# InnUVative Systems Approach to Bringing Systems into STANAG 4586 Compliance

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## *Executive Summary*

*The following proposal details a variety of approaches to unmanned vehicle systems interoperability. This includes:*

1. *Air-to-Ground Interoperability in which a UAV is made to be interoperable with other control stations in theatre;*
2. *Ground-to-Air Interoperability in which a Ground Control Station (GCS) is made to be interoperable with other UAVs in theatre;*
3. *Conversion of Existing GCS to Ground-to-Air Interoperability in which a UAV is made to be interoperable with other GCSs in theatre and the system-specific/ proprietary GCS solution is made to be somewhat interoperable with other UAVs in theatre;*
4. *Advanced User Interface with Cross Domain Interoperability in which InnUVative Systems' 4CE Control Station is integrated into the proprietary system to make it interoperable with other UxVs in theatre (including air, ground and sea).*

*These approaches are described and illustrated with system block diagrams illustrating the deployment of custom developed software modules into an existing system to achieve the stated objectives.*

## Overview of InnUVative Systems

InnUVative Systems is a software development company that is targeted specifically at the unmanned systems industry. With a team total of more than 30 years experience in unmanned systems working on a variety of vehicle, payload, datalink and launch/ recovery systems, InnUVative Systems has seen many different approaches to the various problems of operating unmanned systems.

Leveraging this breadth of knowledge, InnUVative Systems has been active member of the NATO Custodial Support Team (CST) for the STANAG 4586 UAV standard. InnUVative Systems has specifically developed a code base for the complete STANAG 4586 protocol that allows rapid, low risk and low cost development of System Specific Modules (SSMs- previously called Vehicle Specific Modules or VSMs) that allow any system to become compliant with this standard.

In addition, InnUVative Systems has developed the 4CE Control Station- a STANAG 4586 compliant ground control station- that will allow control of any STANAG 4586 compliant system utilizing an advanced, intuitive, portable and domain agnostic user interface to control multiple vehicles with minimal training.

When pursuing STANAG 4586 interoperability, system developers should consider whether or not they wish to achieve compliance from the air to the ground, from the ground to air and/ or cross domain interoperability. Each of these objectives is explained and examined below.

## Overview of a Generic UxV System

The 4CE Control Station provides a STANAG 4586 compliant solution for all systems into which it is integrated. The process of integration itself requires the development of an SSM for the target system (see *Figure 1: Generic System Block Diagram*). This SSM is a separate executable from the 4CE Control Station that is capable of being deployed on and utilized by other STANAG 4586 compliant control stations as well.

The development of this SSM is greatly enhanced by leveraging the existing, tested 4586 code base implemented by InnUVative Systems that effectively provides half of the necessary SSM right up front. The customer need only fund the development of the system-specific protocol and mapping to the 4586 message set and, upon completion of this development, is delivered the source code so that they may make modifications directly without further involvement of InnUVative Systems.

This includes the development of any system-specific user interfaces required for system functionality that is not covered by the 4586 core message set. This utilization of graphical services as a means of extensibility is one of the key features of STANAG 4586 that makes it easily extensible to new and unique systems.

