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SPACE TECHNOLOGIES AND THE WAR IN IRAQ

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Abstract

The paper presents a description of the application of aerospace technologies during the war in Iraq. The specific instrumentation used by the USA and its allies in the field of communication, navigation, and control of weapons and ammunition to schedule war activities is presented. Conclusions are made on the ever growing application of space technologies in modern wars and their impact on the efficiency of decision-making at war times.

State- or private-owned space instrumentation provided coalition troops in Iraq with data of unprecedented scale and quality, required to control military activities at all levels.

This armada of space instrumentation comprises navigation, communication, and meteorological satellites, as well as satellites for remote sensing of the Earth from space (Fig.1) [1].

Navigational provision during the war was supplied by the global navigation system, *Navstar* GPS, owned by the space leadership of the USA Military Air Force. It uses 28 satellites to provide all types of troops with precise data about the objects' location and speed of movement, and time.

The system works steadily, owing to the continuously maintained number of satellites within the group and the continuous replacement of the GPS2A satellites for satellites of the GPS2B and GPS2F type, belonging accordingly to the third and fourth satellite generation, and featuring greater fidelity, precision, and mobility. A typical characteristic of theirs is their nuclear explosion operative identification system, furnished with optical devices and registration sensors for X-ray and electromagnetic emissions.

The major advantages of the *Navstar* GPS, providing for its wide implementation during the Iraqi military operation, are the following: high on-line identification precision of user's 3D coordinates and velocity vector;

global operation zone; independence of GPS precision characteristics on time, weather, or flight height (Fig.2); unlimited system admissibility and user on-board equipment screening during operation; high protection level against jamming and relatively low number of system receivers; multi-purposefulness providing to solve not only navigational, but a large class of other military problems as well.

The *Navstar* signals are captured by the receivers of both mobile and stationary control instrumentation, thus enhancing greatly military decision-taking and implementation processes for various-levelled staff and even for soldiers.

Moreover, the signals obtained by the GPS system are used to control high-precision weapons, including controlled ammunition and rockets (Fig. 1). By comparing the trajectory parameters assigned to them with current on-line parameters, control signals are formed, which jointly with the signals from the correlation system, comparing preset surface and relief images with the area's thermal map, provide to hit the targets with great precision.

The coalition troops used a remarkably great number of images of Iraqi territory and battlefield. To this end, as a rule, private companies (IKONOS, SPOT, QUICKBIRD etc.) are widely used.

Depending on the troops' needs, image taking is scheduled and the ordered images are obtained, which are then processed by dedicated software and submitted for use.

The *Ikonos* satellite flies along a solar-synchronous orbit, providing images featuring resolution of 4 meters for the coloured ones and 1 meter for the black-and-white ones, whereas the *Spot* satellite features a couple of operating spectral ranges, providing spectral-range images, as well as an infrared channel.

These satellites feature a smaller resolution than military space reconnaissance satellites, but provide to form stereo-images. Based on experience from previous wars, this type of satellites is used to plan war activities, inclusive of dealing blows on some particular objects.

Spot's advantage is that it is furnished with standard on-line data transmission equipment, which relieves data access for military users.

Quick Bird provides images featuring resolution of 0.5-1.25 м within the panchromatic range and 2-5 m within the multi-spectral range – 4 ranges within the visible and infrared range. The georeference error of the obtained images following special ground-based processing constitutes no more than 15 m (3σ).

