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Use of the OMG DDS standard in Simulation. A new Way for developing Real Time Distributed Simulations

NADS
Nextel Aerospace, Defence & Security

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- **New Trends in Simulation**
- Why HLA and DDS cohabitation in simulation systems?
- Mixing HLA and DDS standards in an open Simulation architecture
- Some use cases

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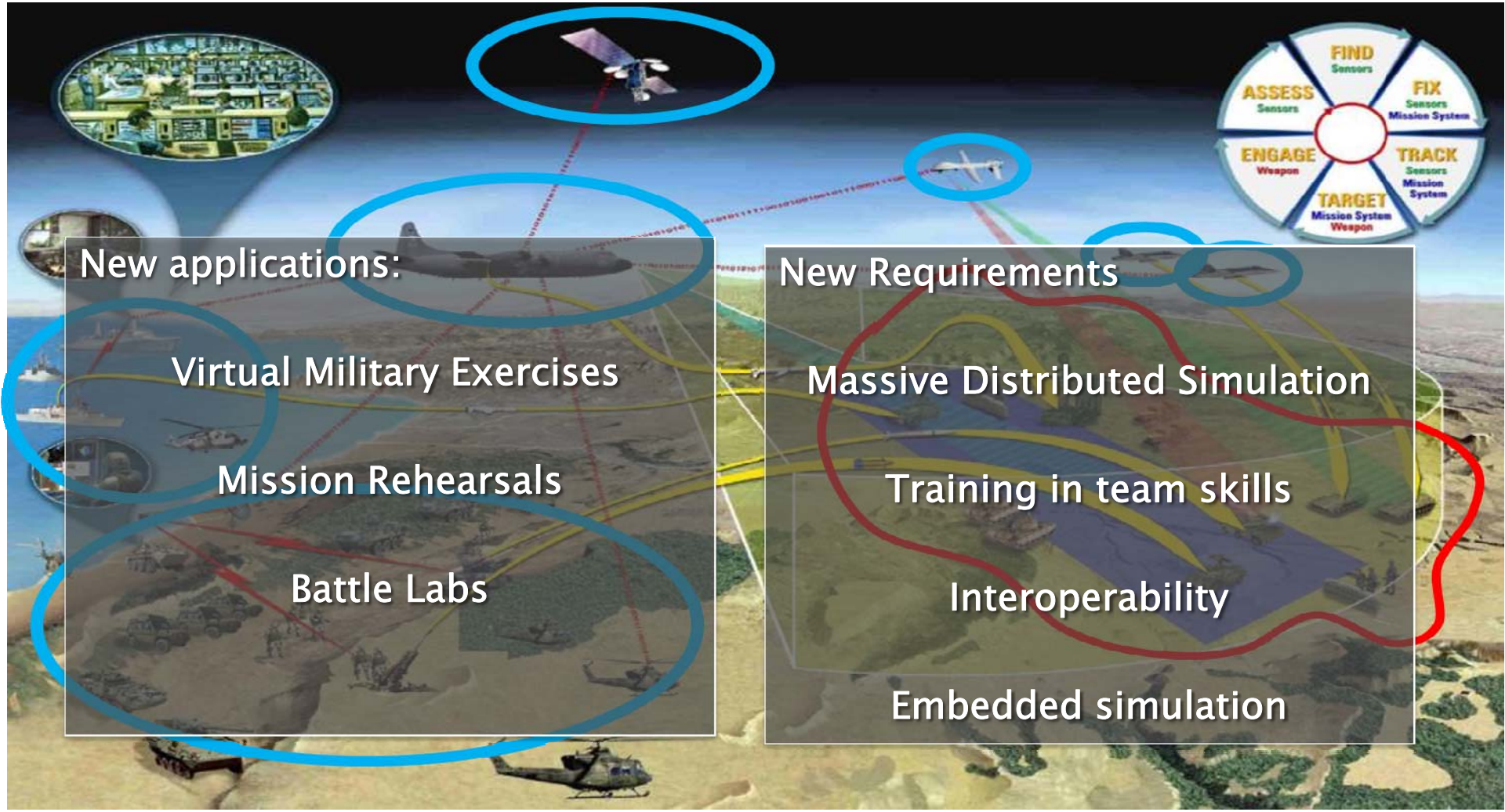
A simulation market in constant evolution …
To integrate in Net-Centric Environments.



… brings new Requirements for M&S Technology

- Simulators as network assets in **Net-Centric federations of Systems**.
- **Open Architectures** and **modular design** for Simulators
- **Plug&play** simulation Architectures
- **Distributed** architectures with **QoS**
- Capability of deployment over **heterogeneus networks.**
- **Development** based on **existing repositories**
- **Seamless interoperability**

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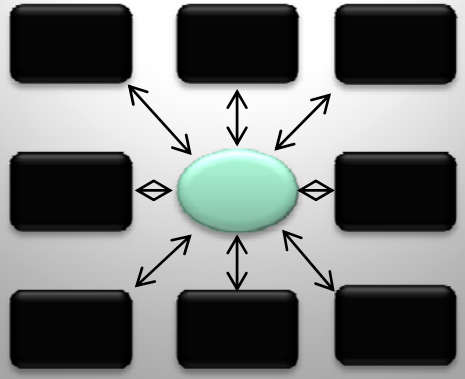
From alone simulator ... → ... To Simulation Networks

