APPLICATION OF DDS TO GENERIC VEHICLE ARCHITECTURE AND GROUND BASED AIR DEFENCE

MAY 22 2019

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LOCKHEED MARTIN MISSILES & FIRE CONTROL

Headquartered in Dallas, TX 2017 Sales: \$7.2B ~15,300 Employees Worldwide **18 Major Operating Locations Integrated Air** Advanced Programs Tactical & Strike Sensors & **LMUK Ampthill** Energy & Missile Global Missiles Defense **Special Programs** Sustainment



LOCKHEED MARTIN UK -



- MANUFACTURING:
- 20,000 M² OF FACILITIES
- RV COMPOSITE MANUFACTURING
- HYDROCLAVE FACILITY



- SPECIALIST PROTOTYPING FACILITY
- SYSTEMS INTEGRATION LABORATORY
- SYNTHETIC ENVIRONMENT FACILITY
- ADVANCED COMPOSITE MANUFACTURING
- WIRE ARC ADDITIVE MANUFACTURING
- \circ TURRETS
- FABRICATION / MACHINING / PAINT/ ASSEMBLY / INTEGRATION & TEST



• AMPTHILL – 64 ACRE SITE



- LMUK Ampthill is the only wholly owned UK Site.
- LMUK Ampthill is a Lockheed
 Martin Company
 Subsidiary.
- LMUK Ampthill is able to operate at Top Secret security classification levels and above – List X.

GENERIC VEHICLE ARCHITECTURE (GVA)





WHY ARCHITECT OPEN



- Workload sharing
- Additional sub systems integration
- Additional sensor integration



WELL

GENERIC VEHICLE ARCHITECTURE (GVA)

- An Open Architecture for electronic systems on military vehicles
- Reducing the cost of through life ownership and upgrades



MODULAR MISSION SYSTEM

- Developed to be GVA (NGVA) compliant from the outset
- Open, modular, scalable architecture
- Class leading latency and performance
- Unique graceful degradation features
- Reduced spares holdings







GROUND BASED AIR DEFENCE (GBAD)





BENEFITS OF OPEN ARCHITECTURES

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Traditional Hierarchical Single Effector Solutions Stove-piped Designs Local Picture

Networked

Shared Threat Evaluation and Weapons Assignment

- Open Architectures, Standardised Interfaces
- Shared Wide Area Situational Awareness





OPEN ARCHITECTURE WITH A DDS BACK BONE

GBAD ARCHITECTURE EVOLUTION





- SkyKeeper Currently it is fielded in two forms with the British Army (LEAPP & AS&W):
 - Land Environment Air Picture Provision (LEAPP)
 - Providing Airspace Management and Surveillance for the Land Component Commander
 - In service since 2014
- Automated Sense & Warn (AS&W)
 - Is a variant of LEAPP delivering an advanced, deployable capability able to detect and classify incoming ballistic projectiles, and alert threatened personnel
 - In service since 2009, rearchitected with DDS in 2011



SkyKeeper (the brains behind FALCON)

- SkyKeeper is a evolution of both LEAPP and AS&W providing a Universal BMC4I backbone with open DDS interfaces.
- Architecture allows C2 of any sensor / weapon pairing across C-RAM/ VSHORAD/ SHORAD/ MRAD domains
- Unique capability in current marketplace



SKYKEEPER ARCHITECTURE



- SkyKeeper's flexible System Architecture supports a wide range of operational scenarios, ranging from fielding a single Node for early entry capability, through to a fully networked Multi-Node system
- Components act as deployable 'processing nodes', either singly or as part of a distributed network
- Provides capability at all levels of the Order of Battle (ORBAT)
- Supports deployment throughout the command structure, and supports information flow up and down the hierarchy
- Existing SkyKeeper instantiations are deployed at Division, Brigade, and below
- Core functionality is built on an DDS backbone.

APPLICATION OF DDS





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UK & NATO MODEL BASED SYSTEM ENGINEERING



LAND DATA MODEL GENERATING DDS IDL

CONFIGURING DDS



TO ALLOW INTEROPERABLE SYSTEMS AND SUB SYSTEMS

INTEROPERABILITY RULES

- Value initialisation of
 - Topic attributes.
 - permutations of cardinality
 - Use of attribute optionality
- Resource and Instance Identification
- Topic Naming
- Type Naming
- Command Response
- DDS Domain Numbering
- QoS Configuration
- Disposal Rules

Rule	Rule Name	Rule Definition
Ret		
A1	Initialisation of Unused Identifier Types	Associations between classes at the PIM level are translated as foreign key attributes in the IDL and the code generated from it. When a class generated from IDL has a PIM cardinality of 01 on its end of the association this is generated as a foreign key attribute of type P_LDM_Common::T_IdentifierType. When there is no class to refer to a standard Null reference value shall be used: T_IdentifierType is {0, 0}, i.e. Resourceld 0.
A2	Initialisation of Used Identifier Types	The Standard Null reference defined in rule A1 shall not be used for the T_IdentifierType value of a resource for an LRU in a key field of a Topic. For example <i>foo.A_sourceID</i> , <i>foo.A_recipientID</i>
A3	11 Cardinality Publication Rule	Associations between classes at the PIM level are translated as foreign key attributes in the IDL and the code generated from it. When a class generated from IDL has a PIM cardinality of 11 on its end of the association this is generated as a P_LDM_Common::T_IdentifierType attribute. Where a generated class has this cardinality on a foreign key attribute and has no set operator its value, then the Topic shall only be published with a valid Resource Identifier in the attribute.
A4	1 to 1 Cardinality Initialisation	Associations between classes at the PIM level are translated as foreign key attributes in the IDL and the code generated from it. When a class generated from IDL has a PIM cardinality of 0.1 on its end of an association this is generated as a foreign key attribute of type P_LDM_Common::T_IdentifierType. Where a generated class has this cardinality on a foreign key attribute with an operator to set its value, the Topic shall be published with the standard Null reference value for that attribute until the set operation is used to populate it (e.g. Mount::Mounted_Equipment).
A5	0 to 1 Cardinality Initialisation	Associations between classes at the PIM level are translated as foreign key attributes in the IDL and the code generated from it. When a class generated from IDL has a PIM cardinality of 01 on its end of an association this is generated as an foreign key attribute of type P_LDM_Common::T_IdentifierType. Where a generated class has this cardinality on a foreign key attribute, the Null reference shall be used when there is no association.

APPLICATION IS REQUIRED TO ALLOW SYSTEMS TO BE INTEGRATED

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FUTURE IMPLEMENTATION

- Our GBAD and GVA products
 - Require Safety Buses
 - Require Secure Messaging
 - Cross Security Domain Messaging
- The challenge is to deliver DDS with
 - Really fast, deterministic messaging
 - Bound latencies
 - Time Synchronisation
 - Fault tolerance
 - Dynamic Scheduling
 - And make it secure
- Using one of the Ethernet technologies out there e.g. TSN/TTE.





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