Unmanned Aerial Capabilities and their future utility in NATO

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UAV, UAS, UAC, UCS

"The long way from dull, dirty and dangerous to effects-based, task-/mission-tailored, glamorous and glorious."

What are we talking about?

Unmanned Aerospace Capabilities (UAC).
UAC are provided by Unmanned Aerial Vehicles (UAV) and their associated support, control and data exploitation systems.

Uninhabited Aerial Vehicle / Unmanned Aerial Vehicle (UAV).
The NATO Military Committee Air Standardisation Board (MCASB) defines UAV as: "A powered, aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or non-lethal payload. Ballistic or semi-ballistic vehicles, cruise missiles, and artillery projectiles are not considered UAV."

UAV system (UAS).
The UAS includes the air vehicles as platforms, modular mission payloads, data links, launch and recovery equipment, mission planning and control stations, data exploitation stations and logistic support.

UAV Control System (UCS).
UCS describes the functional set charged with control of the UAV and interfacing with Command, Control, Communications, Computers and Intelligence (C4I) systems, the UAV payload and UAV system operators. The UCS Includes all the UAV (platform) control systems and encompasses launch and recovery system.

What are the main differences between "manned" and "unmanned"?

The two main characteristics that separate "manned" from "unmanned" (in the sense of fully automated) aerial systems are:

- The onboard decision-making/controlling/activating entity is either a human being or a computer.

- The system is either non-expendable or its loss can be tolerated.

With respect to operating unmanned aerial systems, the same framework of flight procedures applies, with all currently known and agreed standards, restrictions and limitations. There is no flight-procedural difference between “manned” and “unmanned” flights.

Interoperability makes Utility.

UASs have become valuable assets in helping Joint Force Commanders (JFC) to meet a variety of theatre, operational and tactical objectives. The minimum operational requirement is interference-free compatibility. The optimum synergy among the various national UASs deployed requires close co-ordination and the ability to quickly task available UAS assets, the ability to mutually control the UASs (including their payloads), as well as rapid dissemination of the resultant information at different command echelons. This requires the employed UASs to be more than just compatible, i.e. interoperable, in order to be of any meaningful operational utility for the commanders, particularly in a very fluid/dynamic mixed and non-segregated operational environment.

Currently, many UASs are not fully interoperable, some are not even operationally compatible. Current or “legacy” UAS have been designed and procured nationally and contain system elements that are generally unique and system-specific. They do not have standard interfaces between the system elements. This results in a variety of non-interoperable/non-compatible “stovepipe” systems. Although commonality of hardware and software would be a solution to achieve interoperability and may be desirable from an economic standpoint, commonality is not mandatory for operational purposes. In order to enable interoperability for UAS, the implementation of compatible standards for key system interfaces and functions is required. The respective operational requirements and approved Concept of Operations (CONOPS) will determine or drive the required Level of Interoperability (LOI) that the specific UAS have to achieve.

The following items highlight some of the key challenges for planners and decision-makers in the process of creating the required utility of UAS, UAS, and UAC for military applications.

STANAG 4586.

The objective of STANAG 4586 is to specify the interfaces that shall be implemented in order to achieve the operationally required and feasible LOI according to the respective UAS’s CONOPS as applicable to the specific system and theatre of operations. This will be accomplished through implementing standard interfaces in the UCS to communicate with different UASs and their effector-payloads, as well as with different C4I Systems. The implementation of standard interfaces will also facilitate the integration of components from different sources as well as the interoperability of legacy systems, which is essential for composite network-centric operations.

It is assumed that air safety regulations will require the certification of new combinations of UAS, which result from combining the operation of assets from different UAS. Compliance with STANAG 4586 will ease this process and likely UAS combinations can be certified in advance. On this basis UAS that are compliant with STANAG 4586 will increase NATO Combined/Joint Service flexibility and efficiency to meet mission objectives through the sharing of assets and common utilisation of information generated from UAS.

