What can, what could, what should…
…simulation supporting delivery of enhanced effectiveness of JFS training in a live environment.

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ABSTRACT

In an in-depth exploration of modern military training, the research delineates the advancement of simulation and debriefing software integral to NATO exercises and the German armed forces' Joint Terminal Attack Controller (JTAC) training. Utilizing precision-based modeling, the software enhances the fidelity of indirect fire simulations involving modern weaponry and environmental contexts, primarily in air-to-air combat scenarios. The study reveals an untapped potential in Joint Fire Support (JFS) training missions, including air-to-ground and ground-to-ground interactions, emphasizing the necessity for live, virtual, constructive (LVC) environments for genuine, efficient training experiences. It further elucidates the software's critical role in enriching debriefing sessions, facilitating comprehensive performance assessments, and improving operational readiness and training efficiency. This encompasses capabilities for handling diverse Tactical Data Links (TDLs) and integration of emerging protocols. The paper underscores the economic and strategic advantages of LVC environments, providing case studies that validate the approach. It also calls for collaborative efforts to accelerate the Technology Readiness Level (TRL), advocating a concerted movement towards a new era of technologically sophisticated, internationally standardized military training.

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What can, what could, what should… …simulation supporting delivery of enhanced effectiveness of JFS training in a live environment? Advancements in Indirect Fire Simulation with Modern Weapon Systems: Leveraging Live Virtual Constructive Environments for Enhanced Military Training

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In a current research & technology assignment the potential of an advanced simulations and debriefing software is being investigated, derived from an integral component of numerous NATO exercises (Air Defender, TREX…) and the Joint Terminal Attack Controller (JTAC) training provided to the German armed forces. The software, characterized by its precision-based modeling of weaponry and environmental contexts, provides a heightened fidelity in indirect fire simulations involving modern weapon systems. Its largest and, at the moment, sole use in military training takes place in air-to-air combat training. While enhancing the potential in this field, the software in Joint Fire Support (JFS) training missions, such as air-to-ground training, ground-to-ground training, and the combination of both is currently not used to its full potential. The exploration focuses on the software's ability to accurately depict a variety of weapon systems and the inherent complexities in indirect fire situations with all environmental aspects accounted for.