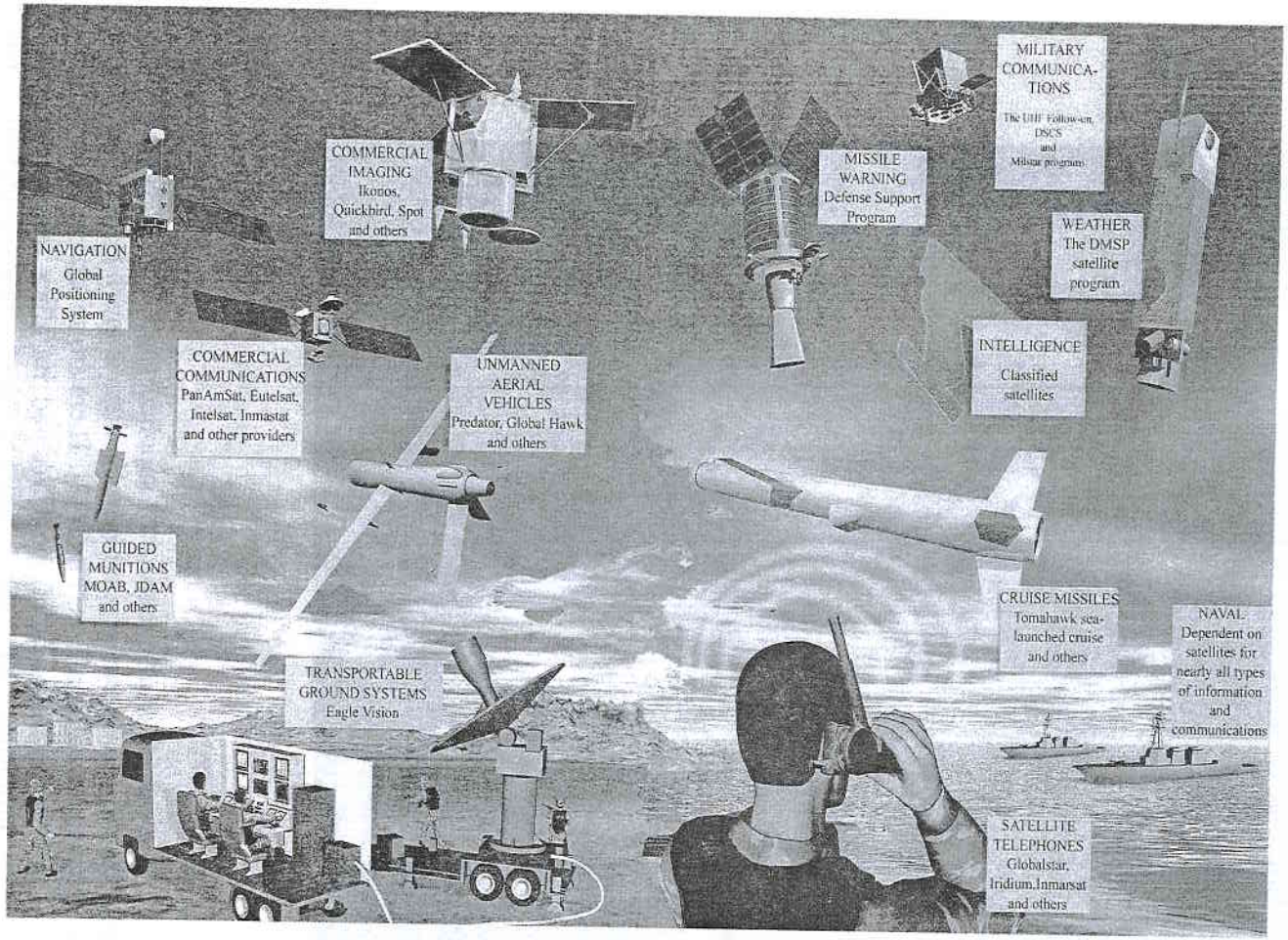
MILITARY COMMUNICA-TIONS
The UHF Follow-on, DSCS and Milstar programs
COMMERCIAL IMAGING
Ikonos, Quickbird, Spot and others
MISSILE WARNING
Defense Support Program
NAVIGATION
Global Positioning System
WEATHER
The DMSP satellite program
COMMERCIAL COMMUNICATIONS
PanAmSat, Eutelsat, Intelsat, Inmastat and other providers
UNMANNED AERIAL VEHICLES
Predator, Global Hawk and others
INTELLIGENCE
Classified satellites
GUIDED MUNITIONS
MOAB, JDAM and others
CRUISE MISSILES
Tomahawk sea-launched cruise and others
NAVAL
Dependent on satellites for nearly all types of information and communications
TRANSPORTABLE GROUND SYSTEMS
Eagle Vision
SATELLITE TELEPHONES
Globalstar, Iridium,Inmarsat and others