An UCS Functional Architecture is required to enable, support and facilitate effects-based and network-enabled interoperability among future and legacy UAS within a complex and dynamic operational environment. This architecture establishes the following functional elements and interfaces:

- Core UCS (CUCS)
- Data Link Interface (DLI)
- Command and Control Interface (CCI)
- Vehicle Specific Module (VSM)
- Command and Control Interface Specific Module (CCISM)

Human Computer Interfaces (HCI) should be defined as CUCS capability requirements rather than just as DLI and CCI.

As integral elements in network-centric operations, UAS and C4I Systems should be capable of interoperating across a routed network of multiple sub-networks, in which the UAV is seen as a terminal element (or terminal sub-network) of the whole network. This will allow the physical components of the UAS and C4I Systems to be anywhere on that network.

Assumptions and Constraints.

STANAG 4586 is based upon the following assumptions and constraints:

- Elements and interfaces of the system (CUCS, DLI, CCI, VSM, CCISM) are not required to be co-located.
- Requirements have been developed independent of national CONOPS.
- The STANAG addresses the interface with Airspace Management Authority required to co-ordinate the operation of UASs in a controlled airspace. It does not address or imply the overall requirements and required certifications that may be necessary to operate UASs in controlled/non-segregated airspace.

- Critical real/near real time requirements of UAS and effector-payload control should be allocated to the VSM function.

UAS Elements.

The UAS element consists of the airframe, propulsion and the avionics required for platform- and flight- management/control.

The UAS effector-payload element is comprised of effects-tailored payload packages. These can be sensor systems and associated recording devices that are installed on the AV, or they can consist of stores, e.g. weapon systems, aerial refuelling systems, associated control/feedback mechanisms, etc. The data link element consists of the air data terminal in the UAV and the ground data terminal.

The UAS control is achieved through the UCS and data link elements. The UCS and the associated data link terminal can be located in any platform, e.g. another manned or unmanned ground, airborne or space platform. The UCS element incorporates the functionality to generate, load and execute the UAS mission and to disseminate useable information data products to various C4I systems. The UAS launch and recovery element incorporates the functionality required to launch and recover the UASs. The launch and recovery element is unique to its platform. The UCS accommodates this platform-specific uniqueness via its VSM in conjunction with the certified HCI.

Current UAS are mostly “stove pipe” systems. They utilize unique data links, communication protocols and message formats for communication between UCS and UAS and the UCS and external C4I Systems. As a result, the dissemination of sensor data is mostly via indirect means, e.g. from UCS to a HCI-controlled exploitation system to the end-user. Dynamic joint co-operative operations require dynamic and fluid near real-time tasking/re-tasking and dissemination of reconnaissance data to support the Tactical Commander, which the “stove-pipe” UAV may not support. Network-enabled command and control and assessments are essential for the full exploitation of UASs, particularly at the tactical level of operations.

Tasking.

The most prevalent method of tasking a UAS is by the use of an Air Tasking Order (ATO) which is common to all air missions, manned and unmanned, across multi-national forces and multi-service operations. The ATO is an Allied Data Publication-3 (ADatP-3) message that may be very large and complex, not all of which will be applicable to UAS. There are other ADatP-3 messages that do not form part of an ATO and that may be used to task individual UAS or payloads.

Airspace Control.

Airspace Management (ASM) is the activity of structuring the airspace and controlling its use. In the military ASM-system, the airspace is structured through the specification of procedural and electronic Airspace Control Means (ACM), which define airspace volumes, surfaces and lines, and specific rules for the use of the resulting airspace partitions as well as for positive and selective identification. The ACMs approved for a given period of time are promulgated in the ADatP-3 Airspace Control Order (ACO). The ACO is based upon the air operations and airspace usage requirements of other Air Command and Control Systems (ACCS), non-ACCS tri-service entities, civil requirements and airspace requests, together with constraints imposed on the use of that airspace. The ACO allows the separation and identification of all types of airborne platforms, manned and unmanned, fixed and rotary wing. The ACO defines how a volume of airspace is to be structured for air missions over a given period of time. Routinely, the ACO defines how this division of airspace will be used by different air operations throughout the standard 24-hour ACO cycle. Therefore, for mission planning, a UCS requires the ACO to define the constraints on the route or in the area to be used by the UAS.