Individual Training

- ✓ Individual training
- ✓ Propietary technologies
- ✓ Client-Server Architecture
- ✓ Very few use of COTS
- ✓ Non Interoperable



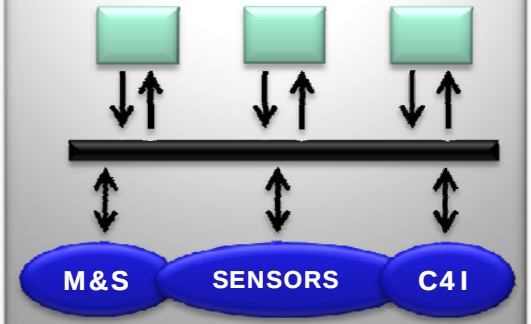
80s,90s

Team Training

- ✓ Tactical Training
- ✓ COTS based (mostly in hardware)
- ✓ Client-Server architecture
- ✓ Simulators as “black box” ystems.
- ✓ Interoperability using GATEWAYS (DIS or HLA)

2000

- ✓ M&S assets in NCW networks
- ✓ Fully distributed arch
- ✓ Data centric design
- ✓ Open architectures for simulators (white-box approach)



2010

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Towards massive distributed Simulation

The Navy identified ***networked trainers as a key requirement in future training systems****. Networking capability exists in many simulators, but frequently the* ***capability is cumbersome to set up and difficult to use, particularly when participants are not collocated****. In addition,* ***the speed is not yet available to support the requirements for real time simulation across distributed networks****. There are work-arounds, but they do not currently support full, real time simulations. The ability to easily and seamlessly link multiple training devices into the same training scenario will greatly enhance the quality and effectiveness of the training.*
[…]
Effective networking of simulators will require a common architecture and industry wide standards*. Over the years,* ***the High Level Architecture has provided the foundation for this standard, but going forward these standards will need to expand to accommodate new capabilities and new participants****. The NASMP needs normalized, consistent architecture and a well articulated business case to justify the investment in the NASMP.*

Is HLA enough?

(*) Extracted from NTSA market survey : **Training 2015: Requirements - Trends - Forecasts for the Decade Ahead.**

The Simulation Standard : HLA (IEEE 1516)

- HLA is a **mature standard for simulation, with next major milestones**:
  - **Born in early 90's** sponsored by US DoD
  - US DoD std in 1998 (HLA 1.3)
  - IEEE std in 2000 (**IEEE 1516-2000**)
  - New release in 2010 (IEEE 1516-2010), best known as **HLA Evolved**.

- **HLA is an architecture** for doing simulation with:
  - **An interface spec**. Defines a **common API** for the HLA middleware : **Run-Time Infrastructure (RTI**).
  - An **Objet Model Template** (OMT). Defines a **metadata model** for HLA simulations.
  - Some **Rules** that simulation must follow to be HLA compliant.

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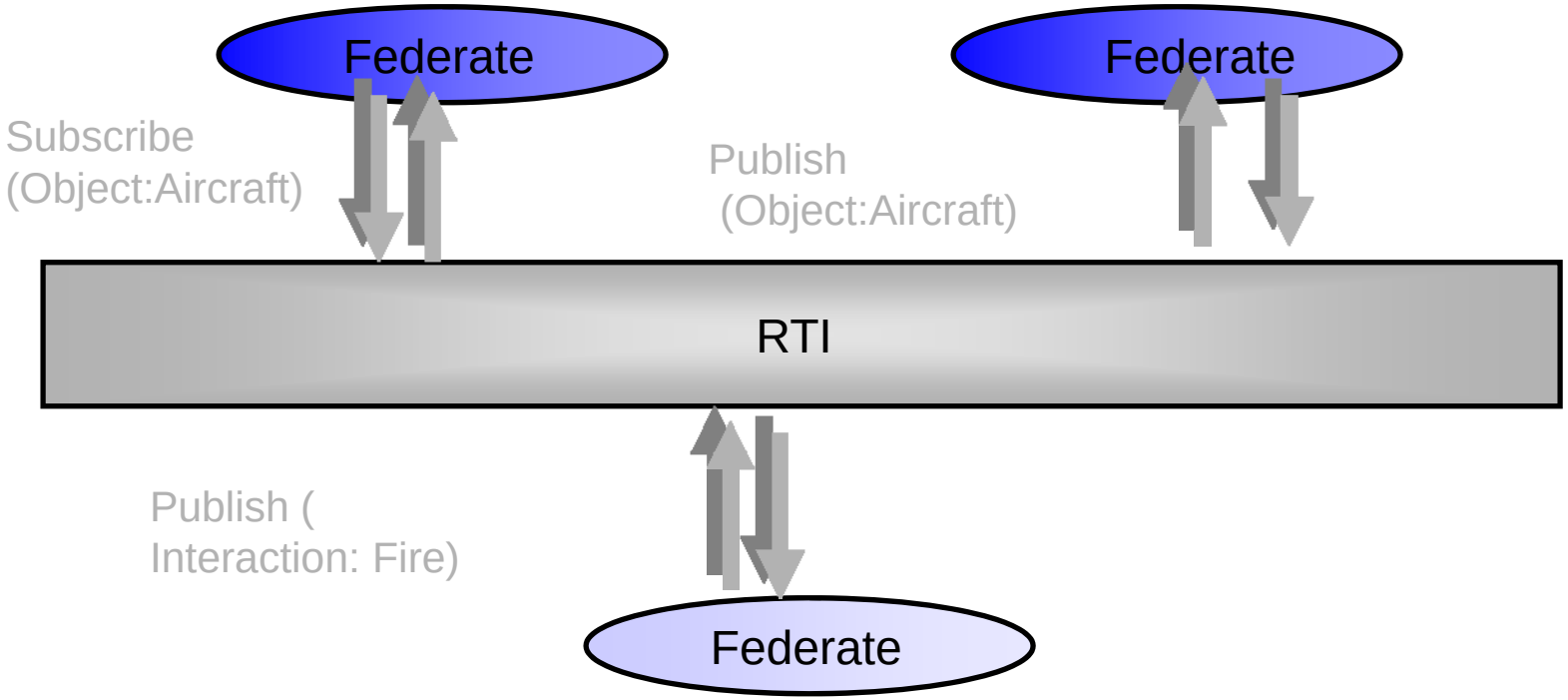
The Simulation Standard : HLA (IEEE 1516)



