

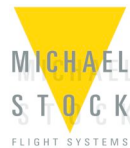
REALITYVISION

UNMANNED VEHICLE PILOT SYSTEMS

UAV Europe 2005: Why Pilots have to be in the loop



A Joint Research & Development Program
by



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- Why we are here & what we will provide to the UV community

This **joint development & research project** is performed out with the purpose to design and implement a **new generation of Command and Control Station** for Unmanned Vehicle Systems (UAV/UGV/USV), based on the CANaerospace communication protocol.

The **goal of RealityVISION** is to identify and **reduce the „Mishap Rate“** associated with UAV operations, especially for take-off and landing. Also, UAVs will **increase flying freedom** and **operation flexibility**. The core of our approach is the combination of pilot well-known cockpit aviation display & interfaces, UAV flying attitude motion platform and advanced visual systems.

NOTE: The research group at A2TECH is actively seeking industry and defence agency stakeholders who can help guide and focus this effort and identify the most crucial points of integration.

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- Trying to keep complexity low

The **complexity** and **capability** of UAVs is expanding rapidly and the **range of missions** they are designed to support is growing. Civil applications also are knocking on the door. By **2012**, the DOD roadmap projects that **F-16-size UAVs** will perform a complete range of combat and combat support missions.

However, in order to for UAVs to reach this potential, **significant technical issues** must overcome. Several of these challenges are **Human-Interface issues**, relatet to the systems used to **command** and **control** UAVs.

Few research & development organisations are working on **new immersive** UAV Ground Control Stations (GCS), but this new concept of **virtual reality** based visulization and control is **very complex** and could add **other technical issues**.

RealityVISION will help to **overcome complexity** in UAV control systems, and **increase flying reliability** using the **Pilots experience, eyes & brain**. Also, the adopted **Open-Source** CANaerospace protocol will **open doors** to all UAV manufacturer and Hardware & Software vendors.

First Value: Experience & Knowledge

- Why the Pilot have to be in the loop

The research group at A2TECH are developing a new generation of unmanned aircraft guidance systems, that allows **Air Force Pilots** to guide unmanned airplanes by sitting on the ground in a **real cockpit environment**, usually used in aircraft flight simulators.

The new guidance system is primarily **designed for combat situations**, where **only a human** being with experience and knowledge could accurately **assess the situation and determine** a course of action.

UAVs, employing RealityVISION, could acting as a **Wingman** or **flying in formation** with real fighter aircrafts, they **will understand** spoken slang, hand signals and other similar techniques to communicate that pilot often employ. This because a **real Air Force Pilot** is flying and controlling the UAV from the ground.

UAV Accidents

- A Summary of UAV Accident/Incident Data: Human Factors Implications

A review and analysis of unmanned aircraft (UA) accident data was conducted to identify **important human factors issues** related to their use. UA accident data were collected from the U.S. Army, Navy, and Air Force. The percentage of **involvement of human factors issues** varied across aircraft from **21% to 68%**.

For most of the aircraft systems, **electromechanical failure** was more of a **causal factor** than human error. One critical finding from an analysis of the data is that each of the fielded systems is very different, leading to different kinds of accidents and different human factors issues. A second finding is that **many of the accidents** that have occurred **could have been anticipated** through an analysis of the **user interfaces** employed and **procedures implemented** for their use.

A breakdown of the human factors issues shows that **over 70%** are related to **Take-off** and **Landing Errors**.

Source: A Summary of Unmanned Aircraft Accident/Incident Data: Human Factors Implications, December 2004
Kevin W. Williams, Ph.D. FAA Civil Aerospace Medical Institute, Oklahoma City, OK

The Dark Side of the UAV

- The Unmanned Aircraft (UA) Mishap Rate

Mishap Rate (MR) is the number of accidents occurring per 100,000 hours of fleet flight time, expressed as mishaps per 100,000 hours.

For comparison, in a recent year, Marine AV-8 Harriers had a Class A mishap rate of 10.5 per 100,000 hours and Air Force F-16s 3.5. Using the logic that aircraft mishap rates tend to be inversely proportional to their acquisition costs, current UAVs still have a reliability gap to close. Unmanned systems should be designed to the same standards of reliability, survivability, and autonomy as manned systems. The magnitude of this challenge is reflected in a 2001 Department of Defense study that noted UAVs have experienced mishaps at 10 to 100 times the rate of manned aircraft.