Air Traffic Control (ATC).

If a UAS, particularly a long range strategic/global UAS, has to pass through controlled airspace, it is necessary to file a flight plan in accordance with the procedures laid down in appropriate Flight Information Publications (FLIP) and Aeronautical Information Publications (AIP), adhering to the procedural framework within each specific Flight Information Region (FIR). The International Civil Aviation Organisation (ICAO) publishes a document that specifies the content of all messages that have to be submitted to ATC authorities before, during and after flights. This document is the "Rules of the Air and Air Traffic Services". The messages may be sent as appropriate and desired over voice channels, by completed paper forms or electronically. Voice messages and paper forms are outside the scope of the CCI, hence only electronic messages are considered below. There are two types of electronic messages specified by the ICAO, Air Traffic Services (ATS) and Automatic Dependent Surveillance (ADS) messages. ADS messages are sent from the air platform via a data link to an ATS unit covering the airspace in which the platform is flying, hence these are not applicable to the UCS and not considered further. However, in order to be compliant with ICAO regulations, the UAV shall carry a compatible Identification Friend or Foe (IFF) device (e.g. Mode S IFF). The STANAG does not mandate the use of these messages because they will not be required for some UAS (e.g. small, miniature and micro UASs), but does require that, if generated in a particular system, the ICAO format should be used.

General Battlefield Picture.

Both enemy and own tactical situation can be exchanged between C4I systems and the UCS. This information is carried by messages, which are both incoming and outgoing. Knowledge of the position of own and enemy forces is useful within the UCS to allow the operators to understand the context of the required mission and to optimise the flight plan. Reciprocally, the UCS may use the results of image exploitation to update the local tactical situation (by generating tactical symbols related to observed targets) and to export it through intelligence networks or to upper levels of command. Information on the tactical situation shall be obtained and reported by use of relevant ADatP-3 messages, particularly the Enemy Situation Report (ENSITREP) and Own Situation Report (OWNSITREP).

Mission Dependent Data.

Information on the tactical situation may be obtained via additional ADatP-3 messages that are specific to particular missions and/or payloads. An example of this is the Meaconing, Intrusion, Jamming, and Interference (MIJI) Warning Report which provides information on hazardous Electronic Warfare (EW) situations.

Nuclear, Radiological, Biological and Chemical (NRBC).

The NRBC situation is handled by a set of specific NRBC reports that are received by all units on the battlefield. These are needed by a CUCS both as a hazard warning and to carry out mission planning for NRBC payloads.

Artillery Targeting.

A UCS can support artillery operations such as target acquisition and firing support. Information has to be exchanged between the UCS and the artillery networks. There are specific ADatP-3 messages to cover this requirement, for example the Artillery Target Intelligence-Target Information Request (ATI.TIR) that is used to request target information either as a one-time query or as a standing request for target information. Another example is the Artillery Target Intelligence-Artillery Target Report (ATI.ATR) message, which provides a report in response to the ATI.TIR.

Meteorological/Environmental Data.

Meteorological/Environmental data may be required for UAS mission planning. This includes information related to wind (direction and speed), visibility, significant current and forecasted weather, amount of turbulence, cloud cover, cloud base altitude, cloud top altitude, temperature, air density, humidity, barometric pressure, and contamination. This is available via the ADatP-3 messages or via international meteorological data.

Image Products.

There will be a requirement for the operator to read imagery and image products, which are relevant to the area of operation, from external C4I systems. Such collateral material could be needed, for example, for detailed mission planning or image exploitation. It is expected that these image products will be accessed from one of a number of Image Libraries (IL) held by various NATO or coalition nations.

