The software systems for managing dissimilar unmanned aerial vehicle groupings and its quality

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Abstract: Development and creation of software systems for managing groupings of unmanned aerial vehicles today is a promising and rapidly developing area of the modern software industry of high-tech aerospace instrumentation. To date, a single well-established and scientifically-based understanding of the canonical architectonics of such software systems has not been developed. The paper shows that in software systems for managing unmanned aerial vehicle groupings, as in real-time software and information systems, a different information processing organization scheme is required, different in the implemented sequence of analysis procedures for input but unsystematic digital data. A conglomerate of knowledge-intensive software technologies for processing data and knowledge, integrated into specific implementations of software systems for managing unmanned aircraft groupings, is unstable and difficult to combine, which is the main threat to ensuring the high quality of such software systems.

1. Introduction
Initially, the sharing of disparate unmanned aerial vehicles was implemented through the parallel deployment of two or more unmanned aircraft complexes in the area of operation and coordination of organizational procedures for the operation of the control operators of unmanned aerial vehicles. With the development and improvement of hardware and software controls in unmanned aircraft complexes, the corresponding organizational procedures became obviously not effective. It is because of this that the processes of goal setting, planning joint use, coordination of dissimilar unmanned aerial vehicles in time and geographic space are implemented using specialized software for managing groups of dissimilar unmanned aerial vehicles as part of software and hardware systems. But more often, software systems for controlling groups of unmanned aerial vehicles are software “add-ons” over software (software and hardware) complexes for direct control of unmanned aerial vehicles.

2. Architecture of software systems for controlling unmanned aerial vehicles
Software systems for controlling unmanned aerial vehicles, which are an integral part of the ground control system for unmanned aerial systems, implement the functionality of direct dispatch and target direction of each respective drone. In essence, software systems for controlling unmanned aerial vehicles act as a lower-level link in the organization of control of an aviation robotic group, and software systems for controlling groups of unmanned aerial vehicles - more high-level. The specific implementation of unmanned aircraft control software systems depends not only on the level of development, generation, class and type of unmanned aerial vehicles robotized, but also on the level of robotization of the carrier,
the specific distribution of functionality between the software and hardware elements, etc. A number of papers [1, 2] formulated a generalizing approach to the representation of the canonical software architecture of the modern unmanned aircraft control system with robotization elements, on the basis of which the software architecture for these complexes is presented within this work. In schematic form, it is shown in figure 1. In turn, the development and creation of software systems for managing groups of unmanned aerial vehicles is today a promising and rapidly developing area of the modern software industry of high-tech aerospace instrumentation. By virtue of this fact, today there is no a single, well-established and scientifically-based understanding of the canonical architectonics of such software systems.

Software server

The program component of the construction and maintenance of the flight task

Calculated functions
Management procedures
Callable Function
Internal IP interface

Software component of integration and preparation of data for display

Object information
Cartographic information
Target
Metric Information

Aerodynamic correction software component

Program component of geodetic correction

Thick mapping client

Display utilities
Video stream handlers
Interactivity Modules

Ultra-Thin Display Client - Unmanned Aerial Operator User Interface

**Figure 1.** Architecture of software systems for controlling unmanned aerial vehicles in generalized form.

Software systems for controlling unmanned aerial vehicle groupings have an unprecedented level of software and technological complexity due to the fact that they have to process heterogeneous data streams generated by downstream aircraft control systems, compile them and present them to the operator implementing the goals of the entire aviation robotic group in the current operation. The inverse problem is no less complicated. Solved using software systems for managing unmanned aerial vehicle groups — developing and delivering a balanced plan for the consistent and effective use of tools (unmanned aerial vehicles and payload they carry) to achieve the goals of the current operation. This complexity is pragmatically manifested in the fact that within the framework of specific models of
unmanned aircraft group control systems, the most high-tech modern information technologies are
implemented in their combination: geo-information technologies for working with cartographic spatial
data, methods for adaptive processing of heterogeneous information, information and
telecommunication technologies for supporting remote access and cloudy computing, intelligent
processing of streaming data network learning and pattern recognition, ontologies of subject areas, etc.
At the same time, these software technologies are not integrated into software systems for managing
unmanned aircraft groupings, but are systematically integrated, resulting in a new quality of processing
flight and navigation information, and as a result, new level in decision-making to control the grouping
of unmanned aerial vehicles. Integration of the above information technologies in the framework of
unmanned aircraft grouping control software systems is not an end in itself, but is brought to life by the
need to implement the basic information technology of streaming processing in these software systems,
to which all other private technologies are already “strung”.