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The Simulation Standard : HLA (IEEE 1516)

- **Historically, HLA has had some problems ….**
  - **Lack of real time** features
  - The **wire protocol** is not standarized.
  - Mainly you only have interoperability and reusability to the **system level**
  - **Interoperability** with other real systems is **very limited.**

- **HLA evolved** improves some things:
  - Add **some QoS** included (smart update rate, Fault Tolerance)
  - Provides a **web services interface**.
  - Add **Dynamic Link compatibility** for different RTIs
  - Enables **modular Objet Models**.

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Is HLA enough?

1. **HLA Evolved** still **lacks of a wire protocol.**
2. **QoS are very limited**.
3. **Web Services** are not always **the best way of integrating with real-time critical systems**
4. **HLA RTIs performances are not enough for massive distributed simulation** federations with real time requirements.

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DDS vs HLA performances

	Data size (bytes)				
Pitch pRTI	10	100	1.000	5.000	
Update rate	33.863	40.000	16.835	9.174	updates/second
Throughput	3	31	128	350	Mbit/second
Latency	125	140	172	250	microseconds
OSDDS	8	128	1.024	4.096	
update rate	3.939.000	661.120	94.184	23.994	updates/second
Throughput	240	646	736	750	Mbit/second
Latency	90	80	110		microseconds

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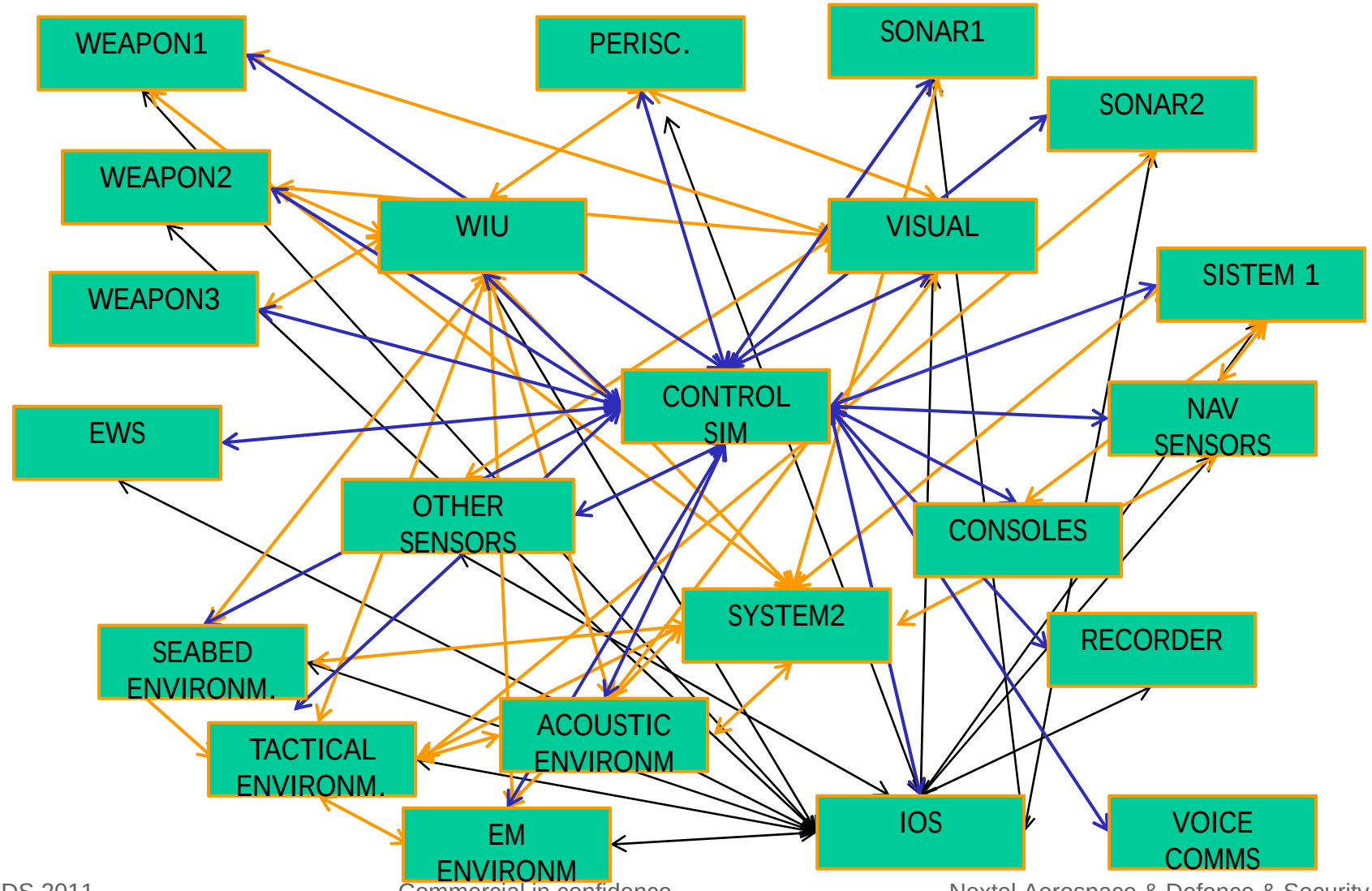
The Traditional software Architecture of a RT Simulator