Mission Plan.

Mission planning for UAS consists of route planning, payload planning, data link planning (including frequency planning), and UAS emergency recovery planning. The combined results of these items comprise the mission plan. It should be noted that the data required to be able to generate a mission plan is normally far more than contained in these items. A detailed knowledge of current Phase and Boundary lines, Engagement Areas, Hazards, Air Defence Units (ADU) and Control Measures is also required. Pre-planned missions may also be provided across the C4I interface in the form of a mission plan that has been developed by another UAS planning system. The mission planner also requires vehicle performance models for UASs controlled by the UCS to calculate energy states, effector-payload states, etc. Other functions that may be available in a mission planner are the ability to do radar shadowing and line of sight evaluations and to show confliction and inter-visibility between waypoints and routes. These calculations require knowledge of ADU/Radar characteristics and the plans of other users. Planning for designator operations will also require a means of co-ordination/implementing of Laser Codes and Keywords. The capability should exist through the HCI to provide the mission plan, or components of the mission plan, as hard or soft copy as required. The outputs from a mission planner may also include printouts of instructions for loading the UAS (e.g. fuel type and amount, sensor/designator settings, task-tailored payload, and communications frequencies).

Dissemination of the Mission Plan.

The mission plan needs to be sent to different recipients at various times, these include:

- The tasking authority, immediately after generation of the mission plan, for airspace deconfliction and approval.

- The UAV via the DLI for those UASs that can autonomously execute a mission plan.

- To another UCS for handover of UAS control whether via the DLI and AV or direct via the CCI.

Ideally, the same data format can be used for each transfer of the mission plan data. However it is recognised that not all recipients will require the full mission plan. For those systems it will be possible to extract only the necessary parts. ATC is excluded from the list of recipients as there are existing civil flight plan formats that are adequate for UCS mission plan formats.

Route Planning.

Route planning may be done at the UCS or passed from an external agency. This
agency may be Headquarters, another UCS, or come from an intermediate level. A route plan from Headquarters may require additional tactical information to be built into it at the squadron of the Forward Operations Base (FOB) to make it compatible with the current state of the battlespace. The instructions might be very detailed, where information about a specific target is required or may be instructions for Intelligence, Surveillance and Target Acquisition, and Reconnaissance (ISTAR) type operations and specify only an area of operations. When a route plan comes from another UCS, this may be a UAS handover operation with detailed route and instructions or may be a plan generated at another UCS for use by other operators. A route plan will comprise a set of waypoints. These waypoints may have different parameters, which drive the action to be taken when a waypoint is reached. Flight profiles may be incorporated into the route either as a series of sequenced waypoints or as ‘seed’ waypoints with height, vector, speed, range and bearing information, which will depend on the sophistication of the UCS and UAS.

Payload Planning.

Payload planning includes details of how a specific payload is to be used. The details of planned payload operations will be incorporated into the payload plan, and associated to waypoints in the route. Additionally, payload planning must include the weight and balance related ramifications on the performance of the UAV as an aerial platform being operated under very specific environmental conditions. Payload planning is a mission critical function. In theory, fuel-related limitations and restrictions could be overcome by aerial refuelling. The JAPCC has studied this matter and produced a compendium highlighting the operational utility and technological challenges. Air-to-air refuelling is currently not seen as a viable option for UAVs as tanker aircraft but only for strategic/global UAVs as receiver platforms once the required high-precision docking technology has reached operational maturity.

Data Link Planning.

Data link planning includes the details of the links, bands, and frequencies to be used. Data link planning needs initial assignment provided by C4I (e.g. through the OPTASK LINK message) and leads to a set of configuration data that is used by the mission planner. The exchange of data must be free of any electronic interference and strive to guarantee the real-time transfer of data between the UAS and the controlling agency, and the operational user.

Emergency Recovery Plan.

