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# The Role of HUMS within the Evolving Generic Vehicle Architecture – the next iteration

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**Abstract**

The term 'Generic Vehicle Architecture' (GVA) refers to the infrastructure required to mount and integrate the range of equipments, sub-systems and crew stations to be fitted to the platform. This includes all aspects of the infrastructure including the Electronic Architecture, Physical Architecture and Power Systems.

The overarching principles for the GVA are openness, modularity and scalability. The drivers for a GVA are cited as economic, as well as practical. The cost of delivering a land platform, integrating multiple OEM capabilities and Total Cost of Ownership is significant. The practical benefits in terms of availability and reliability are apparent.

The Architectures for Electronic Force Protection, for Hard Kill DAS, and for CIS have also evolved independently of the GVA through necessity. There is recognition that Information Assurance requirements will also influence the future of all 3 architectures.

For the 3 architectures to achieve synergy (the whole being greater than the sum of parts) a number of concurrent activities can iterate to a future GVA that meets the MOD vision.

Such activities will include: the development of GVA compliant components (such as; an Intelligent Power Distribution Unit, a GVA compliant Crew Information Screen); the development of a generic protocol for Data Access that integrates/arbitrates messages from all three architectures; the development of platform designs that maximise the benefits of the GVA and reduce weight, power, volume on land platforms. These initiates allow the introduction of Land HUMS to be far more controlled and planned.

**Final Paper:**

## Introduction

## Overview

Land Vehicle HUMS has been slowly evolving over the past 10 years but has faltered due to the lack of standardisation and the failure to coordinate a full requirement covering the range of systems involved within the vehicle operations. Unlike aircraft or helicopters it was deemed that a case for HUMS could not be made around safety requirements but should be focused upon usage and environment. It was only when vehicles were considered to be part of a much wider system, when deployed into theatre, that the need for accurate information on Health and Usage was recognised and worked towards.

With Communications, ISTAR, Electronic Counter Measures, Power Management/ Distribution, Weapons, Situational Awareness, Soldier systems, Ammunition and Automotives all requiring to be monitored for tactical decision making, HUMS gathered pace as a requirement.

The UK MOD has recently published a defence standard (DEFSTAN) for Generic Vehicle Architecture (GVA). The standard has caused much debate in military circles and within the Defence Manufacturing Industry. Notably it has also attracted the

attention of the non- Defence commercial and automotive sectors.

The standard's principles are to have an open, scalable, and modular approach to vehicle systems integration. It shall be applied to all future land platform procurement and current platform refurbishment and upgrade programmes. The standard has drawn on a major piece of work that has been running for over 10 years on vehicle systems integration. With the recent operations in Iraq and Afghanistan there has been a recognition that the UK military land platforms were neither suited for the unique requirements of the theatre nor indeed for the emerging requirements of a fast changing technical adversary. The procurement process in such a situation is necessarily speeded up. UK MOD now finds itself with an eclectic mix of vehicles designed for a cold war long over, a counterinsurgency in Northern Ireland, NATO operations, and now with a fleet tailored for the current operations.

Across the fleet there is little consistency in vehicle architecture. There are over 20,000 vehicles in the MOD – over 12,000 of which have recently been through a major communications upgrade during the installation of Bowman. Over 5000 vehicles have also either been upgraded specifically for Iraq/Afghanistan, of which a significant proportion are new vehicles procured under urgent operational requirements (UOR) procedures – and are largely off the shelf vehicles and modified to a theatre entry standard.

Had the Generic Vehicle Architecture Defence Standard existed 5 years ago the picture might have looked different today!

Now that we have the infrastructure in place and fielded this will allow military users to be able to gather, store and despatch individual vehicles and therefore fleet information to a raft of users.

With the GVA architecture, sub-systems will communicate and transmit data using commonly agreed protocols. The advanced ISTAR technology could be used as local bearers, transmitting HUMS data via secure satellite communications back to users wherever in the world.

## 1.1 Principles

The principles of the Generic Vehicle Architecture are simple. To mandate a common physical, network, data and information standard for all vehicles

The standard is heralded as open: e.g. USB for connectivity; modular e.g. using tested complimentary technologies; and scalable e.g. CANbus.