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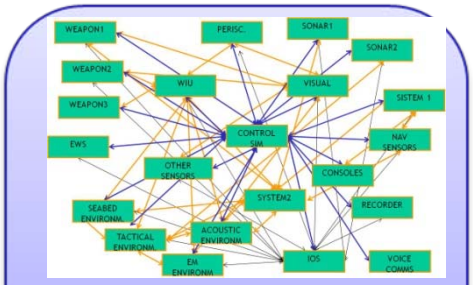
Distributed Simulation with HLA



Simulator 1 (black-box design)

propietary interface

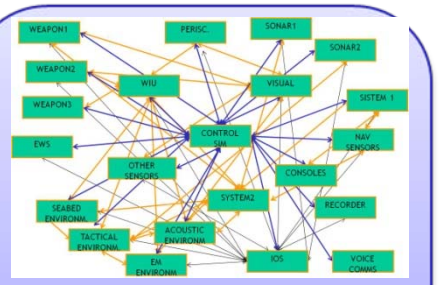
HLA Gateway 1

RTI HLA

Sim A Object Model (SOM)

HLA FEDERATION

Federation Object Model (FOM)



Simulator 2 (black-box design)

propietary interface

HLA Gateway 2

RTI HLA

Sim B Object Model (SOM)

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Our proposal in a snapshot…

Market Requests…

- Open simulation Architectures
- Distributed architectures with QoS
- Interoperate with NEC "clouds"
- Development based on existing repositories
- Interoperability

Our proposal…

- Data centric design based on a HLA & DDS compliant middleware
- Use of DDS for simulation
- DDS as a common messaging technology
- Model Driven Developments
- Cohabitation of HLA and DDS standards.