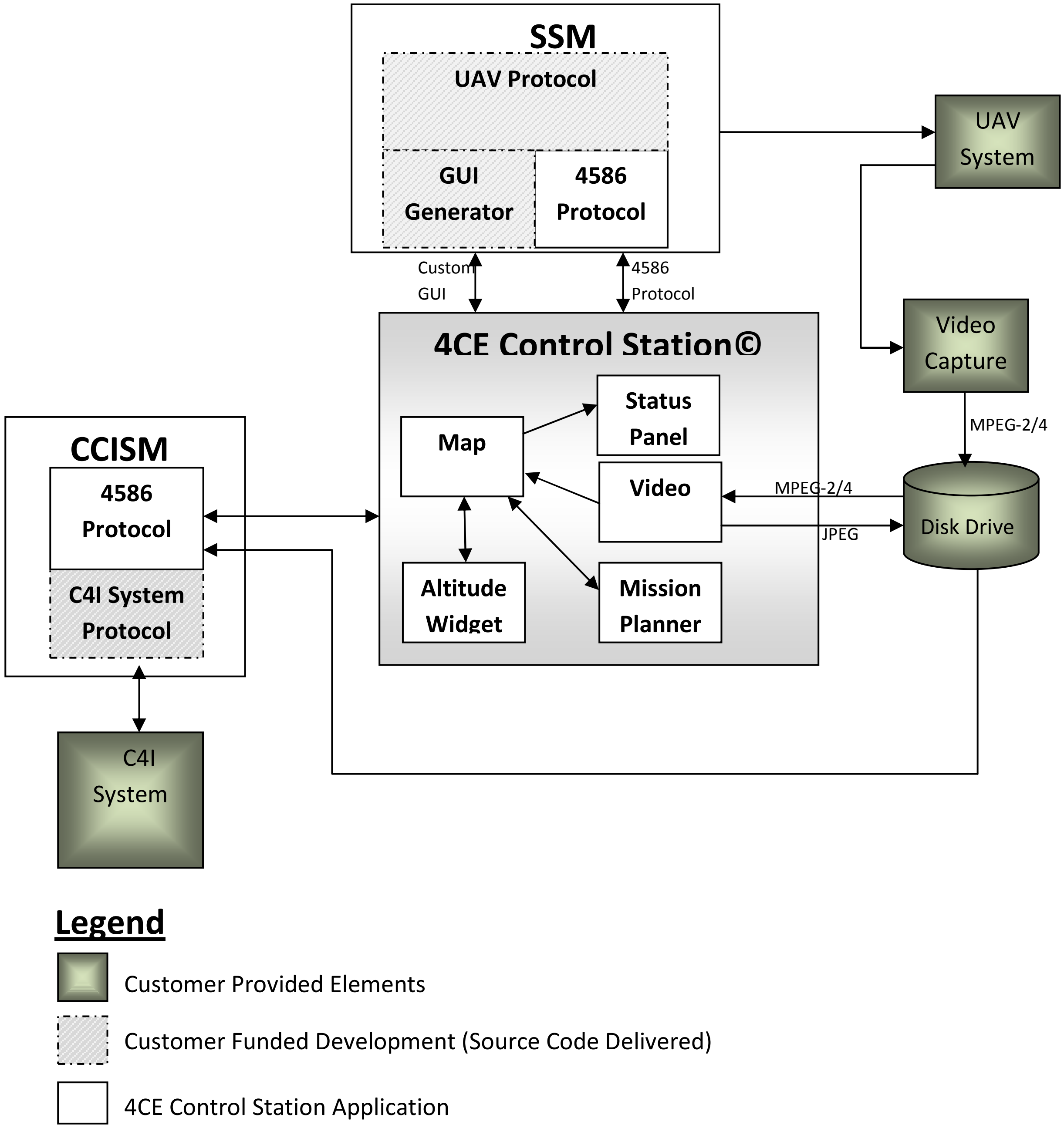



**Figure 1: Generic System Block Diagram**

The design for any modern control station for unmanned systems must recognize that the control station is not simply a front end to the unmanned system itself but is, in fact, a node on the Command & Control network. As such, the system must not only be interoperable across a variety of vehicles, payloads, datalinks and ancillary systems but also must be capable of being integrated onto existing C4I networks. This "back end" interface is often overlooked by engineers focused on building the best unmanned system possible but integration of InnUVative Systems' 4CE Control Station ensures that such extensibility is easily accommodated, greatly increasing the appeal and competitiveness of the system to prospective end customers.

## Objective: Air to Ground Interoperability

When examining STANAG 4586 interoperability objectives, if the system integrator decides that the interoperability goal is for other 4586 control stations to be able to take control of the vehicle while it is in the air then this is "air to ground interoperability". This means that the SSM for the vehicle must (at least partially) reside on the air vehicle itself so that the message protocol sent over the RF link consists primarily of the 4586 core message set. In this way, any other control station that is also STANAG 4586 compliant can monitor and even take basic control (e.g. "fly there", "point camera here", "perform this type of loiter at that location", etc.) using this message set.