Additionally it has been declared that the standard would not do in hardware what can be achieved in software.

And whilst you would expect this to be implicit in the name – the standard applies to all land platforms, and is mandated.

The standard has included in its description the boundaries between it and other platform role specific systems and subsystems – essentially the GVA describes the Data, and Power Standards, the HMI, and HUMS standard, as well as the automotive gateway for data, some mechanical standards and expects to describe the interfaces with Legacy equipment, or role specific equipment. Figure 1 shows the GVA and its system boundaries.

## 1.2 Perceived Advantages

### 1.2.1 Cost

The MOD believes that the advantages of this approach lay in the through life costs of fleet management. The benefits come from the reduced cost of technology insertion and over time the economy of scale (relative to existing fleet sizes) of procuring technology refresh and components for platforms across the land environment.

### 1.2.2 Agility

There is also a perception – yet to be tested – that by using open standards, already universally accepted, that cost of design, and component procurement will be lower, and bespoke military build will be replaced by off the shelf components.

## 1.3Implementation Method

The implementation is going to be a challenge. Whilst the advantages may seem obvious there are some cultural, technical and financial hurdles to overcome. The intent is that the DEFSTAN will be reviewed and reissued every 18 months to keep it in date as technology progresses and new standards are developed.

### 1.3.1 Cultural

The standard will be mandated – but certainly in the UK MOD there is a challenge to ensure that each Delivery Team conforms to a common standard.

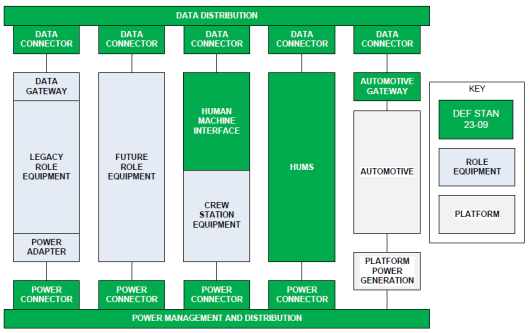



*Figure 1 The Boundaries of the GVA*

Such standardisation may undermine their independence and may on the face of it limit their procurement options, especially in today's urgent operational requirements where no vehicle may exist off the shelf with the mandated standard!

Counter intuitively the culture of accepting existing GVA conforming equipment to meet perceived future requirements also is a challenge to a procurement system that is faced with long procurement timelines, long in service life, and a wide spectrum of potential environments in which to deliver the capability!

Industry also has a cultural challenge to overcome. Defence has traditionally been a cash cow in respect of the provision of bespoke and consequently high margin products and services. Usually the mark up is entirely legitimate based on the unique nature of the requirement, or some time the insistence of the customer who has not been as SMART as they are now becoming.

It is also not in the Defence Industry's financial interests to agree to a common standard where it allows the customer to move freely between suppliers.

HUMS technology is certainly at the forefront of this cost model. The traditional airborne HUMS technologies are orders of magnitude above the cost required for Land vehicles. It is certainly true that the software standards are far less harsh and the hardware based on automotive specifications but reliability and accuracy are still implicated in the requirement. The expectation for most militarised Land HUMS data collectors are sub $5,000.

### 1.3.2 Technical

The 18 month refresh and reissue of the DEFSTAN is laudable and certainly recognises that changing nature of many of the underlying technologies. The challenge here is to ensure that the procurement cycle is also within or at least recognises that changing nature of both the technology and the DEFSTAN! A vehicle procurement will rarely take 18 months.

The freedom of action and financial agility to technically refresh the platform as the DEFSTAN evolves is key to the success. And whilst arguably the scalable, modular, and open nature of the standard should allow for such refresh to occur some of the enduring technologies are likely to drive the

architecture for significant periods – by default a number of iterations of the standard.

### 1.3.3 Financial

The standard is declared as applicable to all new and re-furbished legacy platforms. The rationale is that the through life cost of fleets and fleet management are reduced pan-land environment. This must be measured and re-enforced because whilst the Delivery Teams remain independent savings are likely to fall elsewhere (and not incentivise the Delivery Team to procure to the standard).
Worse, the savings may become completely masked by the cost of implementing the standard!
Development of sustainable cost models is key in justifying the implementation of GVA with HUMS the core technology in establishing savings to the end user.