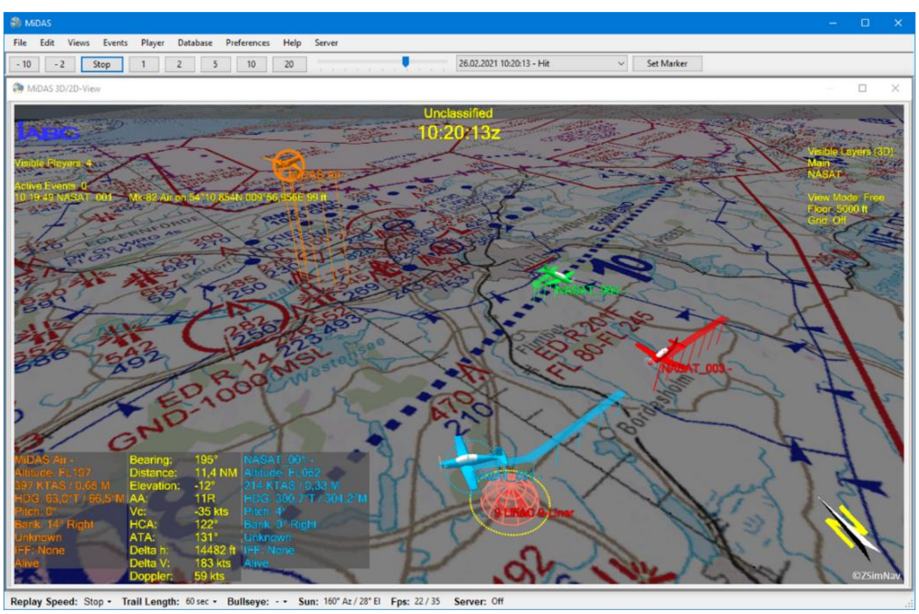

Figure 1: Screenshot MiDAS simulated employment of MK-82 airburst

The research also highlights the pivotal role of the software in fabricating live, virtual, constructive environments, a necessity for engendering authentic, efficient training experiences. This parallels its proven effectiveness in JTAC training and extends its application to the realm of Joint Fires. The software's capability in enriching debriefing sessions, facilitating comprehensive performance reviews, and thereby streamlining training optimization is also elaborated, leveraging its practical application and the proven track record with the German armed forces to underline the improvement in operational readiness and training efficiency. By enabling multiple players to be visualized, both air-based and ground-based, you enhance situational awareness of the trained military personnel while debriefing. Thus, debriefing is brought to a significantly more detailed level and the invested time in military training is used more efficiently.The following possible items can be visualized: the flight path of the aircraft (Figure 1), deconfliction of all players (Figure 3) (vertical, lateral, and temporal), the weapon delivery trajectory (Figure 2) from point of origin to point of impact and the dome of a weapons effect (Figure 1 and Figure 2).

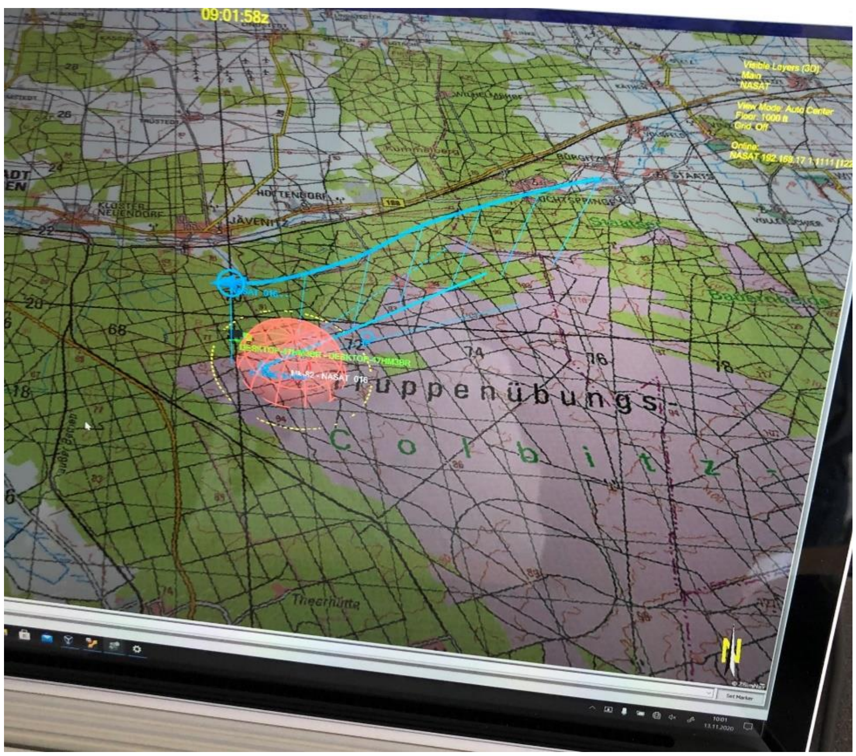

Figure 2: Weapon delivery trajectory (blue arrow)

The advantages of Live Virtual Constructive environments, such as cost-effectiveness, adaptability, and scalability, are discussed in the context of JFS training. A significant decrease in costs is possible by implementing LVC environment.