The reason that the SSM may only be "partially" resident on the air vehicle is that the capabilities that do not map to the 4586 core message set are- within the 4586 architecture- implemented through the use of a graphical service on the control station by which the SSM "pops up" a system-specific GUI by which the operator can access the system-specific functionality. However, sending graphical information across an RF link is bandwidth intensive so often the SSM is effectively split into two elements with the portion that maps the system protocol to the 4586 core message set residing on the vehicle but the portion supporting the generation of system-specific GUIs resides on the control station, allowing a less bandwidth intensive message set to be used across the RF link for the additional functionality.

The deployment architecture for such an "air to ground interoperable" system can be seen in *Figure 2: Air-to-Ground Interoperability*.

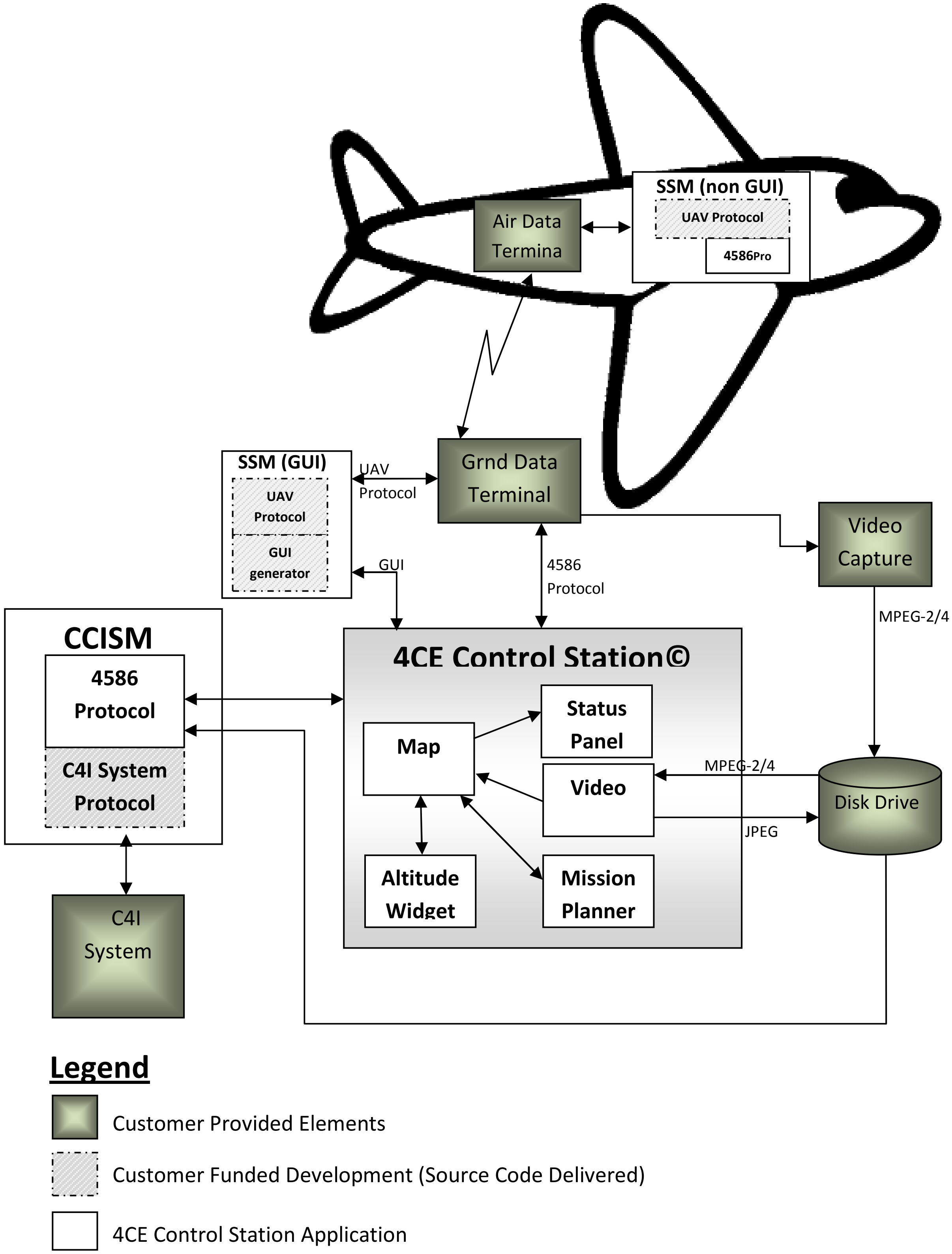



**Figure 2: Air-to-Ground Interoperability**

## Objective: Ground to Air Interoperability

When examining STANAG 4586 interoperability objectives, if the system integrator decides that the interoperability goal is for the 4586 control station to be able to take control of other 4586 compliant vehicles but that the ability for those other systems to control their vehicle is unimportant then this is "ground to air interoperability". This means that the SSM for the vehicle resides on the ground control station, translating between the vehicle protocol and the STANAG 4586 message set and then transmitting that proprietary, non-interoperable vehicle protocol over the RF link. In this manner, the system as a whole has still achieved 4586 compliance because- through the ground control station- it is able to interoperate with other 4586 compliant systems. That is, the ground station for this system is able to monitor and/ or take control of systems that are 4586 compliant and support "air to ground interoperability". Interoperability of the vehicle itself with other ground control stations can even be achieved through the deployment of the SSM to those other 4586 control stations with which interoperability is desired and permitted (see *Figure 3: Ground-to-Air Interoperability*).

An example of when this level of interoperability may be desirable is when developing a system that has capabilities that absolutely require specific training and/ or clearance to operate. In this instance, implementing a "ground to air interoperability" solution would enforce that only personnel with system-specific training and authorization were able to monitor or control; otherwise, the systems SSM would not be delivered to other system. At the same time, the ability of the operator of this system to monitor and/ or control other compliant systems is unimpeded.

In this deployment architecture, the transmission of graphical interfaces across the RF link is of no concern since all of the translation is done internal to the ground station.