## 2. Other Architectures

The standard has recognised that a GVA is challenged by scalability issues, both horizontal and vertical scalability. Horizontal scalability is defined as; the ability of systems performance to be scaled by the addition or subtraction of systems elements. Vertical scalability is defined as; additional resources being available or added to existing systems elements to increase their performance. The challenge lies in the rapid iteration of technology. Moore's law doesn't look as though it is slowing up and it too has an 18 month cycle. Recognising where an emerging technology sits on the Hype curve is fundamental to its adoption. [Gartner Technology Hype Curve describes whether a technology is in its peak of inflated expectation or on the plateau of productivity!]
From a platform perspective the interface between the GVA and other architectures also becomes a major challenge. The GVA recognises the following potential interfaces (and hence challenges);

- Security of the data architecture;
- Safety Critical Systems;
- Communications Systems;
- Defensive Aids (hard Kill DAS, and ECM);
- Remote Weapons Systems.

Not least a recognition of the platform EMC characteristics with all such subsystems present! Whilst the standard has addressed them generically two are worthy of mention explicitly;

### 2.1 HUMS Architectures/Standard

In the UK HUMS came to the fore with the introduction of Defence Standard 25-24 which outlined the military specification for HUMS on Land vehicles. This was a major step forward for HUMS in the Land arena, giving credibility to the emerging technology. The parallel development of automotive standards such as JP1939 and Milcan further enhanced the Land HUMS position.
Over the 4 to 5 years Land HUMS providers have been able to focus upon a number of standards and initiatives and more the technology from vision to reality.

### 2.2 Communications

The GVA is also explicit about the requirement to work with the extant communications system in service with UK MOD – Bowman. But also recognises that Bowman (an above RESTRICTED system) will require an interface to allow the GVA to monitor and control it.
The GVA also recognises that alternative or additional communications systems may be fitted to meet specific requirements! Both statements appear contradictory, and also do not reflect the challenge of interfacing multiple sources of information to the

communications subsystems either from within or without the GVA for the benefit of off platform users. The transmission of information, in near or real time, is key to the success of networked enabled capability.

## 3. Future Iterations

So what about the next iteration? The GVA is a fantastic start. It puts the MOD in the moral high ground with a standard for all future vehicle procurements. With the best of intents to have a common architecture across the land environment to reduce costs of maintenance, and to improve cross platform functionality of systems and sub-systems. Additionally they will iterate the DEFSTAN on an 18 month cycle. Essentially allowing continued engagement and an iterative improvement of the standard.

As it stands the architecture includes very little, and much of what it doesn't include can claim independence for safety, security, or legacy reasons not to be implemented within the intent of the GVA.

So what would be important in terms of the next iteration of the standard?

### 3.1Role/Sub System Endorsement of GVA – Physical/Mechanical standards.

A quick win is to get all mechanical interfaces, regardless of subsystem to conform to the GVA architecture. So notwithstanding the nature of the sub-system – its independence or otherwise of the GVA, it should be governed by the same mechanical standards. This is where the GVA is explicit and stands sensibly. By this measure, EMC standards, cabling, connectors, and physical installations such as antennas, brackets, mounts, racking, trunking, can be standardised.

Where currently many of the sub-systems are procured by different Delivery Teams there is little time or stomach to engage in the holistic platform integration that would realise savings on power, volume, weight, and redundancy.

The GVA needs to be mandated not just to the platform integrators within industry but also internal within the MOD.

### 3.2An agreed Safety Critical and Security Architecture

The GVA needs to iterate the detail on Security architecture and Safety Critical elements. Safety critical elements of the architecture should be included and explicit details can be included on the design of the transport layer, network and the associated protocols. Industry has numerous proven safety critical architectures that rather than be interfaced could be adopted as part of the standard.

As far as security is concerned there is often confusion as to the requirement and intent of securing a vehicle. Predominately it falls into two categories; protection from compromise of equipment that is classified because of its disruptive design or technology; or protection from compromise of information that would give benefit to an adversary. There are many pieces of equipment which store information and consequently fall into both categories! An architecture that describes a shared transport layer, with different networking protocols –operating at different classifications would reduce the requirements for multiple discrete security infrastructures. With some clever information management and holistic design the removal or protection of classified information can be achieved with no requirement to remove physical devices.