Fig. 1

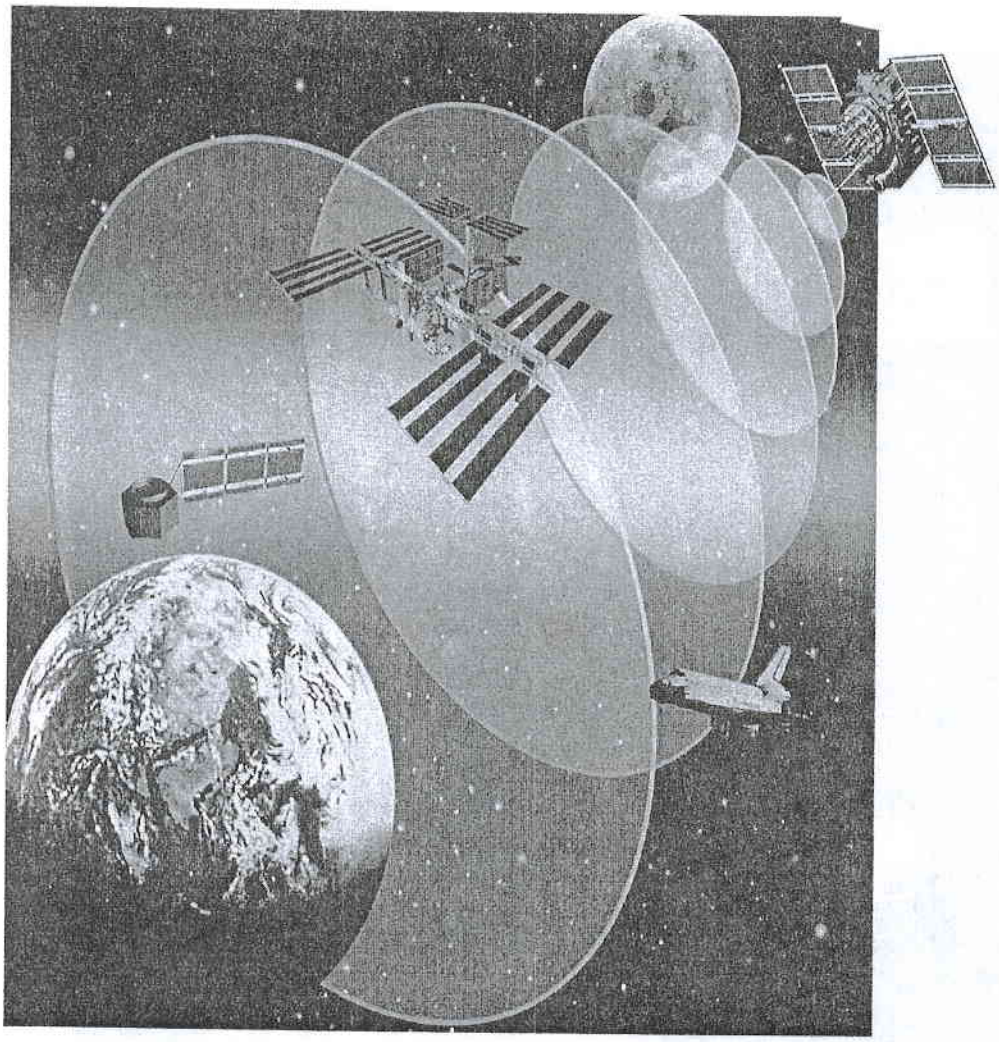

Fig.2

The quantity and intensity of supplied space data (reconnaissance or other) to the appropriate ground-based centers is much greater than it was with all previous war conflicts (Fig.3) [2]. There are several reasons for this:

- the requirement of the USA and its allies for overall space provision of the high-precision instrumentation and ammunition;

- the requirement to provide for harmonization of the actions of the various forces and institutions of the coalition partners, located at great distance from each other.

Since the time the USA and their allies dealt their first blows, major importance has been attributed to the USA military optical-electronic reconnaissance satellites, *KN-11*, and radio-location reconnaissance satellites, *Lacrosse*.

The *KN-11* (***H*=300÷1000 km; *T* = 97,5 min**) satellites perform survey or detailed optical-electronic reconnaissance. Survey optical-electronic reconnaissance is accomplished within **a band of 1250÷2500 km** with resolution of a couple of meters, and detailed optical-electronic reconnaissance is accomplished for some specific regions sized **2,8x2,8 km** at nadir and **8,2x23,3 km** along the band's edges with resolution of up to **15 cm**. This type of satellites provides digital images of the area both within the visible and the infrared range, the latter being successfully used to monitor various objects at night. The obtained images are then transmitted on-line from the on-board equipment via retranslating satellites to ground-based centers where they are processed.