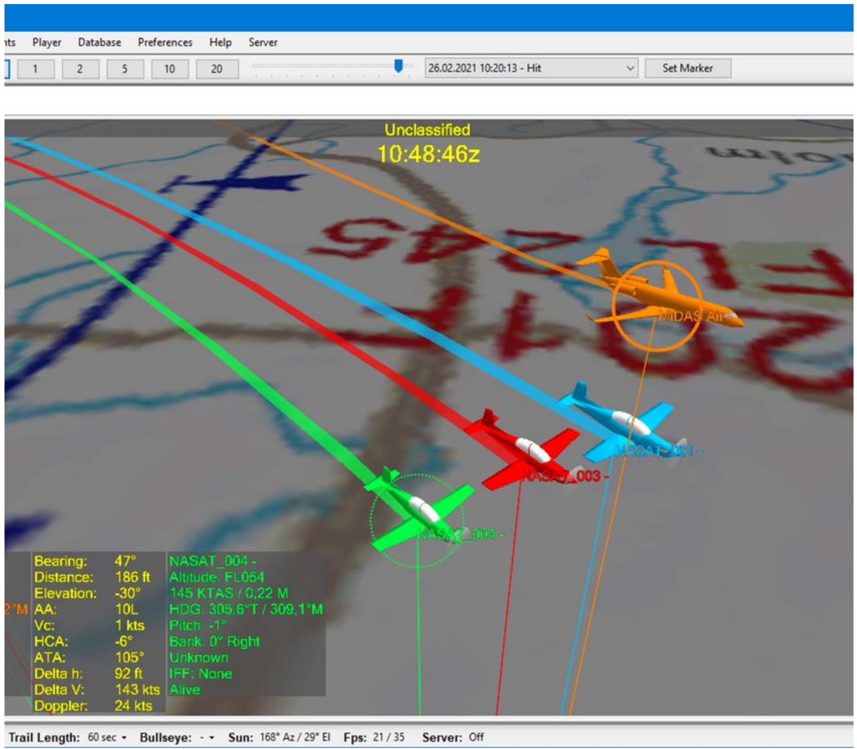

Figure 3: Visualization of deconfliction of multiple A/C

Furthermore, the paper examines case studies of military organizations that have successfully incorporated LVC-based Joint Fires simulations into their training. These case studies underscore the effectiveness of this approach in enhancing decision-making, strategic planning, and tactical execution in simulated Joint Fires scenarios.
Additional elements and features are:

- The ability to handle several TDLs like Link16, (SIMPLE, JREAP-C), Asterix, CESMO, and Protocols like NMEA and potentially VMF, which is giving the opportunity for…
- …the integration of upcoming procedures like DaCAS

The research and development highlight the need for accelerating the Technology Readiness Level (TRL) of this software to fully harness its potential. The imperative role of community contributions is underscored for outlining the requirements necessary to attain this escalated TRL, keeping in mind the multifarious needs and prerequisites of all stakeholders. It is foreseen to be a collaborative effort, blending the expertise, cognizance, and perspectives of diverse participants to materialize a more evolved, potent tool.

The following paragraph will examine the need and integration of Digitally aided Close Air Support (DaCAS) as a necessary implementation in LVC-based training experience.
DaCas is a Variable-Message-Format(VMF)-based digital data transmission and messaging technique to ensure reliable close air support (CAS) missions. Previously, target designation was only possible by the means of radio voice

communication. DaCAS ensures target designation and correct engagement. Based on the principle 'Train as you fight', the IABG Close Air Support Live Simulation & Training System (IABG CAS-LSTS) offers an additional DaCAS enhancement (Figure 5). This system enables Joint Terminal Attack Controllers (JTAC) and Instructors to fulfil their live training requirements. This system implements the VMF capability for the Contractor-Owned Contractor-Operated (COCO) civil aerial targeting services (ATS).

The integration of VMF messages in DaCAS has revolutionized the traditional methods of target designation and engagement in CAS operations. Previously, target designation relied heavily on radio voice communication, which was susceptible to errors, delays, and misinterpretations. DaCAS, with its VMF messaging capability, enables the transmission of target designation data in digital form between the JTAC and the aircraft, significantly reducing the risk of errors and time delays.