Importantly it may be necessary to specify that a discrete safety critical infrastructure

exists independent of normal or routine infrastructure. Similarly a discrete security architecture may be required for high classification information. But on both counts the benefits of all the other subsystems are negated and some duplication introduced.

### 3.3Develop HUMS, and SIE (System Information Exploitation)

The existing GVA contains some detail on HUMS. It is fantastic that it is included. The business case for HUMS is not often understood, and rarely does it survive contact with the programmers when money is scarce.

The definition for HUMS in this context remains too constrained. Already across the automotive industry HUMS has a much wider remit than just the exploitation of information generated from the automotive elements of a platform. Indeed the usage and health of all the other subsystems generate much richer situational awareness and can be utilised for the benefit of the mission as well for the benefit of decision makers, both operational and logistical. Data sourced from across the platform can be used, stored, and processed to generate a wide range of useful information. Compare the current with historical and you have a rich platform centric operational picture that is in context with the tactical environment. Then use the information, off-platform aggregated and consolidated, for operational, diagnostic, prognostic, training and for strategic decisions. The SIE could address this wider use of the information.

Critically the standard also fails to recognise the inherent challenge with setting the standard too proscriptively in this area. What happens when the user wants to measure something not detailed in the standard? By having a generic data structure (schema) for both the HUMS devices and the captured data any current and future information exchange requirement can be catered for. There is an implicit suggestion that the system will collect data inclusively rather than by exception. This will generate significant amounts of data with little or no benefit.

### 3.4 Opportunities for Industry

HUMS is now an important element in military Land thinking worldwide as governments look actively towards cost savings in the difficult economic climate. Decisions on support, maintenance, logistics, safety and tactical availability are all enhanced by HUMS information. No longer is the decision on Land HUMS based just on affordability or justification, now the argument has moved towards better analysis and interpretation of the data. Without data, no improvements can be considered or made, the sentence used at this conference in 2003 “that which can be measured can be improved” is still valid.

Effort is now being applied by the user community to look at how best to acquire, transport and analyse the data. The potential use of ISTAR bearers, ISTAR tactical hubs, satellite download, data warehouse and linked systems for logistics and tactics. The importance of industry working with common standards is key to success. The emergence of DefStan 25-24, GVA, GBA and others, allow industry to develop and grow technology embracing architectures and thus establishing profitable systems through volume sales.

Industry has the opportunity to develop a service provision of consistently delivering the integration of systems and subsystems on a GVA/HUMS compliant platform.

In both instances Industry will face the dilemma of producing a non-GVA/HUMS compliant product or integration if it feels its design will improve capability over competitors sufficiently to entice the MOD away from the GVA/HUMS. Clearly

industry may have a Machiavellian agenda to create a monopoly as well. Defence must recognise that is in Industry's interests to increase margins, profitability, and market share – as it is in MOD's interest to ensure a Defence Industry survives!

Perhaps with the introduction of the GVA/HUMS newcomers to the defence supplier base will come and challenge the traditional domination by the defence old guard.

### 3.5 SUMMARY

The GVA/HUMS standard is welcomed, and starts the UK MOD on a journey of standardisation and holistic thinking for its land platforms.

It has addressed in the first instance the physical and mechanical interfaces, as well as HMI and HUMS.

There is a planned 18 month iteration of the standard also welcomed to ensure that it matches technology improvements and changing standards. As it stands the GVA/HUMS standard is wanting in some areas with respect to interfacing with other role specific subsystems.

The next iteration should address the information architecture in light of the systems and subsystems exploitation. But also elaborate on the inclusion in the architecture of subsystems such as communications, defensive aids, which should be considered generic rather than role specific.

The GVA/HUMS presents opportunity to industry and defence and yet from both ends of the telescope there is much to do, culturally, financially and technically.

## 4. References

[1] UK MINISTRY OF DEFENCE, Defence Standard 23-09, Issue 1, 20 August 2010, Generic Vehicle Architecture (GVA)