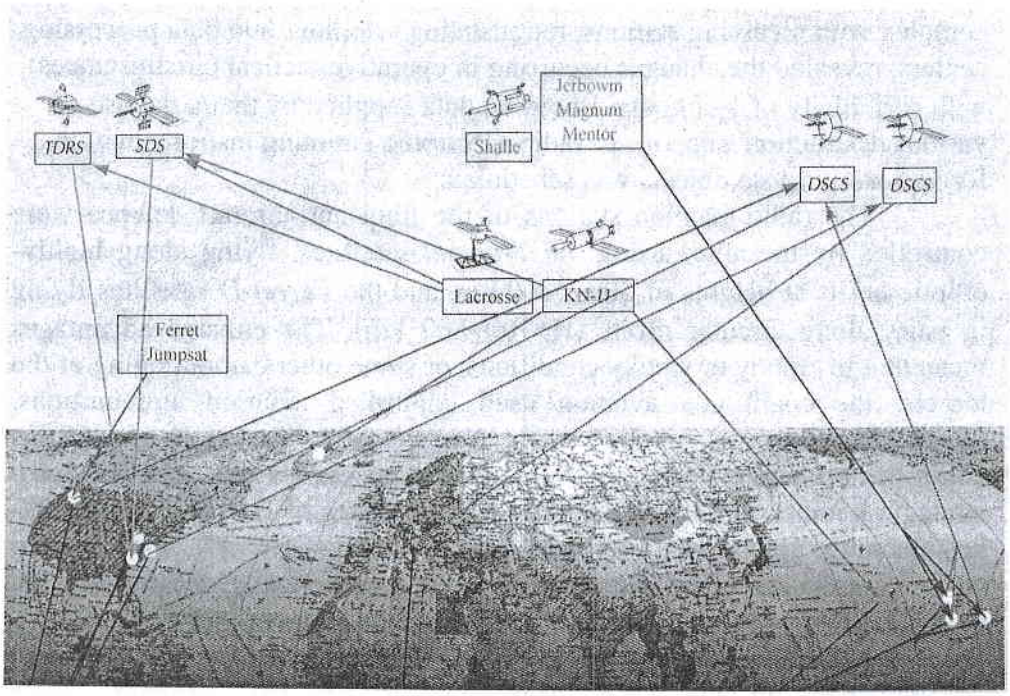

Fig. 3

The *Lacrosse* (***H* = 660÷700 km; *T* = 98 min**) satellite performs radio-location reconnaissance using an on-board **RLS with synthesized aperture**, providing to monitor various objects at night or in cloudy weather with great resolution (**0,6–3 m**), comparable to the resolution of the optical-electronic equipment. With **viewing** band width of **1000 km,** the **range** width is **20-40 km**. Using this satellite makes it possible to identify under various conditions armoured tanks or cars, artillery weapons, parked airplanes, anti-aircraft rocket complexes, and camouflaged, but radio-location-contrast targets, inclusive of targets located under camouflage networks. The obtained images are transmitted nearly on-line via a **TDRS retranslating satellite** to a ground-based centre to identify the targets for the USA airplanes, the **Tomahawk** and **Cruise** flying rockets.

Alongside with optical-electronic and radio-location reconnaissance, the USA are using on a wide scale satellites intended for radio-technical and radio reconnaissance, designed under the **Magnum, Orion, Ferret-D, Trumpet, and Vortex** programs. They are flying along various earth orbits, inclusive of geostationary ones, and account for about 80% of the USA reconnaissance satellites. During the war conflict, these satellites, in complex with receiving stations, retranslating satellites, and data processing centers, revealed the changes occurring in operative-tactical circumstances with periodicity of 1–2 hours. Based on data supplied by them, the use of various destruction weapons or radio-electronic jamming instrumentation for various-purpose objects was scheduled.