One of the key advantages of VMF messages in DaCAS is the accuracy and speed it brings to target engagement. By digitally transmitting target designation data, including Designated Ground Target (DGT) and Sensor Point of Interest (SPI) data, DaCAS ensures precise and correct engagement, aligning with the principle of 'Train as you fight'. This digital communication also allows for real-time updates and adjustments, improving situational awareness and operational responsiveness. Figure 4 displays the featured transmissions between the JTAC and the attacking aircraft. All displayed transmissions have been committed via voice communication. Blue lines show the transmissions still committed via voice communication while the red lines display the VMF Message / K-Messages. Thus, the time decrease is displayed.

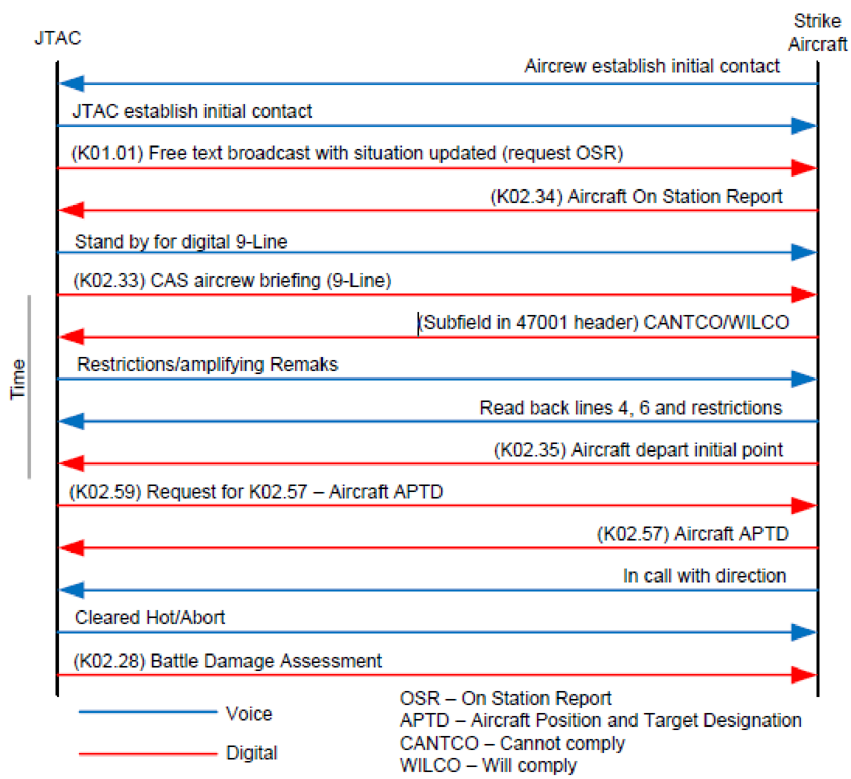

Figure 4: DaCAS Thread Source: AERONIX 2021

Furthermore, DaCAS enhances interoperability among different military platforms and forces. VMF messages are standardized communication protocols that can be implemented across various aircraft types and JTAC systems, facilitating seamless coordination and collaboration in joint and multinational operations. This interoperability is crucial for enhancing joint fire capabilities and maximizing the effectiveness of combined arms operations.
The implementation of DaCAS with VMF-messages extends beyond just CAS missions. It encompasses a range of capabilities, including digital acquisition of target data, real-time mission monitoring, and integration with advanced simulation and training systems. The use of VMF-messages in DaCAS is not only limited to live operations but also extends to simulation-based training, ensuring that operators are well-trained and proficient in utilizing digital communication technologies for CAS missions.
In conclusion, the adoption of DaCAS and the use of VMF messages represent a paradigm shift in modern military operations. By leveraging digital communication technologies, DaCAS enhances the precision, speed, and effectiveness of CAS missions, while also fostering interoperability and enhancing training capabilities across military forces. As technology continues to evolve, DaCAS with VMF messages will remain a cornerstone of advanced close air support capabilities, contributing to mission success and operational superiority on the battlefield.