In case of failures such as data link loss or emergency cancellation of task, UASs need to automatically carry out default or recovery actions referred to as Rules of Safety (ROS). The ROS are selected at the mission planning stage. The ROS differ according to the priority given to emergency action relative to that given to mission execution. Using the mission planning application, the UCS operator selects the appropriate safety scenario (e.g. to define a pre-programmed recovery route to a suitable landing/recovery site).

Handover Control.

When control of a UAV (platform) and/or effector-payload is handed over from one UCS to another UCS, various data will need to be transferred between systems before, during, and after that handover procedure. The detailed operating procedure adopted for handover and the actual data to be transferred will vary according to national and NATO CONOPS. If a common handover procedure were to be defined among several NATO nations, it should be described in an Allied Technical Procedure (ATP).

The STANAG 4586 recommends procedures for the CCI and DLI handover-related sections to provide the exchange support messages, the sequence of these messages and data needed to allow implementation of different CONOPS. The handover process is further complicated by the fact that data transfer and co-ordination may take place via the DLI, the CCI, by HCI voice communications or some combination of all three. Data transfer and co-ordination via the DLI and/or voice are outside the scope of the CCI and will not be considered further here.
To provide the flexibility needed to accommodate any operating procedures and UAS design, it is desirable that the CCI provide the capability for:

- Exchange of all or any subset of necessary data and/or

- Exchange of co-ordination messages

This information is sent across the CCI either during mission planning or during the flight to specify the information contained in the DLI handover message set.

The C4I must also specify the transfer time and transition location. Execution of the handover operation will require various means of co-ordination synchronisation or handshake messages. During that phase, communication between the two UCSs is usually done by voice and/or by data and messages exchanged via the UAS.

Mission Progress.

This data is required primarily to inform higher levels of command about the effects-defined progress of the mission. This includes information on the UAS position, status of onboard equipment, energy levels, and ongoing achievement of mission effects.

Resource Availability.

The CCI must have the capability to provide, as well as receive, the status and operational capability of the sub-components of the UAS. This will include both the Air Segment and the Ground Segment of the UAS.

Air Segment Status.

The status and operational capability of the air segment of the UAS will consist of data relevant to the UAV(s), the payload(s), and the air data link(s).

Payload/Sensor Data.

Sensor data may be received from the air platform in a variety of formats depending on the type of UAV (platform) and sensor. Where possible, the formats used to transmit data from the UCS to the C4I systems across the CCI will use existing international standards (NATO or commercial) so as to minimise the number of formats used in the CCI and by the receiving C4I systems. It is impossible to cover all existing and future types of payloads because of the rate of change in sensor technology. Therefore, only the most common types of sensors have been considered to-date; and specific UCS implementations may need to convert from a particular sensor data format to the CCI required data format if the two do not match.

Target Data.

Near real-time target data transmission across the CCI has not been included. Target reporting requires a commander to approve the target and issue authority to fire.

Mission Reporting.

The UCS will provide the various C4I systems with payload dependent core UCS products; including, but not limited to, payload reports, mission status, mission progress, mission effects, and mission reports. This information may have to be provided on a routine basis during the flight of the UAS, on completion of the mission, on demand, or when specified threshold criteria are met or trigger events have occurred.

Man-in-the-Loop.

The role of the man-in-the-loop focuses mainly on planning, operational system interface (deployment and employment), and assessments of products and effects of the UAS. HCI is an essential CUCS capability with specific responsibilities and CCISM-facilitated human control functions as DLI and CCI. Specific task-tailored processes must be defined for the selection, the training, and the role-specific certification of HCI. Operational procedures for their tactical employment within the conceived combined and joint NATO mission spectrum must be developed, ideally supported by staff-embedded UAS-liaison specialists at the appropriate controlling agencies. Standardisation, compatibility and interoperability are major objectives to be achieved in the context of HCI. It is essential that all procedural elements are trained, practiced, exercised, and assessed as an ongoing process of keeping the man-in-the-loop. The man-in-the-loop makes the UA<u>C</u> out of the UA<u>S</u>. The man-in-the-loop determines to a large degree the tactical utility of UAC, also encompassing the logistic support such as service and maintenance of the UAS in deployed and sometimes austere locations.