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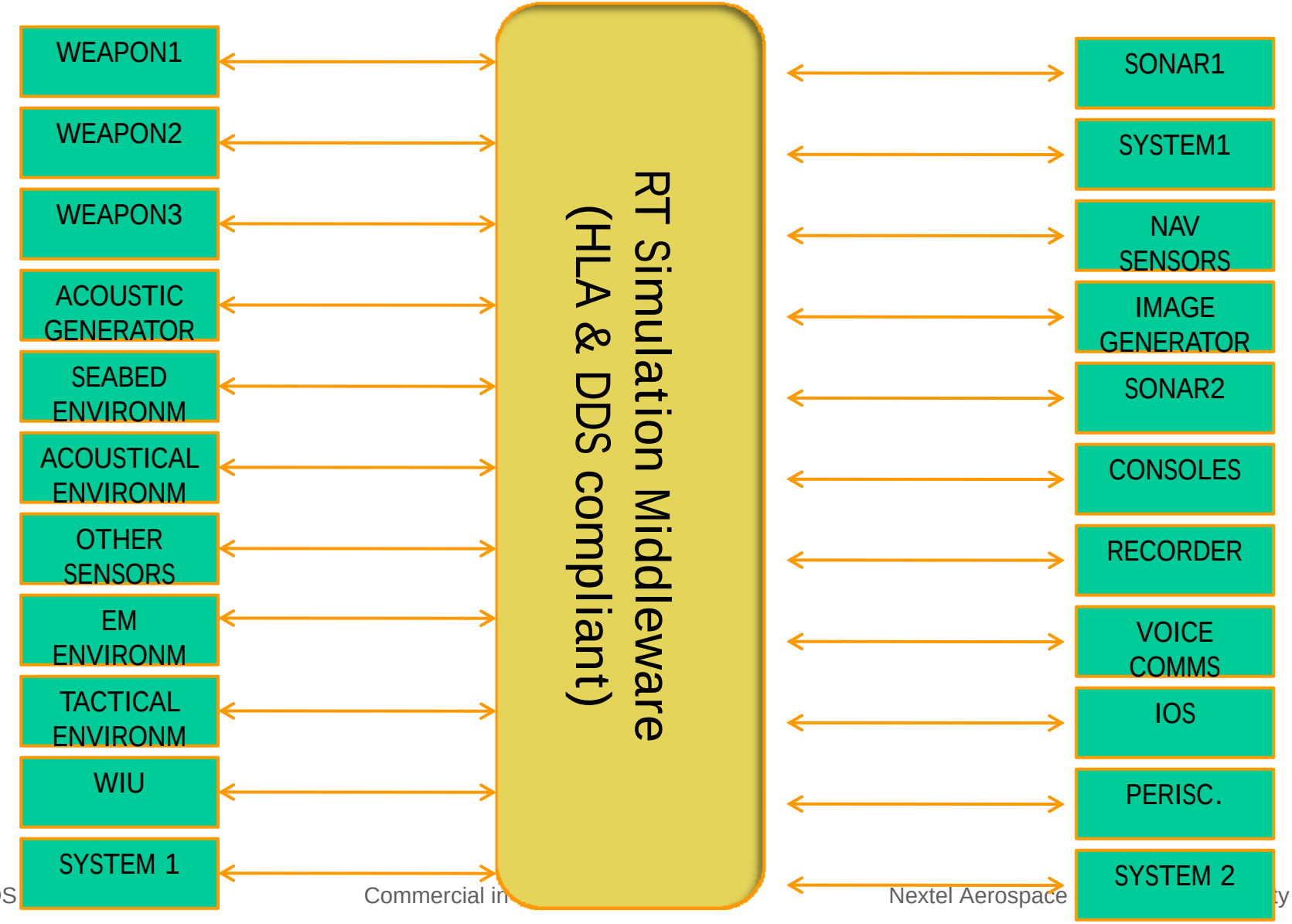
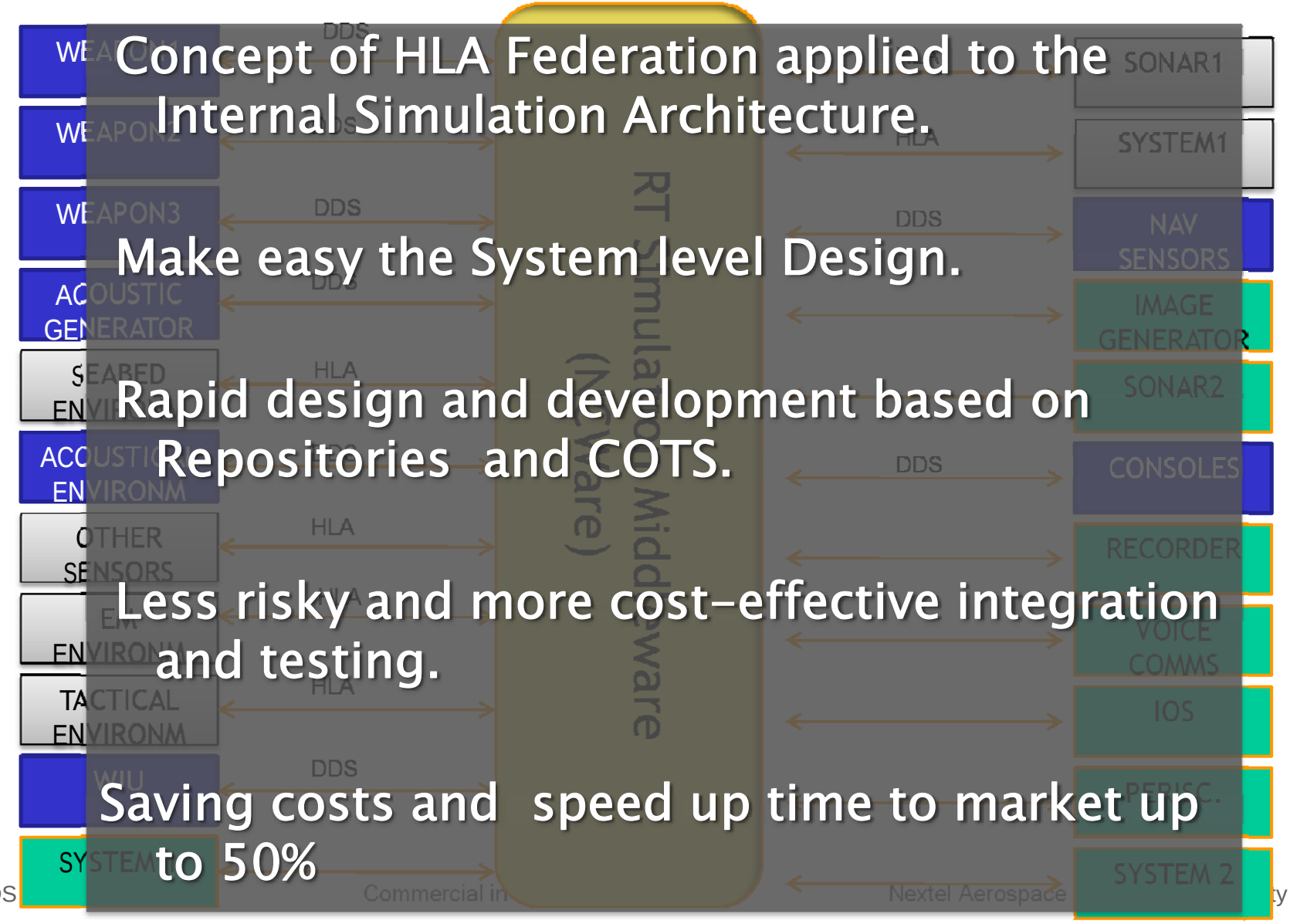
Migrating to an Open Distributed Simulation Architecture



Some advantages of an Open Simulation Architecture



Concept of HLA Federation applied to the Internal Simulation Architecture.