The target acquisition procedure, in the context of CAS, is a complex sequence of operating steps carried out by the pilot and the JTAC via visual means and manual input of data. The Navigation-based System for Aerial Targeting (NASAT) supplied by the ATS supports this. However, this procedure is susceptible to several possible errors, which can lead to inaccuracies and time delays.

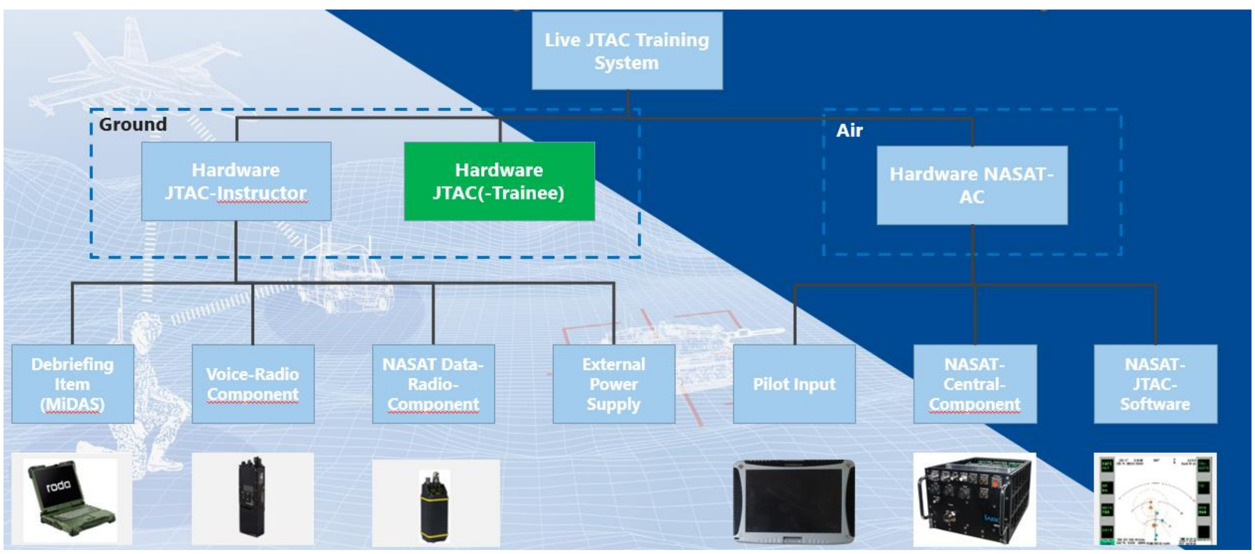

Figure 5: JTAC Training components

The armed forces from different nations with different training structures, whose first language is often not English, must ensure coherent voice communications. To ensure the required level of precision and success both a great deal of training and experience are essential. The DaCAS procedure provides digital messagebased communication between the JTAC and the aircraft. This avoids time delays and inaccuracies in radio voice communications during

Joint Close Air Support operations. Reduced error rate and time delay are a result of the one-time input of the target designation passed directly in digital form by the Aircrew and JTAC. DaCAS also includes the digital acquisition of DGT (Designated GroundTarget) / SPI (Sensor Point of Interest) data.
The NASAT-A / C DaCAS system complements training facilities from initial JTAC training to live simulation of complex battlefield scenarios. Like the existing NASAT-A / C module, NASAT-A / C DaCAS upgrades COCO aircraft used in Combat Training Centres (CTC) and CASEX for live simulation-based training (Figure 5 JTAC Training components).