Reliability Metrics for UAV (MR):

- Predator: 32
- Pioneer: 334
- Hunter: 55

NOTE: A Department-wide effort should be implemented to decrease the annual mishap rate of larger model UAVs to less than 25 per 100,000 flight hours by FY09 and less than 15 per 100,000 flight hours by FY15 while minimizing system cost growth.

Source: UAV Roadmap 2002 - Section 5, page 51

Systems Design Process

- How to reduce the Mishap Rate

An **improvement in electromechanical reliability** will probably come only through an **increase in the cost** of the aircraft. However, a **reduction of human errors** leading to accidents might **not necessarily** entail **increased costs** if suggested changes can be incorporated early in the design process. In the systems analyzed, human factors issues were present in 21% (Shadow) to 67% (Predator) of the accidents. These numbers suggest **there is room for improvement** if specific human factors issues can be identified and addressed.

Source: A Summary of Unmanned Aircraft Accident/Incident Data: Human Factors Implications, December 2004
Kevin W. Williams, Ph.D. FAA Civil Aerospace Medical Institute, Oklahoma City, OK

UAV Advantages over Real Aircraft

- Unmanned Vehicle Applications

Long relegated to the sidelines in military operations, UAVs are now making national headlines as they assume **missions normally reserved for manned aircraft**. UAVs are thought to offer **two main advantages** over manned aircraft: they are arguably **cheaper** to procure, and they eliminate the risk to a pilots life. UAVs **protect the lives of pilots** by performing the "3-D" missions - those Dull, Dirty, or Dangerous missions that do not require a pilot in the cockpit. However, the **lower procurement cost** of UAVs must be weighed against their **greater proclivity to crash**, while the minimized risk should be weighed against the dangers inherent in having an unmanned vehicle flying in airspace shared with manned assets.

UAV primary advantages over real aircrafts:

- Smaller, lighter, cheaper to procure and to maintain
- You can fly and change Ground Control Station crew every 2-4 hours
- No People/Pilots in the enemy field/sky
- No G-Force stress

Source: Report for Congress, April 25, 2003: Unmanned Aerial Vehicles, Background and Issues for Congress. Order Code RL31872

UAV Operational Issues

- How to fly an Unmanned Aircraft?

It has not always been easy for the aviation culture to adapt to **flying aircraft from the ground** vice in the air. Deputy Secretary of Defense Wolfowitz, during a hearing on transformation, stated that:

*Not long ago, an Air Force F-15 pilot had to be persuaded to forego a rated pilots job to **fly Predator**. Now Air Force leadership is working hard to encourage this pilot and others to think of piloting UAVs as a major mission and to become trail blazers in defining new concepts of operations.*

Note: The Air Force has realized the retention implications of requiring rated pilots to fly their UAVs, and has offered enticements such as plum assignments after flying the UAV, and allowing pilots to keep up their manned flying hours during their UAV tour of duty.

Source: Report for Congress, April 25, 2003: Unmanned Aerial Vehicles, Background and Issues for Congress. Order Code RL31872

Piloting the UAV/UCAV

- What a F-15 Pilot is used to see on his job place



F-15 Fighter Cockpit

Advanced Aviation Technology - UAV Europe 2005 - Unclassified

Piloting the UAV/UCAV

- What a F-15 Pilot will see on his new job place...

Dual Redundant Pilot/Payload Operator Control Stations



Predator Ground Control Station

Piloting the UAV/UCAV

- What a F-15 Pilot would dream to see on his new job place



UAV Operational Issues

- UAVs are aircrafts and must being flown as it

Part of the cause for human factor issues is that the **developers** of these **system interfaces** are **NOT** primarily **aircraft manufacturers**. Another reason is that these aircraft are **not „flown“** in the traditional sense of the word. Only one of the aircraft reviewed (Predator) has a pilot/operator interface that could be considered **similar** to a manned aircraft.

For the other UA, **control of the aircraft** by the GCS pilot/operator is accomplished **indirectly** through the **use of menu selections**, **dedicated knobs**, or **preprogrammed routes**. These **aircraft are** not flown but **„commanded“**.

This is a paradigm shift that **must be understood** if **appropriate decisions** are to be **made** regarding pilot/operator qualifications, display requirements, and critical human factors issues to be addressed.