Make easy the System level Design.

Rapid design and development based on Repositories and COTS.

Less risky and more cost-effective integration and testing.

Saving costs and speed up time to market up to 50%

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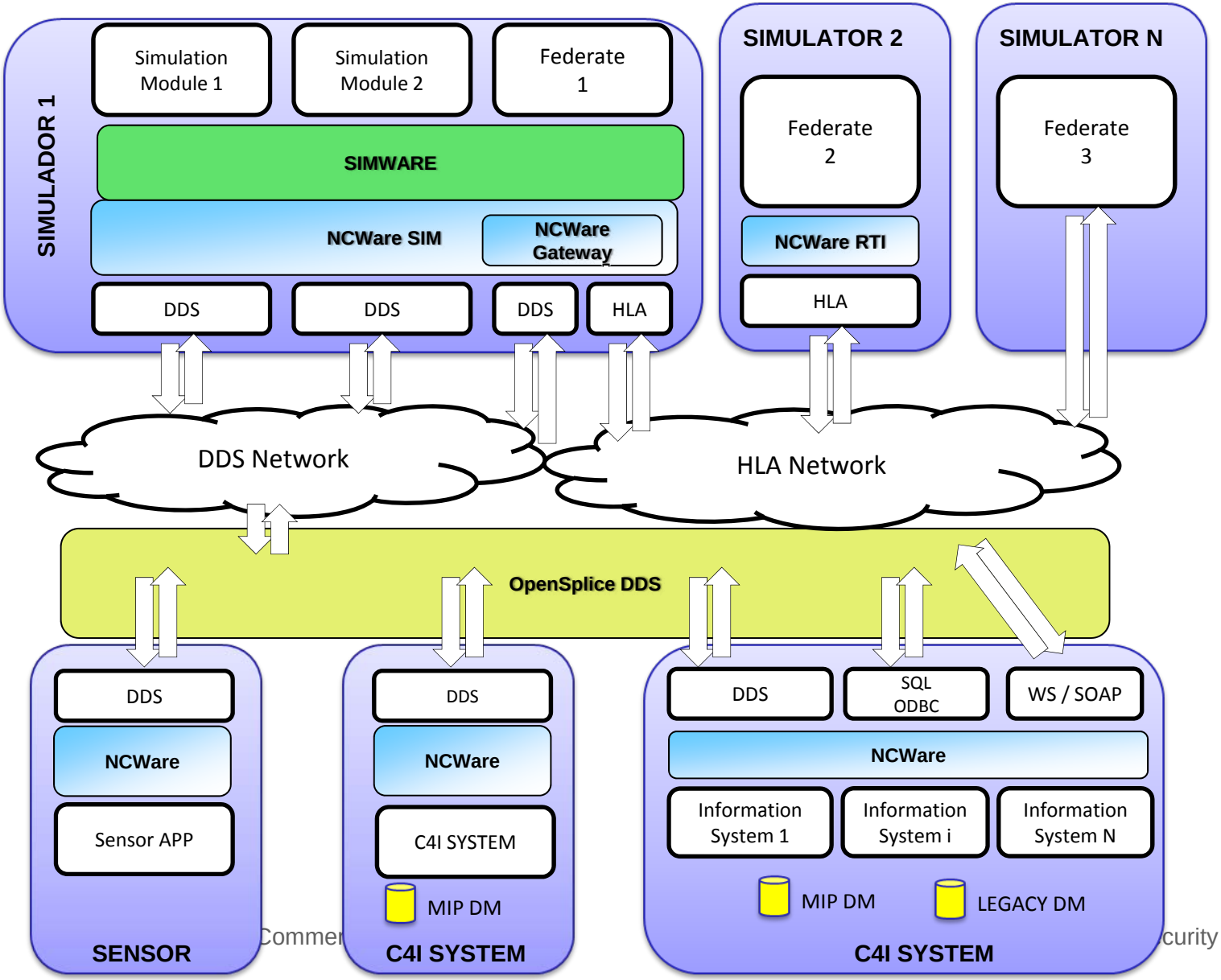
Our technology : SIMWARE