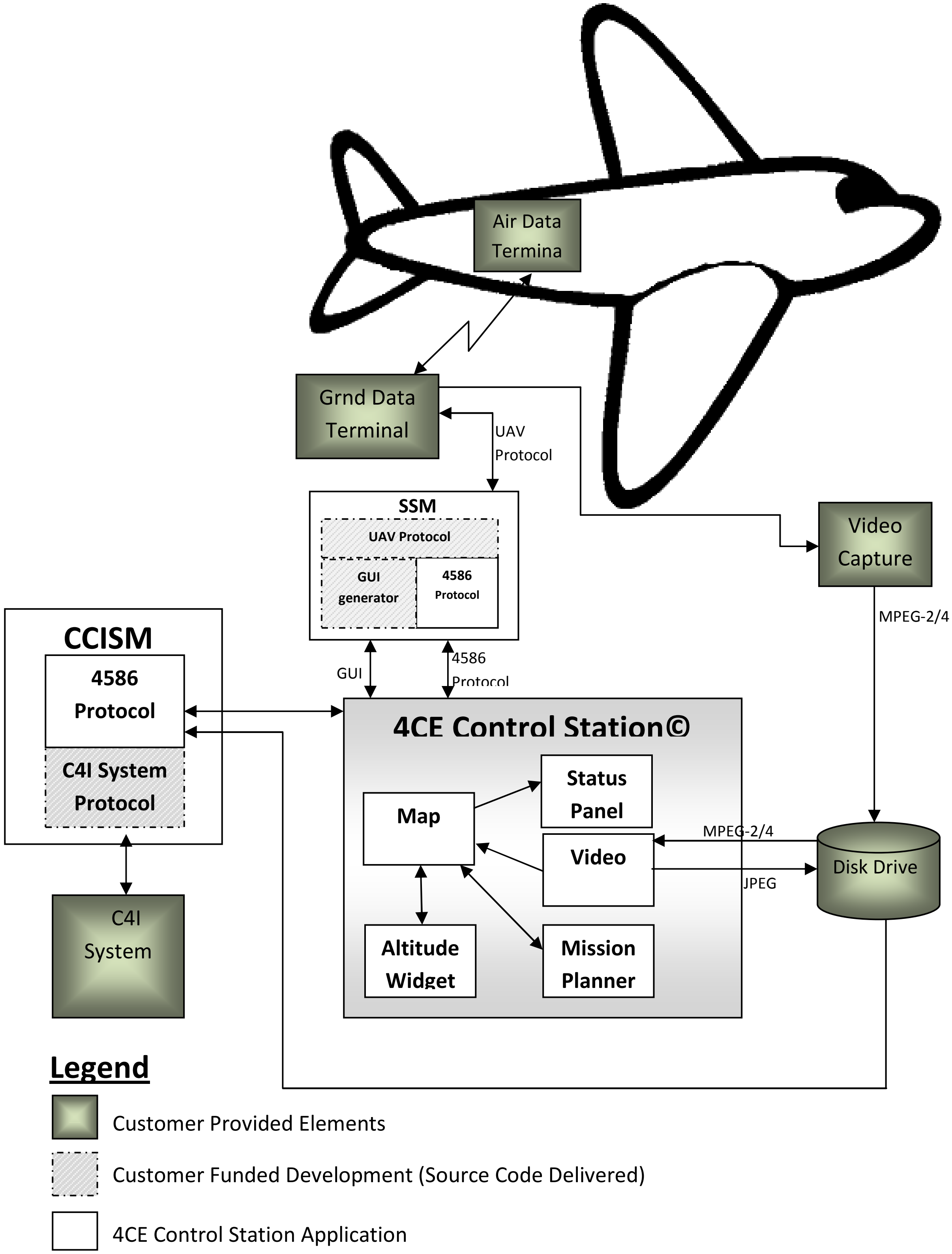


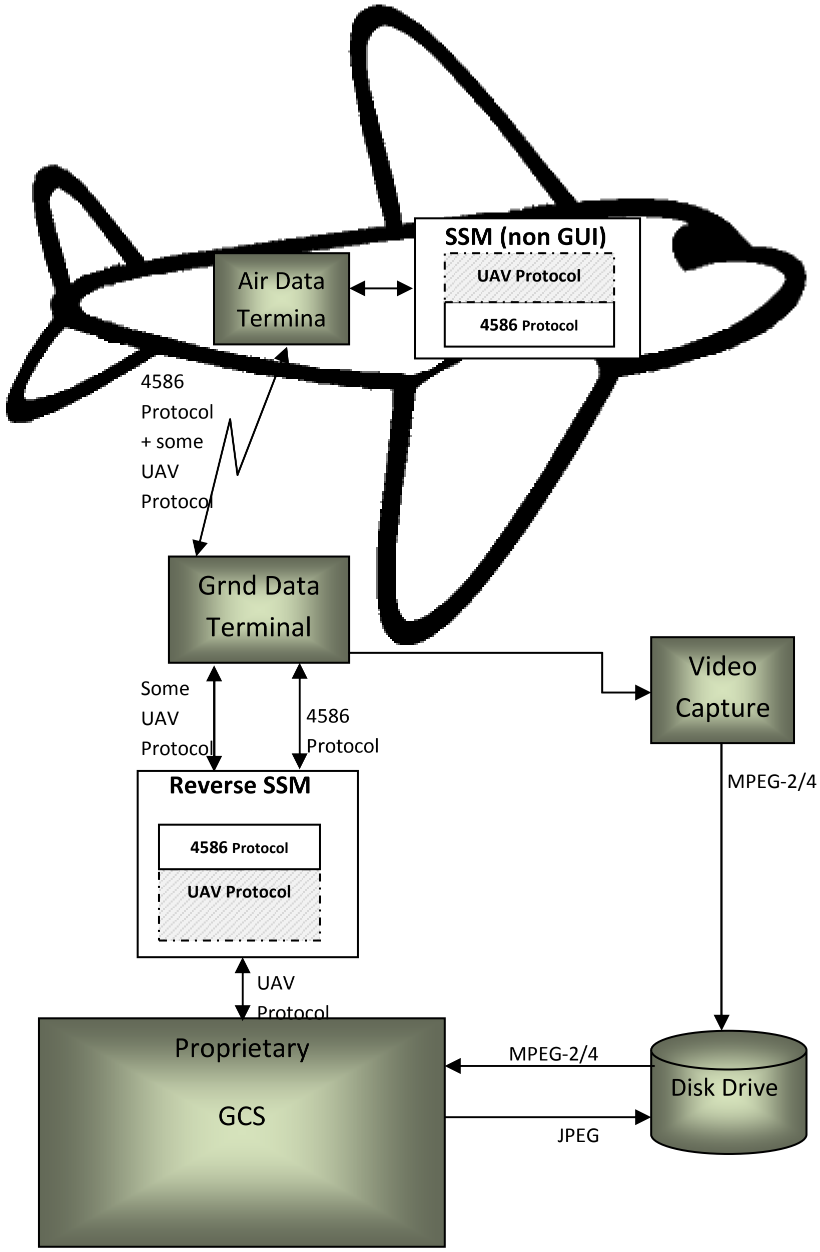

**Figure 3: Ground-to-Air Interoperability**

## Objective: Conversion of Existing GCS to Ground-to-Air Interoperability

The vast majority of systems are developed- at least initially- as stove pipe solutions, with a basic control station custom developed to the needs- specifically, the developmental needs- of the system. There is sometimes a need or desire to make the system interoperable via STANAG 4586 without changing the control station that has been developed.

The InnUVative Systems approach to this kind of development is to combine the airborne (non-GUI) System Specific Module allowing Air-to-Ground interoperability with a Reverse SSM on the ground that converts the 4586 protocol back into the proprietary protocol originally used by the system (see *Figure 4: Converting Existing GCS to 4586*). In this manner, the air vehicle has become interoperable with other 4586 systems by utilizing 4586 messaging across the RF link but the proprietary control station has also attained interoperability with other fielded 4586 air vehicles in that it is able to receive 4586 core messages and translate these into the expected ground control station protocol, as if it were controlling and monitoring one of the vehicles for which it was originally designed.

This decision is best examined to ensure that it is truly a requirement, vice simply a preference, since it is often more expensive and more risky than simply integrating an already 4586-compliant control station into the system. The ability for the proprietary station to support capabilities that are not present in the native system are likely to be very limited due to the legacy of the developmental effort focussing on the target system, not on a generic solution. However, in the cases where it is well and truly a requirement, this approach allows a path forward to some degree of interoperability for such system-specific control stations.




