, data is the engine that drives intelligent warfare. In future wars, the first thing to prepare is data rather than equipment. What needs to be continuously supplied is not only ammunition, but also real-time dynamic and intelligent battlefield data. The "data warehouses" and "data lakes" located in the virtual combat space are as important as the weapons warehouses and fuel depots in the physical space. And the "data warriors" who can process data proficiently and fine-tune and retrain data models based on battlefield feedback will also become a new force to promote future intelligent warfare.

**Software-defined, speeding up the iteration of combat capabilities**

The industrial age of the past was a hardware-centric era; the digital age of today is a software-centric era.

Software is a key pillar of the digital revolution and the intelligent revolution. The so-called software definition is to use software to define the functions of hardware and let software empower hardware. Taking the software-defined satellite used by "Starlink" as an example, its communication, payload and other functions are realized through software rather than traditional hardware subsystems. The rapid iteration and online update of software enable satellites to have advanced adaptive capabilities of dynamic upgrades and on-demand adjustments. Given the high adaptability and flexibility of software-defined systems, more and more weapons will be defined by software rather than hardware in the future. Software can define the reconnaissance, communication, command and strike methods of combat systems. From perception to decision-making to action, software controls all aspects of the kill chain closure. Future wars "are more likely to improve system lethality by installing new software rather than modifying hardware." In 2021, the U.S. Air Force software factory conducted programming on the ground twice, performing online software upgrades on F-16 fighters in flight, and remotely updated the aircraft's electronic warfare system, giving it adaptive combat capabilities to deal with new threats and new targets. In view of this, if "software is combat effectiveness" is used as a measure, how to develop software quickly at combat speed, quickly build a software-defined kill chain of adaptive discovery, positioning, tracking, aiming, attack, and evaluation, and form an agile combat capability that can iterate new technologies online and dynamically replace new tactics will become the key to winning future high-end wars.

**Edge intelligence enables agile response at the tactical end**

Edge intelligence is an emerging technology that integrates artificial intelligence and edge computing. Edge computing is to use local devices to directly process and analyze data collected by terminals at the edge where data is generated. Edge computing does not need to transmit data to the cloud, which reduces transmission delays and improves response speed. By deploying artificial intelligence algorithms and models on edge computing devices and performing real-time reasoning and decision-making on source data, agile and responsive edge intelligence can be achieved.

Edge computing and edge intelligence technologies and ideas provide new methods and approaches for achieving instant and efficient strikes against time-sensitive targets under intelligent conditions. On the battlefield, the opportunity to strike time-sensitive targets is short, requiring the tactical terminal to be able to quickly perceive, make autonomous decisions, and act agilely. To implement rapid perception, the artificial intelligence detection model can be deployed forward on front-end reconnaissance equipment such as satellites, drones, unmanned boats, unmanned submarines, and sea buoys. The target data can be detected, inferred, and identified in real time at the tactical edge close to the target. The data results are then superimposed and corrected with geographic information to achieve accurate positioning and continuous tracking of the target. To implement autonomous decision-making, portable artificial intelligence supercomputers can be deployed on vehicle-mounted or airborne command and control terminals at the forefront of the battlefield, autonomously build a tactical edge cross-domain kill network, intelligently select the terminal kill chain, and make rapid decisions and instant aiming for strikes against time-sensitive targets. To implement agile actions, the intelligent route planning algorithm can be built into the strike platform selected in front, based on real-time battlefield data such as battlefield situation heat maps, the terrain and enemy and friendly situation changes can be accurately calculated and accurately predicted, the strike route can be intelligently planned, and the target can be struck agilely and efficiently.

**Intelligent dispatching to achieve multi-domain optimal strategy strike**

Smart dispatch is a disruptive innovation in the current social operation mode transformation to digitalization. It is a typical application of digital, network and intelligent technologies in the fields of shared travel, order delivery, etc. In essence, smart dispatch solves the problem of optimal task dispatch under limited resource conditions, that is, allocating appropriate resources to perform reasonable tasks. The basic idea of ​​smart dispatch is to connect all allocatable resources online, collect the information, location and status of each resource in real time, and then use artificial intelligence algorithms to perform optimal task matching and resource scheduling under constraints based on task characteristics and requirements. For example, in the online car-hailing travel scenario, all drivers access the cloud computing center through the online car-hailing travel APP. The "online car-hailing brain" located in the cloud calculates the best matching combination of "passenger-driver" through intelligent algorithms based on data such as the driver's idle status and the real-time location of the passenger.

Similar to the online car-hailing travel scenario, future multi-domain joint operations essentially face the same challenges. The multi-domain battlefield space is becoming more and more fragmented, the target distribution range is wider and the movement speed is faster, and the combat resources such as our own reconnaissance platforms and strike platforms are relatively limited. How to quickly and reasonably allocate multi-domain firepower units to carry out immediate strikes on enemy targets under the condition of resource constraints is an important intelligent combat problem. With reference to the online car-hailing travel solution, the reconnaissance platform and strike platform can be digitized and connected to the "intelligent command brain" combat cloud. The cloud command center calculates the weapon load, ammunition quantity and damage effectiveness of each combat platform based on its location, status and other information, and uses intelligent dispatching algorithms to quickly allocate combat resources, implement the optimal matching of "target-firepower", and achieve the optimal strategic strike against the target.

**Crowdsourcing applications, innovative forms of digital people's war**

In the Internet business model, crowdsourcing, as an innovative decentralized problem-solving method, refers to a work model in which an organization or institution outsources tasks that were previously performed by employees to non-specific volunteers on a voluntary basis. The concept of crowdsourcing is to use the Internet as a medium to utilize the collective wisdom, skills and contributions of a large number of people in society to solve problems and complete tasks. A typical crowdsourcing application is Wikipedia, which has become one of the world's largest and most comprehensive online knowledge encyclopedias by relying on the collaborative input, addition, modification and organization of netizens around the world.

The crowdsourcing model has a natural advantage in collecting war intelligence. With the help of modern information technology, the public can widely participate in collaborative intelligence operations. In the latest local war practice, the warring parties have developed and applied military intelligence crowdsourcing applications, through which the public can report to the intelligence center in real time the targets, positions, command post locations, marching routes and other information they have discovered. Crowdsourcing has creatively realized the universal collaborative intelligence model in the Internet era in the digital space. Not only that, crowdsourcing can also play an important role in the defense of air targets such as cruise missiles and drones. Cruise missiles and drones usually fly at low altitudes and low speeds. Although they can avoid military radar monitoring, ordinary people can observe them with their naked eyes. Once the public finds such targets, they can report their location and rough heading through customized mobile phone applications. The air defense forces can calculate and draw their tracks based on the target information provided by all the people, and deploy weapons in advance to shoot them down in time.

Looking back at the present and looking forward to the future, digital technology is and will continue to influence and change the form of warfare. How to learn from, absorb, and integrate the continuously developing advanced digital technology means, innovatively introduce the cutting-edge scientific thinking of "digitalization + intelligence", create high-level and high-dimensional digital warfare methods, and seize the initiative in the next digital war will become a continuous and critical challenge for promoting national defense and military modernization in the future.

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