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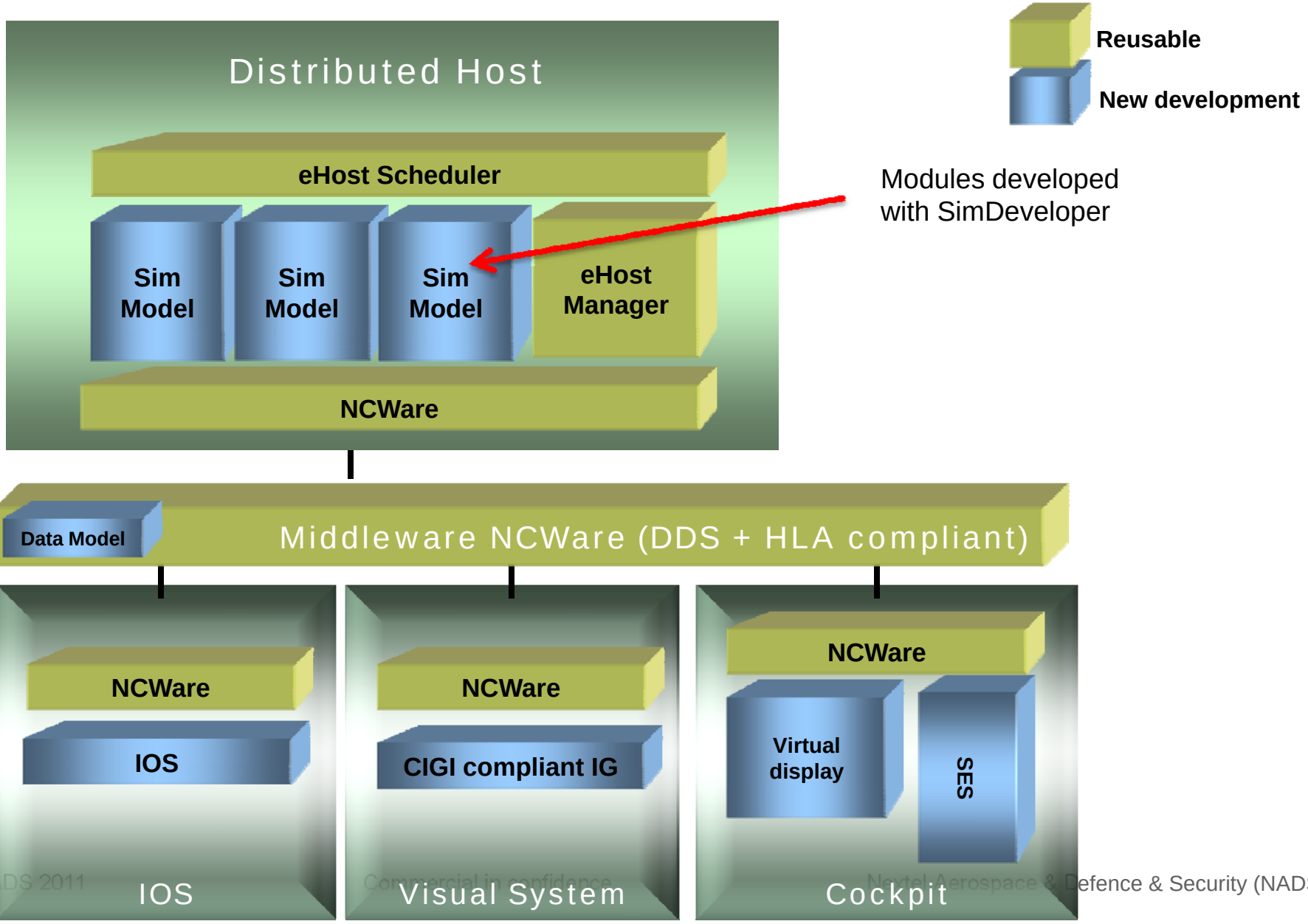
SimWare: Framework for building a Federation of Sim Assets



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- **Some use cases**

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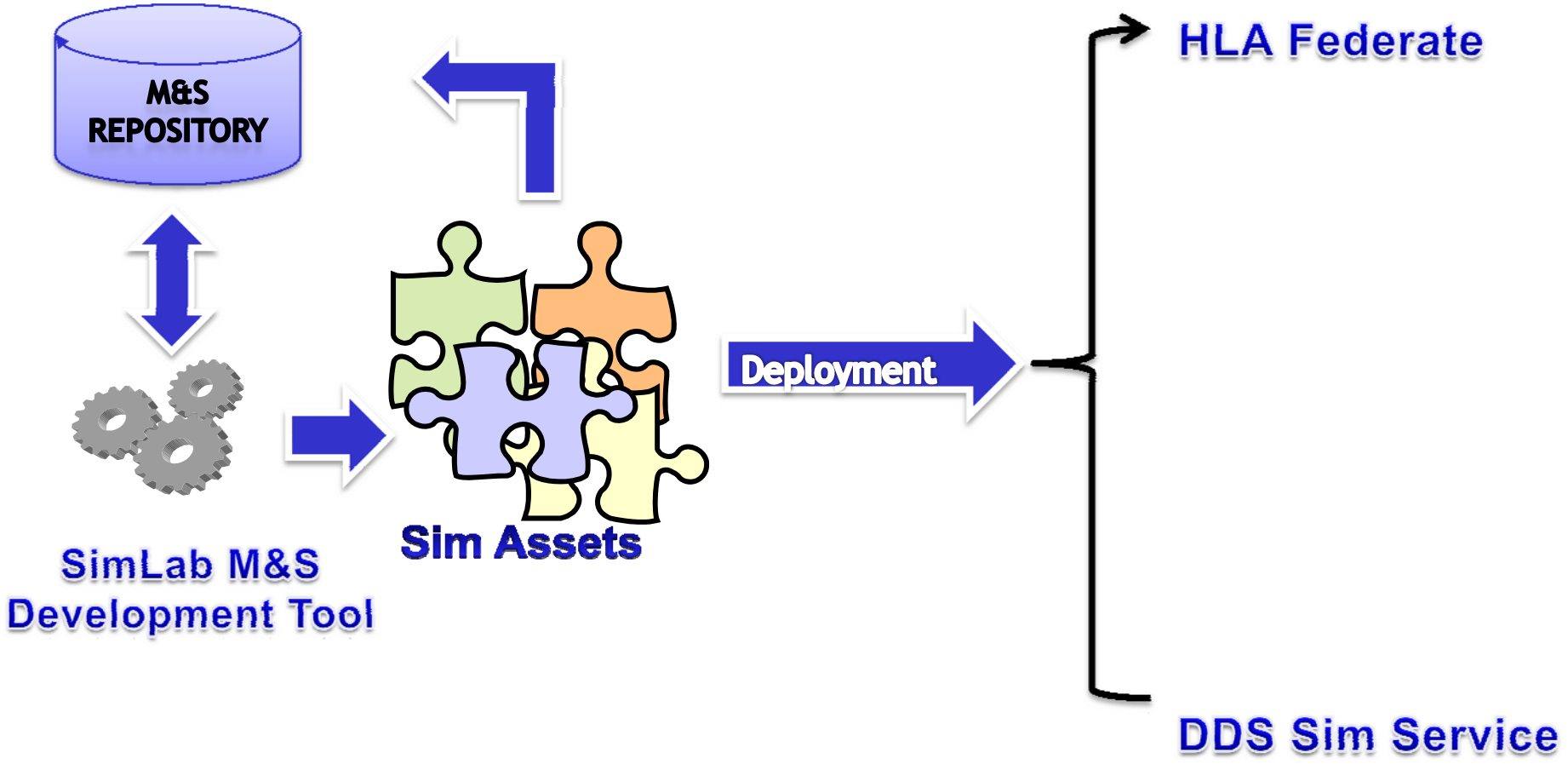
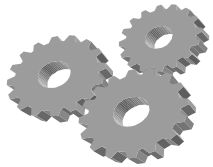
Somes use cases : A Federation of Sim Assets for the SP MoD