## Legend

- Customer Provided Elements
- Customer Funded Development (Source Code Delivered)
- 4CE Control Station Application

**Figure 4: Converting Existing GCS to 4586**

## Objective: Advanced User Interface with Cross Domain Interoperability

When the objectives of the system integrator are to achieve full Air-to-Ground interoperability as well as to control unmanned vehicles in domains other than air (e.g. ground, sea, underwater or space) then InnUVative Systems' 4CE Control Station supplies just such a solution. The 4CE Control Station has been developed to support not only the STANAG 4586 Interoperability standard for air vehicles but also has an SSM available that supports the Joint Architecture for Unmanned Systems (JAUS) interoperability that is promulgated by the Society of Automotive Engineers (SAE) (see *Figure 5: Advanced Cross Domain Interoperability Solution*).

Furthermore, since it was designed from the start with cross domain implementations in mind, the 4CE Control Station has developed a domain-agnostic control and status interface that allows operators to easily switch back and forth from air vehicle to ground vehicles to sea vehicles using the same control interfaces for each. This allows for easily trained, intuitive and concurrent operations of multiple vehicles across different domains.

Any system integrator needing to quickly become both STANAG 4586 compliant and support operations of ground, sea or other vehicles can achieve this simply through integration to the 4CE Control Station, developing an SSM for their system.