The US-led Joint Fire Support Executive Steering Committee (JFS ESC), in cooperation with NATO and non-NATO countries, prepared a memorandum for the training of Joint Fire Observers (JFO), who are the interface between pilots and JTACs. It is precisely this interface, which this system supports. The hardware components of the air segment (NASAT-A / C DaCAS) and the DaCAS software installed on the aircraft enable VMF data transmission. These form the Aircrew User Interface (UI). The system consists of a complete package of operating and installation manuals. The High-Level Architecture (HLA) interface embedded in the Mission Display and Analysis System (MiDAS) captures the pertinent VMF DaCAS Tactical Data Radio System (TDRS) content, translates, and enables display and analysis of the mission data within a real time live simulation network. Recording and playback are also possible. The DaCAS extension (plug-in) further enhances the MiDAS software and enables the visual display and analysis of operations. MiDAS is an advanced software application, which provides users with a powerful suite of display and analysis capabilities for joint distributed and test bed simulation as well as live and simulated weapons system operation on multinational exercises.

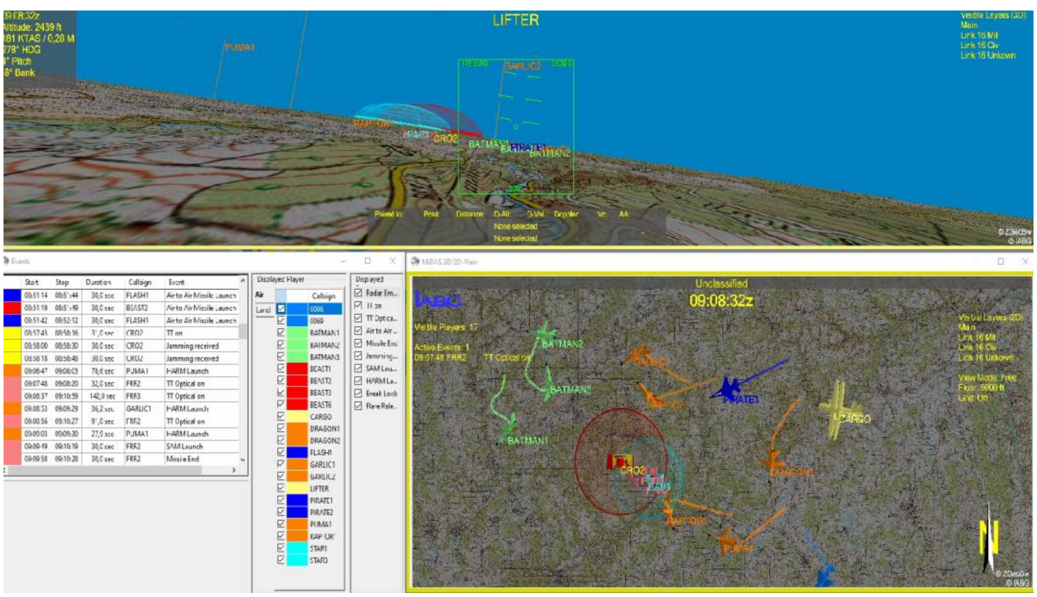

Figure 6: Visualization of real time monitoring in MiDAS

MiDAS enables coherent display of weapon system data to support operational test & evaluation, decision makers, exercise command and aircrew debriefing. The system offers the possibility to display truth and perceived data on simulation networks and as well as the downloaded data from weapons system platforms. The data generated in joint combined exercises and missions is extensive, multilayered and is therefore extremely difficult to structure without the help of advanced software. MiDAS is the solution for today's mission debriefing and analysis (Figure 6). MiDAS provides the software algorithms and interfaces required to realize a common picture. MiDAS runs in live and simulated operation modes on IP-based simulation networks. MiDAS undergoes continual enhancement to provide an optimum tool to fulfil future visualization (Figure 6) and debriefing user needs and system requirements.