The radio-location stations of the Iraqi anti-aircraft defence were controlled by the allies using the *Trumpet* satellites, flying along highly-elliptic orbits at heights of 500–3900 km, and the *Ferret-D* satellites flying in pairs along circular orbits (H=700÷800 km). The enlisted advantages mean that in cloudy or smoky conditions, or some other camouflaging of the targets, the coalition's aviation used controlled aviation ammunitions, whose correction was supplied by the *Navstar* GPS. The major user of this controlled armament during the Iraqi military operations was the *B-2A Spirit* strategic bomber. It delivers successfully 16 pieces of IDAM cassette 907-kg planning aviobombs (versions GBU-29 and GBU-30) with inertial control system and GPS correction. These bombs were also delivered by the B-52N bombers. The target-hitting precision was of the order of 10–15 m.

A similar system complex featuring the same precision was accomplished by the USA deck fighters **F/A-18C Hornet**, using experimental specimen of the controlled aviation bomb cassettes Δ GM-154.

The global *Navstar* GPS provided for flight control of the sea-based **Tomahawk** flying rockets and the **Cruise** rockets delivered by the B-52N strategic bombers, whereas the deviation from the scheduled targets lied also within the range of 10–15 m.

It should be noted that the targeting systems of the strategic bombers **B-1B** and **B-52N** are supplied with built-in GPS-receivers, which makes it possible to deliver effectively 227-kg or 454-kg frec-falling bombs onto area targets.

The strategic-, operative- and tactic-level control of the USA forces and missiles during the Iraqi operation was provided for by communication satellites. The various users obtain data from the **DSCS** system, from retranslating satellites with various destination and functional relations with other satellite systems, as well as from the **Skynet** (Great Britain) and **UFO** (USA) satellites.

The optic-electronic reconnaissance satellites, obtaining images from the visible and the infrared spectrum, have monitored targets with plausible physical characteristics, which were further scheduled to be hit by rocket or aviation equipment.

Using the USA early-warning system satellites, **DSP,** data about the start of the Iraqi **Scud** operative-tactical rockets was collected providing for their destroyal by the **Patriot anti-aircraft rocket complex**.

The changing atmospheric conditions forced into using a substantial number of meteorological satellites during the operation. They (military earth satellites **Block-5D2** of the **DMSP** system, meteorological satellites **"NOAA"** (Fig.4) and **Meteosat)** provided data about the status and change of synoptic circumstances in the region of military activities

with periodicity of 1 hour. Judging the data about cloud cover provided by the *Block-5D2* satellites, it was decided which satellites fit best for optical-electronic reconnaissance (military or civil).

Summarizing the foregoing, it could be concluded:

1. Space systems and reconnaissance, navigation, communication, and meteorological provision instrumentation are essential to providing information superiority in modern military conflicts.

2. The *Navstar* GPS ensures great accuracy of navigation, carrier and destroying instrumentation's launch, if the latter are provided with adequate receiving-indicating equipment.

The system's operation for the needs of aviation and flying rockets does not depend on meteorological conditions, daytime, relief characteristics, or