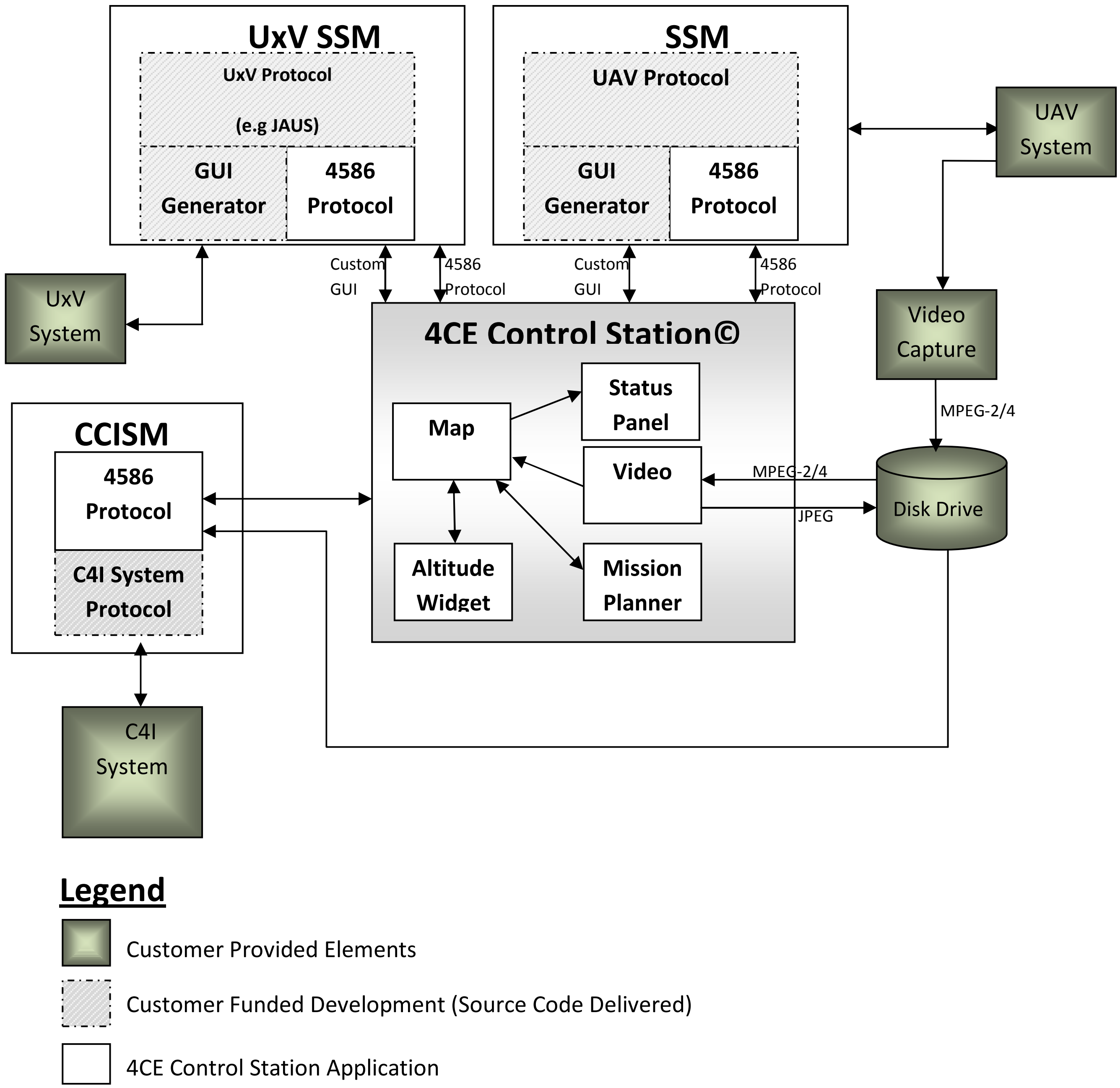



**Figure 5: Advanced Cross Domain Interoperability Solution**