3. Information processing in software management complexes of groups of unmanned aerial
vehicles
The task of introducing stream processing methodology into the software systems under consideration
is caused by the need to ensure the real time scale of information processing in the automated control
system of unmanned aerial vehicles with objectively limited computing resources of the hardware
platform and high volatility of information load parameters of input data channels. To solve this
problem, the developer of any modern unmanned aircraft group management software must overcome
a fundamental problem that manifests itself in any information system with geometric growth of input
digital information, namely, initially digital input data is accumulated in the corresponding database of
the specified information (software-information) system, and then they are only processed to extract the
essential for the management process Nia applicable to support management decisions. This problem
fully applies to software systems for managing unmanned aircraft groupings, and given the need to
ensure the mobility of unmanned aircraft systems (software and hardware systems for controlling
unmanned aircraft groups) is even more important than in other classes of software and information
systems. In other words, with the traditional organization of information processing in the software
systems of spatial management, both the data content itself and the digital noise accompanying it are
recorded in the working memory of the system. Obviously, for the restrictive conditions of the
functioning of software systems for managing groups of unmanned aerial vehicles, the indicated digital
noise should be isolated and removed.

But the logical contradiction of the traditional organization of information processing is that the
indicated detection of digital noise is carried out based on the analysis of all data, which follows the
fixation of the specified data in memory. This means that in software systems for managing unmanned
aerial vehicle groups, as in real-time software and information systems, a different information
processing organization scheme is required, different in the implemented sequence of analysis
procedures for input (primarily digitized) but unsystematic digital data. The essence of the promising
information processing organization implemented today in modern and designed software systems for
managing unmanned aircraft groupings is as follows: initially implement the identification of the
essential content management for data against the background of digital noise, and only then analyze
the useful content to substantiate the management decision.

The constructive perspective of the organization of information processing implemented today in
modern and designed software systems for managing groups of unmanned aerial vehicles is the absence
of the need for previous accumulation in the system’s memory of the entire volume of input digital data
produced by heterogeneous information sources. In this case, the identification of the essential for the
management of data content on the background of digital noise is carried out before memorizing the
specified fact. Essentially, the implementation of streaming processing methodology in the considered
software systems changes the digital data processing scheme from a variety of heterogeneous sources
with the conditional formula: <memorization - processing>, into the formula: <processing -
memorization> [3-5]. The result of this implementation is the emergence of a real opportunity to ensure
high efficiency in the management of a group of unmanned aerial vehicles, and, with costs, an increase in the complexity of information and telecommunication technologies (their complex combinations) to implement such functionality. Graphically, the essence of the organization of stream processing of information implemented in software systems for managing groups of unmanned aerial vehicles is shown in figure 2.

Figure 2. Scheme of stream processing of information in software management complexes of groups of unmanned aerial vehicles.

With regard to the organization of streaming information processing implemented in software systems for managing unmanned aircraft groupings, it is clearly seen that the higher the percentage of digital noise dropped in the input data, the less essential for managing data should be stored in the system’s memory the totality of the input data, and accordingly, the smaller the total amount of stored operatively variable data. Because in the framework of unmanned aircraft complexes and related information systems, the majority of digital data sources provide them in real time during the flight of unmanned aerial vehicles, the indicated detection of digital noise should be carried out in the same real time, i.e. infotelecommunication basic technology of stream processing, reducing the requirements for the amount of stored data in computer memory, overestimates the performance requirements of the software system, hardware and computing platform. This is how the strategic (in terms of technology) direction of basic development of software systems for managing groups of unmanned aerial vehicles, their comprehensive improvement and improvement of fundamental capabilities is determined.

4. Conclusion
Thus, the complexity of developing and building software systems objectively arises from the specifics of their intended purpose, which sets the requirements for highly efficient support of group control operators decisions to generalize the software and technological options for implementing software systems for managing unmanned aircraft groupings, combined with limitations on the provision of hardware and software computing resources platforms. The basic nature of streaming information processing technology for integrating the capabilities of all other information processing methods significantly complicates the process of developing software systems for managing unmanned aircraft groupings, which also drastically burdens the process of monitoring and ensuring their quality. It is obvious that the conglomerate of high-tech software technologies for processing data and knowledge,
integrated into specific implementations of software systems for managing unmanned aircraft groupings, is difficult to combine and unstable. This is the main threat to ensure the high quality of such software systems.

At the same time, the existing set of modern methods, methodological tools and corresponding applied methods of software quality management for aviation instrumentation, focused on the formation of an accurate and inclusive conclusion about the current quality level of unmanned aerial vehicle control systems, generally allows the formation and monitoring the quality of these complexes. However, modern methodological schools of applied software qualimetry are traditionally aimed at supporting the quality management processes of creating software systems focused on the above described scheme of traditional information processing organization, i.e. they are not focused on the specifics of stream processing.

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