Source: A Summary of Unmanned Aircraft Accident/Incident Data: Human Factors Implications, December 2004
Kevin W. Williams, Ph.D.FAA Civil Aerospace Medical Institute, Oklahoma City, OK

UAV Operational Issues

- Issues in using NOT standard aviation display concepts

In that regard, it is **important to note** that today many of the human factors issues identified are very much dependent on the particular systems being flown. For example, both the Pioneer and Hunter systems have problems associated with the **difficulty External Pilots** (EP) have in controlling the aircraft. For both of these systems, the majority of accidents due to human error can be **attributed to this problem**. However, the other three systems discussed do not use an EP and either use an IP (Predator) or perform landings using an Tactical Automated Landing System - TALS (Shadow and Global Hawk). The design of the **user interfaces** of these systems are, for the most part, **not based** on previously established **aviation display concepts**.

Understanding this task and **creating the interface to support** it should help to improve the usability of the interface and **reduce** the **number of accidents** for these aircraft. This is **especially important** as these aircraft begin to transition to the National Airspace System (NAS), conducting civilian operations in among **civilian manned aircraft**.

Source: A Summary of Unmanned Aircraft Accident/Incident Data: Human Factors Implications, December 2004
Kevin W. Williams, Ph.D. FAA Civil Aerospace Medical Institute, Oklahoma City, OK

Avoiding UAV Operational Issues

- Why reinventing the wheel?

In order to avoid and reduce human factor issues, we encourage to use:

- Standard General Aviation Cockpit Displays and Interfaces
- Standard Aviation Pre-Flight Ground Check List
- Standard Aviation Pre-Flight Cockpit Check List
- Standard Aviation Post-Flight Check List
- Standard Aviation Flight Procedures
- Standard Flight Management Systems (MCDU/FMC)
- Pilot and Payload Operator have to be in a close cockpit environment in order to avoid to be superceded by other personnel in the area
- Communication from and to the Pilot have to be done only over standard aircraft communication ways (Radio/Interfon)
- Be interoperable to Hardware and Software vendors for easy application integration
- Civil or Military Aviation Pilots with flying experience for UAV/TUAV/VTUAV
- Fighter Pilots with combat experience for UCAV
- Keep in mind, a UAV is an aircraft and have to be piloted as it

UAV Interoperability

- Standards that we should to be compliant

TCS - Tactical Control System:

The TCS is an open architecture, common interoperable control system software for UAVs and supported Command, Control, Communications, Computer, and Intelligence (C4I) nodes currently in EMD. TCS will provide five scalable levels of UAV vehicle, sensor, and payload command and control, from receipt of secondary imagery (Level 1) to full control of the UAV from takeoff to landing (Level 5). It will also provide dissemination of imagery and data collected from multiple UAVs to a variety of Service and Joint C4I systems. <http://uav.navair.navy.mil>

CDL - DoD Common Data Link

The Common Data Link (CDL) program is designed to achieve data link interoperability and provide seamless communications between multiple Intelligence, Surveillance, and Reconnaissance (ISR) collection systems operated by armed services and government agencies. CDL provides full-duplex, jam resistant, digital microwave communications between the ISR sensor, sensor platform, and surface terminals. <http://jtc.fhu.disa.mil/cdl/index.html>

NATO UAV Control Station (UCS) Standardization Agreement:

- STANAG 4586 – Standard Interfaces of the UCS for NATO UAV Interoperability
- Developed to facilitate UAV interoperability / standardization
- Developed by government, military, and industrial members



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- Some key-advantages in adopting the RV Concept

Easy cooperative UAV flying for civil and military applications

- UAVs as Tactical Wingmen
- Formation flying

Real fighter pilot job will further not become „obsolete“

- After completing a Specialized Undergraduate Pilot Training (SUPT), a pilot can expect to be able to fly any UAV or UCAV
- Pilots are familiar with general aviation cockpit displays and instruments

Autopilot is usefull, but not indispensable for standard mission flying

- A UAV needs the capability to be flown as a ULM in case of sensors outage (data and video link have to be in place)
- Piloting a UAV with the pilot-in-the-loop will result in a higher degree of freedom and flexibility

Easy take-off and landing procedures

- Flying a UAV as a real aircraft will eliminate the need of complex and expensive automatic landing systems and external pilots (EP) reversed-control problem

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- UAV Integration Steps

The research group at A2TECH is actively seeking industry and defence agency stakeholders who can help guide and focus this effort and identify the most crucial points of integration.