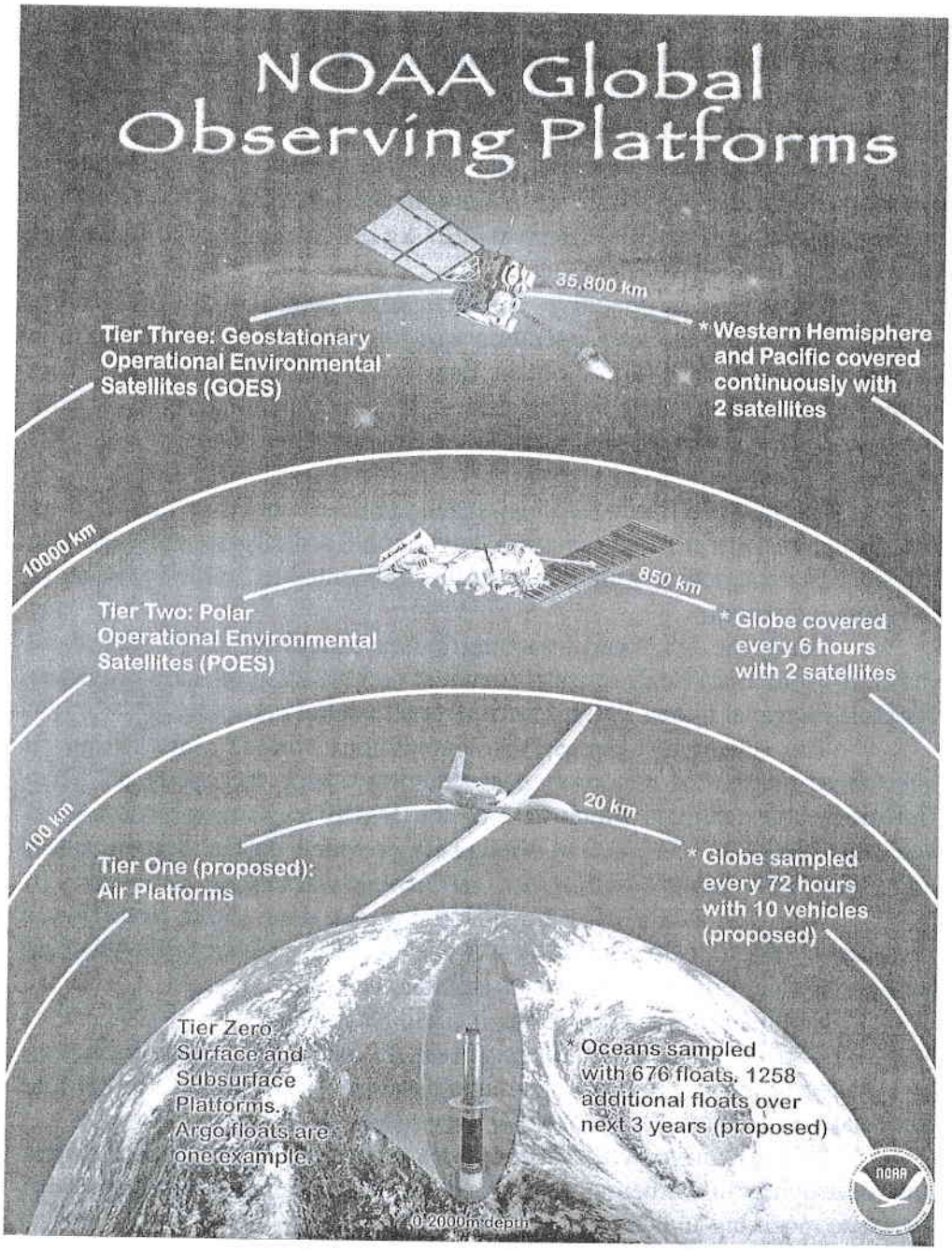
NOAA Global Observing Platforms
35,800 km
Tier Three: Geostationary Operational Environmental Satellites (GOES)
* Western Hemisphere and Pacific covered continuously with 2 satellites
10000 km
850 km
Tier Two: Polar Operational Environmental Satellites (POES)
* Globe covered every 6 hours with 2 satellites
100 km
20 km
Tier One (proposed): Air Platforms
* Globe sampled every 72 hours with 10 vehicles (proposed)
Tier Zero: Surface and Subsurface Platforms. Argo floats are one example
* Oceans sampled with 676 floats. 1258 additional floats over next 3 years (proposed)
0-2000m depth
NOAA

Fig. 4

flight height. It should be noted down, however, that during the last war in Iraq, certain cases of GPS signals' disturbance and substantial deviations of the controlled objects were observed, which calls for design of supplementing protection.

3. The armies of the countries, which do not have their own space systems or instrumentation and do not use these to provide for war activities, are lagging dramatically behind and have no chances with possible military conflicts.

4. The analysis of the space instrumentation used by the NATO and USA troops during the wars in the Persian Gulf, the Republic of Yugoslavia, and Afghanistan evidence of a persisting tendency for introduction of space reconnaissance, intercommunication, navigation and rescue instrumentation to provide for the troops' military actions, reaching as far as the technical level. It reveals the potentials of using strategic reconnaissance instrumentation at the tactical level in the conditions of local conflicts, which complies with the requirements for provision of the national security of each individual country.

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АЕРОКОСМИЧЕСКИ ТЕХНОЛОГИИ ВЪВ ВОЙНАТА В ИРАК

Резюме

Петър Гецов

В статията се разглежда приложението на аерокосмическите технологии във войната в Ирак. Показани са конкретните средства, които САЩ и коалицията използват в областта на комуникацията, навигацията и управлението на оръжията и хората при воденето на военните действия. Направени са изводи за все по-широкото приложение на аерокосмическите технологии в съвременните войни и за тяхното влияние върху ефективността при вземането на военните решения.