Special Focus on Tactical Utility.

The scope of tactical UAV utility is increasing with the advent of new technology, particularly in the areas of miniaturisation, modularity, and operating power provisions. As a result, a robust and all-encompassing definition of the term "tactical UAV" is difficult[1]. The possible definition criteria are numerous and a convincing effects-based distinction between the attributes "tactical, operational and strategic" cannot be made fitting all UAV. The following main capability criteria are offered for the definition/description of *Tactical* UAV:

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[1] Jane's International Defence Review, September 2005: "Tactical UAVs: redefining and refining the breed" by Bill Sweetman. "In fact, two related trends are apparent. One of them is a watershed split, based on mobility. On one side of the split are UAVs that operate from rear-area runways, but have a range and endurance to support forward-deployed troops for 12 hours or more per sortie; on the other side are UAVs that can move with ground forces, and are owned and controlled by those forces at all times." and further on "The other trend is that UAVs linked to ground forces are-one way or another-becoming more mobile." and finally "When it comes to new-design vehicles, however, the watershed trend of UAVs getting either smaller or larger seems to rule."

a. Current and future employment spectrum (See Effects-based Operations below). Operational Employment Spectrum (Mission/Task) as Unmanned Aerospace Capability (UAC).

b. Operational Utility/Purpose for the Tactical User at or below the Corps level. Command/Echelon-related Operational Utility Requirements as UAC.

c. Main Technological Characteristics as Unmanned Aerial System (UAS).

(1) Unmanned flying platform to carry tactical payload.

(2) Operation, Service and Maintenance suitable for more rugged battlespace applications.

(3) Launchable from unprepared surfaces.

(4) Remotely controllable or autonomous/automated flight plan following.

(5) Predominantly mobile, recoverable, yet disposable without endangering the live of aircrews.

(6) Weight category small and lower.

(7) Size category small and lower

d. Aeronautical Performance Qualities as UAV.

(1) Persistence (Endurance, Loiter and Range/Penetration).

(2) Low speed regime.

(3) Low to medium height regime.

(4) High agility/manoeuvrability.

Effects-based Operations.

a. Operational Employment Spectrum (Mission/Task) as UAC. The utility of UAC can be maximised by a complementary mix of swing-role capabilities, ranging from single payload/single task to exchangeable payload/swing role to multiple payload/multiple task capabilities. This scope of utility will probably also require a mission-tailored, layered mix of UAV/UAS, providing almost interchangeable and overlapping effects of tactical, operational and/or strategic nature. The utility-challenges arising from the simultaneous employment of a multitude of UAS in close proximity will be significant. With the task-specific payload, UAC are/will be capable of delivering/performing:

(1) Reconnaissance, Surveillance and Early Warning.

(2) (Fleeting) Target Acquisition, Designation, Illumination, and Tracking.

(3) NEC-enabling Communications Relay/Up- and Downlink.

(4) Battle Damage Assessment.

(5) SIGINT/ELINT.

(6) Electronic Warfare.

(7) CBRN Detection.

(8) Payload/Cargo Delivery.

(9) Information Operations.

(10) Search and Rescue Support.

(11) Close Air Support.

(12) Offensive Air Operations (SEAD/CCF).

(13) Environmental Surveillance and Reporting.

b. Command/Echelon-related Operational Utility Requirements as UAC.

(1) Direct utility for the main first/immediate tactical-echelon producer/user of effects within the "battlespace"[2] [3], including areas beyond the FLOT [4].

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[2] US Department of Defence: "The environment, factors, and conditions which must be understood to successfully apply combat power, protect the force, or complete the mission. This includes the air, land, sea, and the included enemy and friendly forces, facilities, weather, terrain, the electromagnetic spectrum, and information environment within the operational areas and areas of interest."