UAV platforms that will benefit today from the RealityVISION concepts would be:

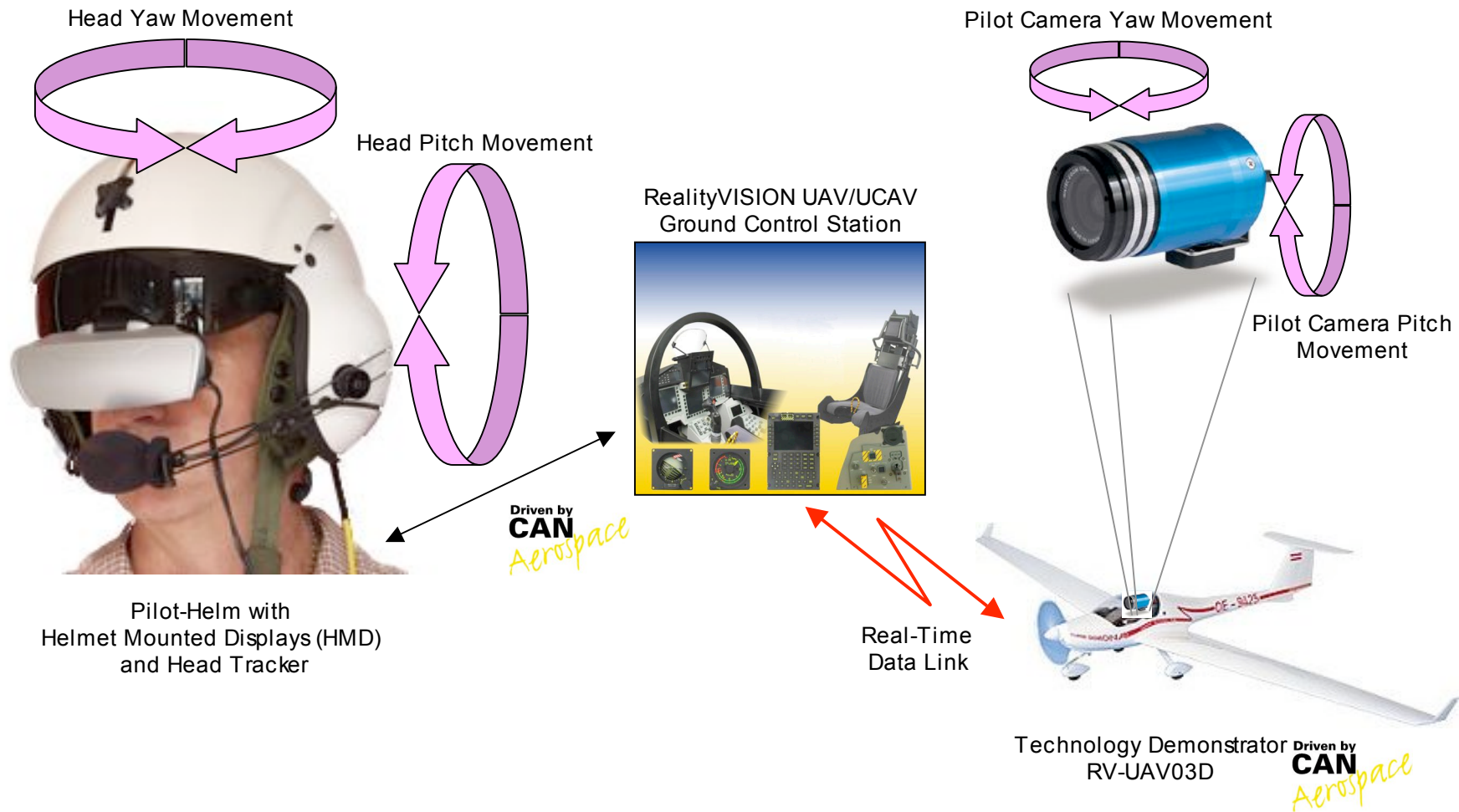
- U.S. Army Hunter
- U.S. Army Shadow
- U.S. Navy Pioneer

Next higher UAV platforms would be:

- Air Force Predator
- Air Force Global Hawk
- U.S. Navy Fire Scout VTUAV

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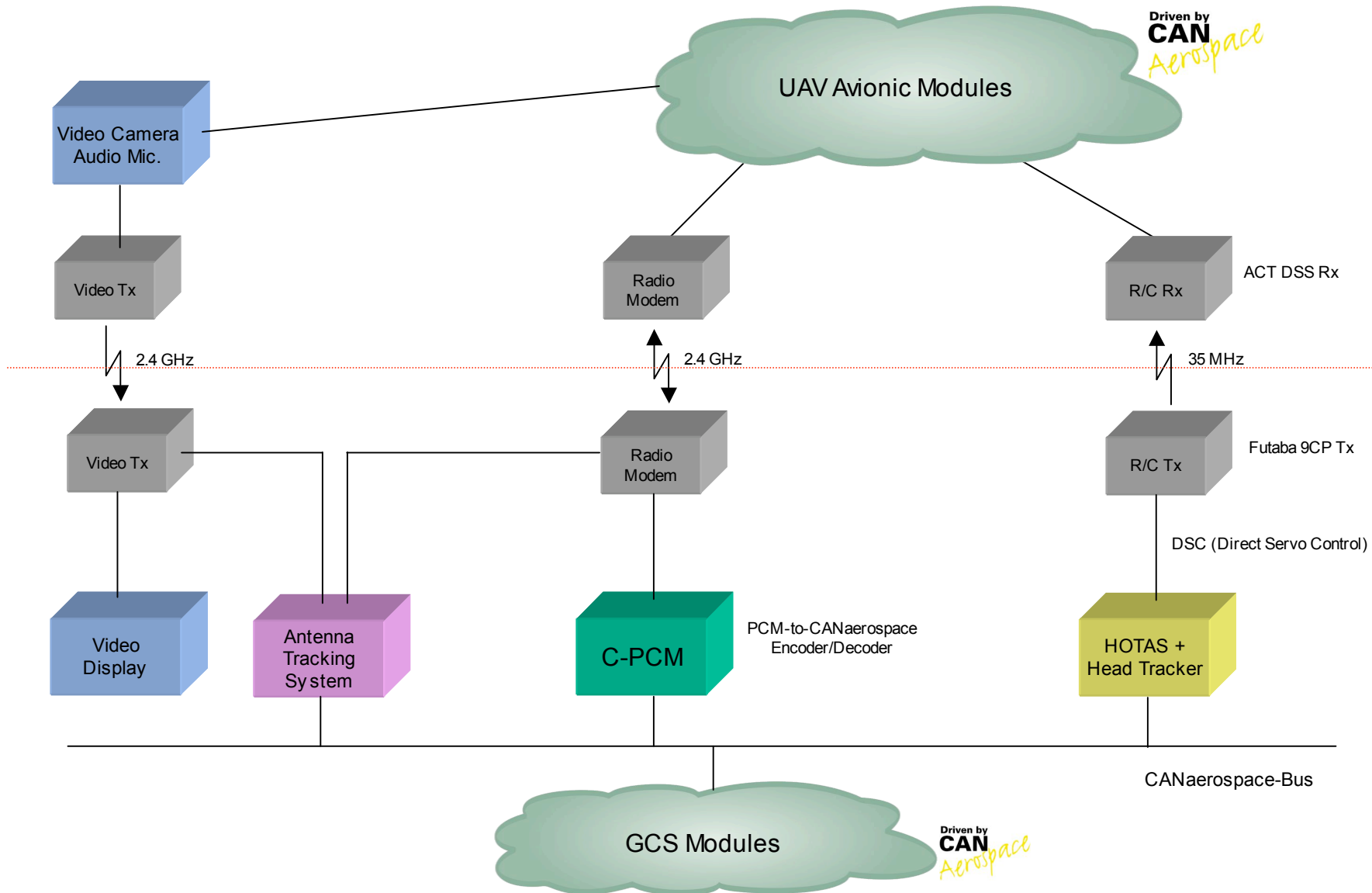
- Base Concepts