MiDAS ingests the various data formats, fuses them, correlates, and displays them in a single comprehensive view. This view uses time as a common reference to differentiate between which datasets are displayed. MiDAS is able to import data from various data sources such as DIS, HLA, EAG, TDMS, SIMPLE (Link-16) and many more. The data can be imported online or via data recordings.
MiDAS allows the user to display and analyze tracks and pairing lines, also enabling users to select an object from the screen and have configurable metadata associated with the object displayed in the corner of the screen (Figure 3). Users can customize how metadata is displayed based on all the data captured via the tactical data link and simulated messages (e.g., call-sign, STN, velocity, altitude, heading). All data is merged and can be displayed in multiple views and screens (Figure 5). In the case of online data capture, real time mission monitoring and control is possible, including Real Time Kill Removal. MiDAS incorporates Built-in Missile Simulation, Weapon Events, Emission Events, Counter Measure Events, Jamming Events and Sensor Data.

Yet this survey examines the usage of fixed wing aircraft used for LVC-based-training purposes. A field that needs more focus on is the use of COCO rotary wing CAS to expand cost-effectiveness in military training.
COCO rotary wing CAS has emerged as a significant paradigm in modern military operations, offering unique advantages and capabilities to enhance mission effectiveness and operational flexibility. The following paragraph delves into the concept of COCO rotary wing CAS, its benefits, challenges, and implications for military forces globally.
COCO rotary wing CAS refers to the procurement and operation of rotary wing aircraft by private contractors to provide close air support services to military forces. These contractors are responsible for owning, maintaining, and operating the aircraft under contractual agreements with military authorities. This model allows military forces to access specialized rotary wing capabilities while leveraging the expertise and resources of private contractors.

Benefits of COCO Rotary Wing CAS:

1. **Specialized Expertise:** Private contractors often have specialized expertise in operating rotary wing aircraft, leading to enhanced operational proficiency and effectiveness in CAS missions.
2. **Flexibility and Rapid Deployment:** COCO arrangements offer flexibility in deploying rotary wing assets to meet operational demands quickly, especially in dynamic and time-sensitive scenarios.

3. **Cost-Effectiveness**: By outsourcing aircraft ownership and maintenance to contractors, military forces can potentially reduce acquisition and operational costs, optimizing resource allocation.
4. **Innovation and Technology Integration:** Contractors often bring innovation and advanced technologies to enhance aircraft performance, mission capabilities, and overall operational efficiency.
5. **Risk Mitigation:** Contractors assume certain risks related to aircraft maintenance, ensuring military forces can focus on core operational tasks without significant logistical burdens.

Challenges and Considerations:

1. **Contract Management:** Effective contract management is crucial to ensure compliance with operational standards, safety protocols, and mission requirements.
2. **Dependency on Contractors:** While COCO arrangements offer benefits, over-reliance on contractors can pose challenges in terms of maintaining operational control and sovereignty.
3. **Security and Confidentiality:** Protecting sensitive information and ensuring operational security are paramount considerations when engaging private contractors in military operations.
4. **Regulatory Compliance:** COCO arrangements must adhere to regulatory frameworks, export control laws, and international agreements governing defense procurement and operations.

Several nations have successfully implemented COCO rotary wing CAS programs to augment their military capabilities. For example, countries like the United States, United Kingdom, and Australia have leveraged COCO arrangements for enhanced operational flexibility, rapid response capabilities, and cost-effective utilization of rotary wing assets in various theaters of operations.

The future of COCO rotary wing CAS is intertwined with advancements in technology, unmanned aerial systems (UAS), and autonomous capabilities. Integrating these technologies into COCO models can further enhance mission effectiveness, reduce operational risks, and expand the scope of rotary wing CAS in diverse operational environments. Contractor Owned Contractor Operated rotary wing close air support represents a dynamic and innovative approach to enhancing military capabilities and operational flexibility. While presenting numerous benefits, COCO arrangements also necessitate careful management, adherence to regulatory frameworks, and strategic planning to maximize their potential and contribute effectively to modern defense strategies.

In conclusion by extending an invitation for open discussions and inviting the community to share their insights, experiences, and innovative ideas to further discuss software capabilities. Such concerted participation will pave the way for a new epoch of technologically sophisticated military training, bolstering preparedness and operational efficiency on an international scale.