[3] WIKIPEDIA, the free encyclopedia: "Battlespace is a unified strategy to integrate and combine armed forces for the military theatre of operations, including air, information, land, sea and space. It includes the environment, factors and conditions that must be understood to successfully apply combat power, protect the force, or complete the mission. This includes enemy and friendly

(2) Real-time/near real-time and short-term task-/effects-focused.

(3) Local manoeuvres in the combat zone to meet immediate military objectives.

(4) Short to medium distance/range.

(5) Short time scale (real-time/near real-time).

(6) Direct contact with opposing manoeuvring forces.

(7) Execution-level of operations, in direct co-ordination between units.

(8) Conducting "deep battle/strike" (up to 200 kilometres and beyond).

(9) Operating radius in relation to Fire Support Co-ordination Line-FSCL[5] (up to 100 kilometres).

c. Desired Overall Effects as UAV.

(1) Maximise on-station times of UAV.

(2) Minimise non-operational ground times of UAV.

(3) Minimise the potential for mishaps during launch and recovery of UAV[6].

d. Desired Mission Effects as UAS.

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forces, facilities, weather, terrain, and the electromagnetic spectrum within the operational areas and areas of interest."

[4] AAP-6: Forward Line of Own Troops (FLOT): "A line which indicates the most forward positions of friendly forces in any kind of military operation at a specific time."

[5] AAP-6: Fire Support Co-ordination Line (FSCL): "A line established by the appropriate ground commander to ensure co-ordination of fire not under his control but which may affect current tactical operations. The fire support co-ordination line is used to co-ordinate fires of air, ground or sea weapons systems using any type of ammunition against surface targets. The fire support co-ordination line should follow well defined terrain features. The establishment of the fire support co-ordination line must be co-ordinated with the appropriate tactical air commander and other supporting elements. Supporting elements may attack targets forward of the fire support co-ordination line, without prior co-ordination with the ground force commander, provided the attack will not produce adverse surface effects on, or to the rear of, the line. Attacks against surface targets behind this line must be co-ordinated with the appropriate ground force commander."

[6] US Congressional Research Service on UAV Background and Issues for Congress, 21 November 2005: Table 2 shows selected mishap rates with peak figures for RQ-2 Pioneer and RQ-7 Shadow, some attributed to launch and recovery incidents/accidents (unquantified number).

(1) Maximise endurance potential.

(2) Maximise penetration/range potential.

(3) Maximise loiter potential.

(4) Facilitate ingress with combat potential.

(5) Facilitate combat with manoeuvring potential (speed, agility, persistence).

(6) Facilitate egress with manoeuvring potential.

(7) Facilitate recovery with loiter/endurance potential.

Where to go.

The JAPCC should pro-actively support the workplan of the NATO Joint Group On Unmanned Air Vehicles (JUAVG) by aligning its activities with the agreed scope of work of the JUAVG, preferably as a leading member of the JUAVG:

• Capability Integration for UAS.

• Advancement of a UAS Autonomous Operations Concept.

• Interoperability for UAS.

• And in general, promoting the Acceptance of UASs as mission-essential capabilities (UAC) in the Alliance.

How to get there.

Due to the complexity of the overall challenge, a strategically structured approach must be taken, encompassing the leading facts, expectations and requirements in order to improve the availability, interoperability, utility and operation of UAC as a complementary airborne capability in NATO:

• Increase the capability of UASs to support military missions and increase the rate of introduction and reliability of these systems in NATO.

• Develop standards for the employment of UAS in Joint and Coalition Operations.

• Develop and support the integration of a NATO scheme for UAS interoperability and improved levels of autonomy among UASs.

- Support documentation of requirements, standards, training and doctrine necessary to field and operate UASs in accordance with the Concept for Alliance Future Joint Operations (CAFJO).

- Promote the maturation of technology to improve the effectiveness of UASs for military tasks.

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