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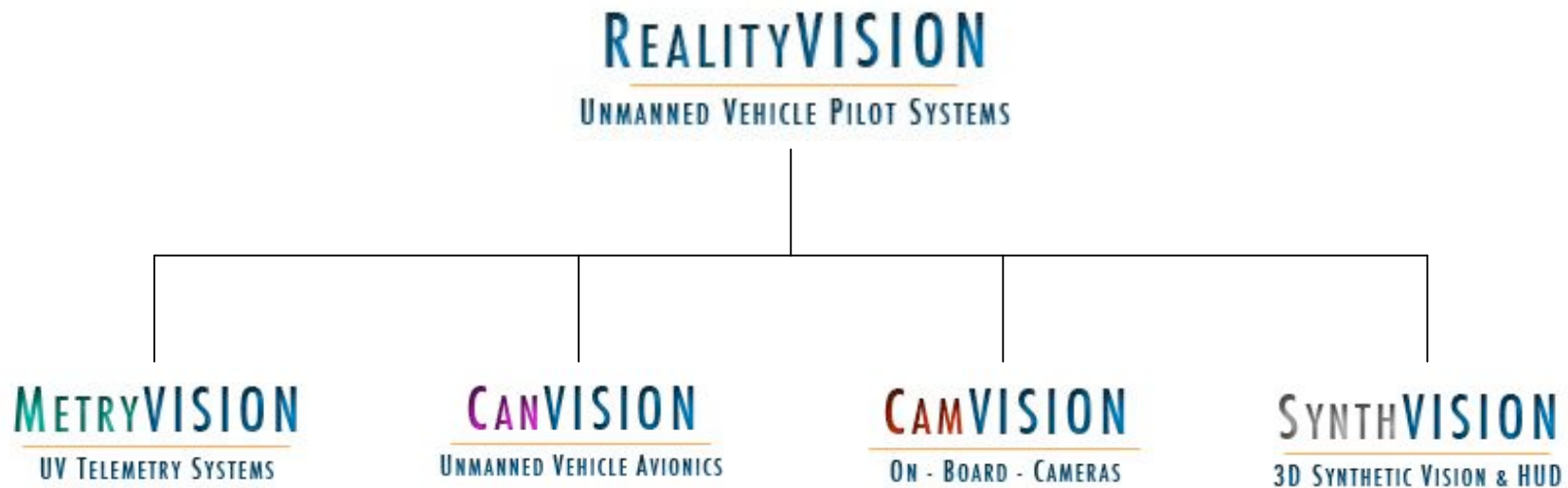
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- Technology Demonstrator Concept



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REALITYVISION - Architecture



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- GCS Categories

RealityVISION will be available for three categories:

- Man-pack portable system for Micro-UAVs
- Van-Version (or off-road) for mobile and flexible „Fast-Deployment“ of Mini-UAVs
- Shelter-Version for use of UAV/UCAVs of MALE (Medium Altitude Long Endurance) and HALE (High Altitude Long Endurance) UAVs Systems



Micro-UAV GCS



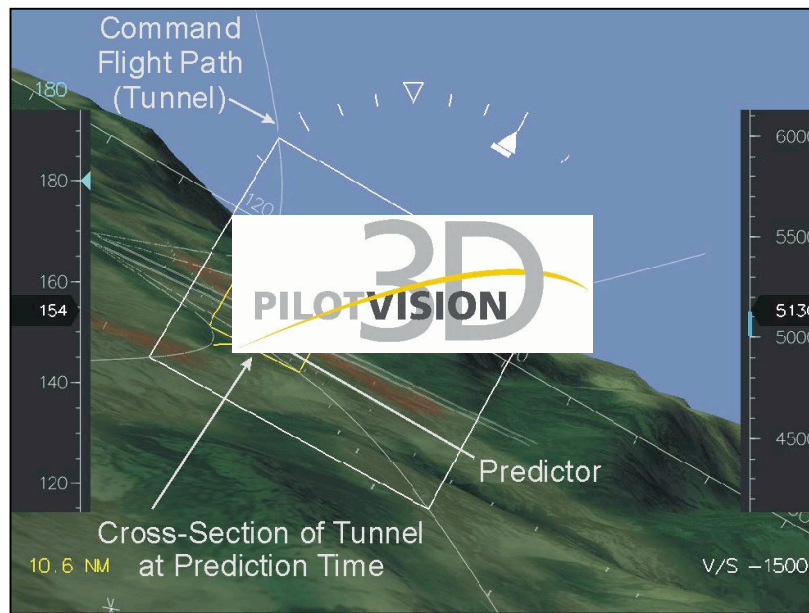
Van- GCS



Shelter-GCS

RealityVISION Software Module

- GCS Optional Cockpit Module **Driven by CAN Aerospace**



PilotVISION-3D - 3D Synthetic Vision



Navigation Display

RealityVISION Software Module

- GCS - Laptop Version for OEMs

classified



Primary Flight Display and HSI



Primary Flight Display and HSI



Moving Map

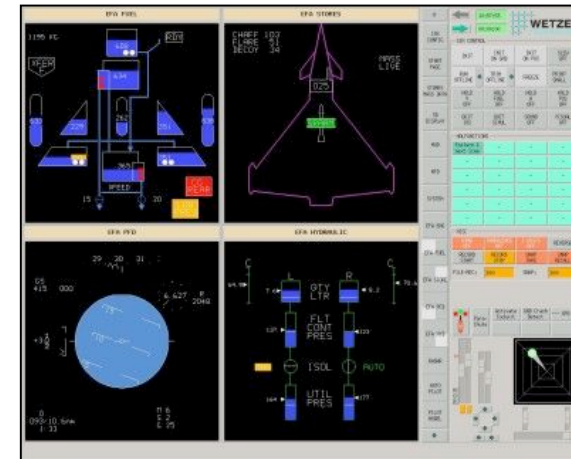
RealityVISION Software Module

- Virtual Tower (IOS) Module

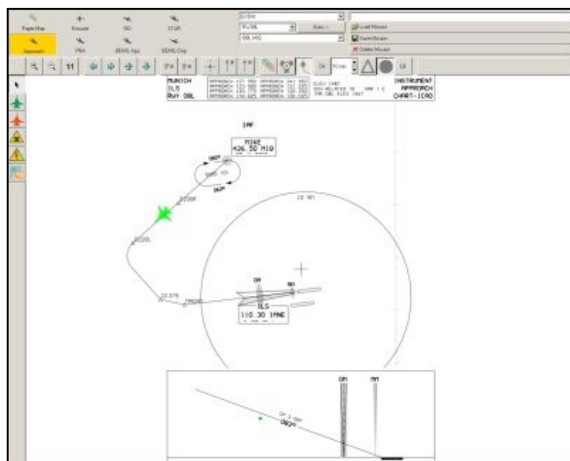
Driven by
CAN
Aerospace



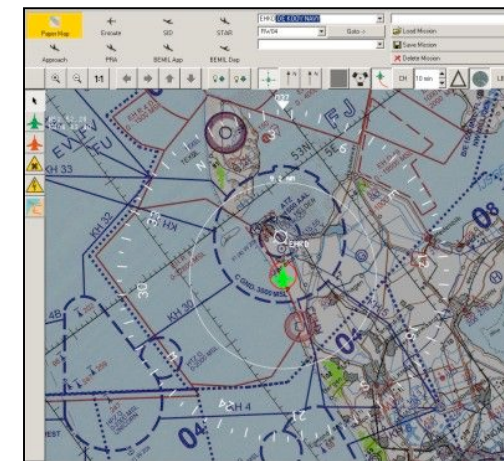
UAV/UCAV Telemetry Display



UAV/UCAV Payload Display



UAV/UCAV Landing Approach Planning



UAV/UCAV Mission Planning

Available Virtual Tower Modules:

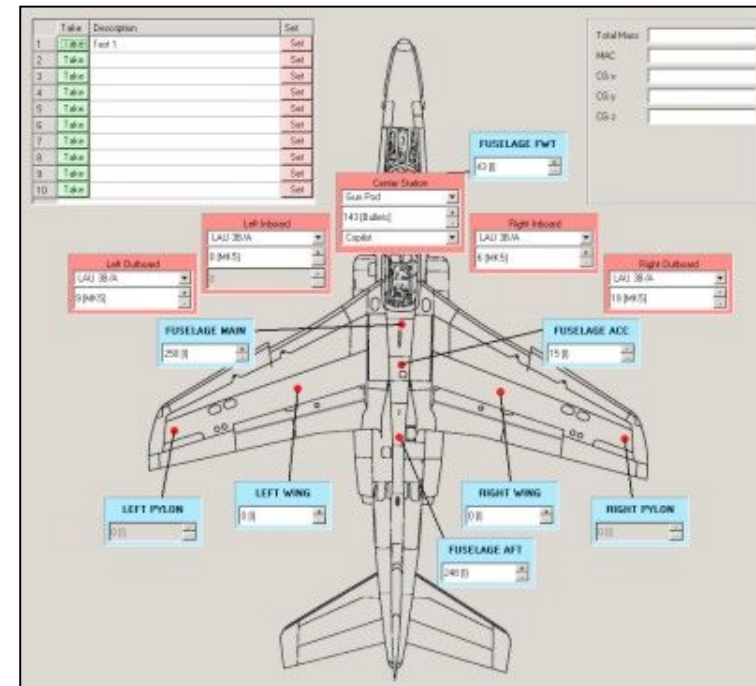
- Fixed Wing UAV/UCAV
- Rotary Wing UAV/UCAV
- Unmanned Ground Vehicles
- Unmanned Marine Vehicles
- Unmanned Sub-Marine Vehicles
- Payload Specific Modules
- Application Specific Modules
- Multi-Role Specific Modules
- Combat & Attack Planning
- Landing Approach Planning
- Mission Planning
- Multi Vehicle Coordination
- Rescue & Civil Protection
- Electronic Warfare
- Cybertracker Software Module
- MapAction Integration Module

RealityVISION Software Module

- UAV/UCAV Flight Simulation & Training **Driven by CAN Aerospace**



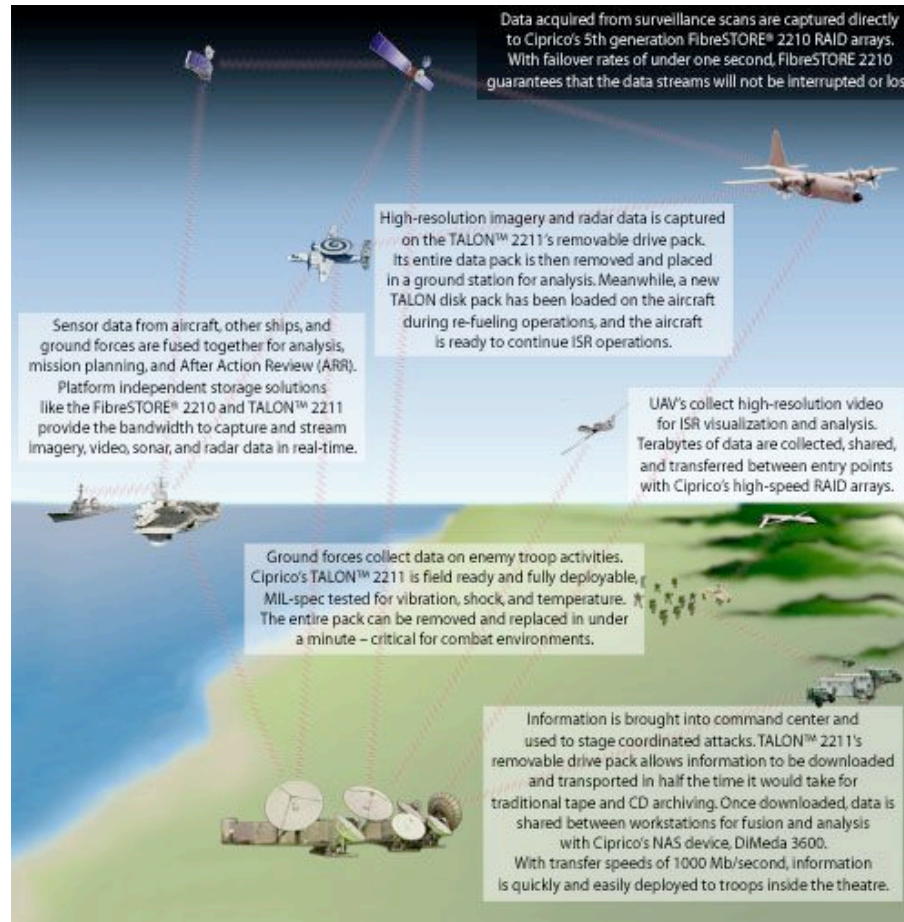
Take-Off / Landing and Mission Simulation




UAV/UCAV Weight & Balance / Weapon Configuration

RealityVISION AV Treatment

- Audio/Video Recording & Playback Systems



How to contact us



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we are representatives
for