Somes use cases : A Federation of Sim Assets for the SP MoD



SimLab M&S Development Tool

Sim Assets

- MDD based on SimDeveloper
- Development of Simulation Assets
- Development of Sim Asset's IOS.
- Enables reusability of blocksets and other libraries of Mathworks products
- Automatic code gen

- Sim Assets Database
- Configuration Mgment
- Content Mgment
- Web access

- Specialized Sim Components
- Sim Entity with HMI, business logic and data interfaces
- Independence of Sim runtime infrastructure

Somes use cases : A Federation of Sim Assets for the SP MoD

=

Simulation Model

- ❖ HiFi dynamic Model
- ❖ Event based
- ❖ Compliant with a State Machine

+

Simulation HMI

- ❖ Parameter Control during execution
- ❖ Parameter configuration in planning session.

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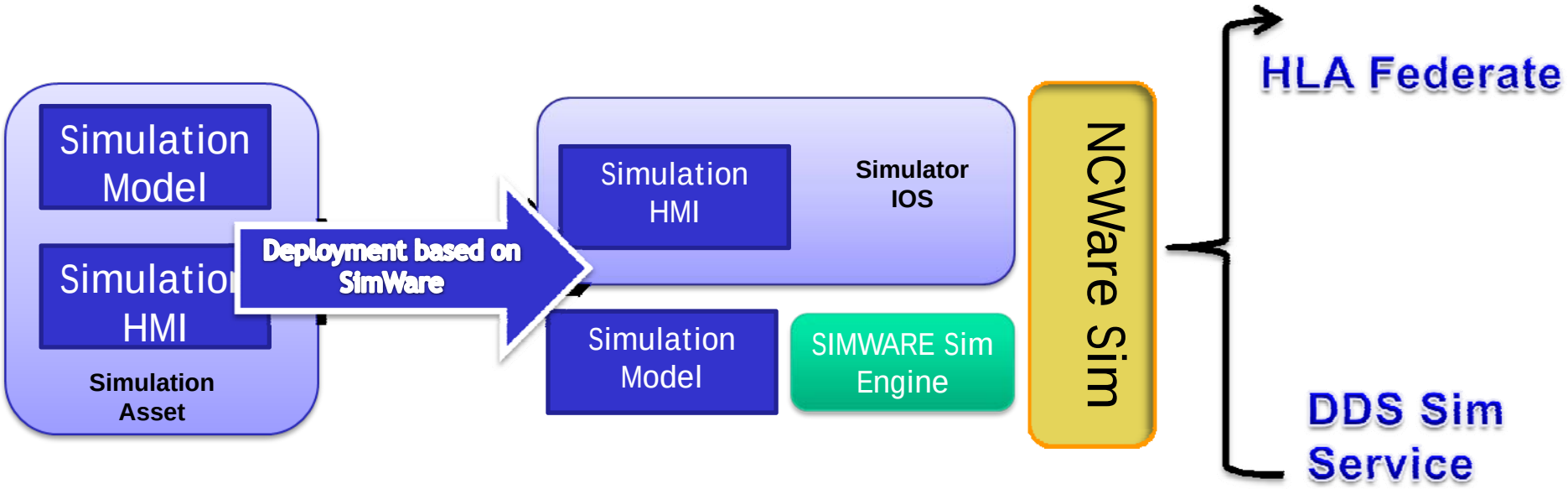
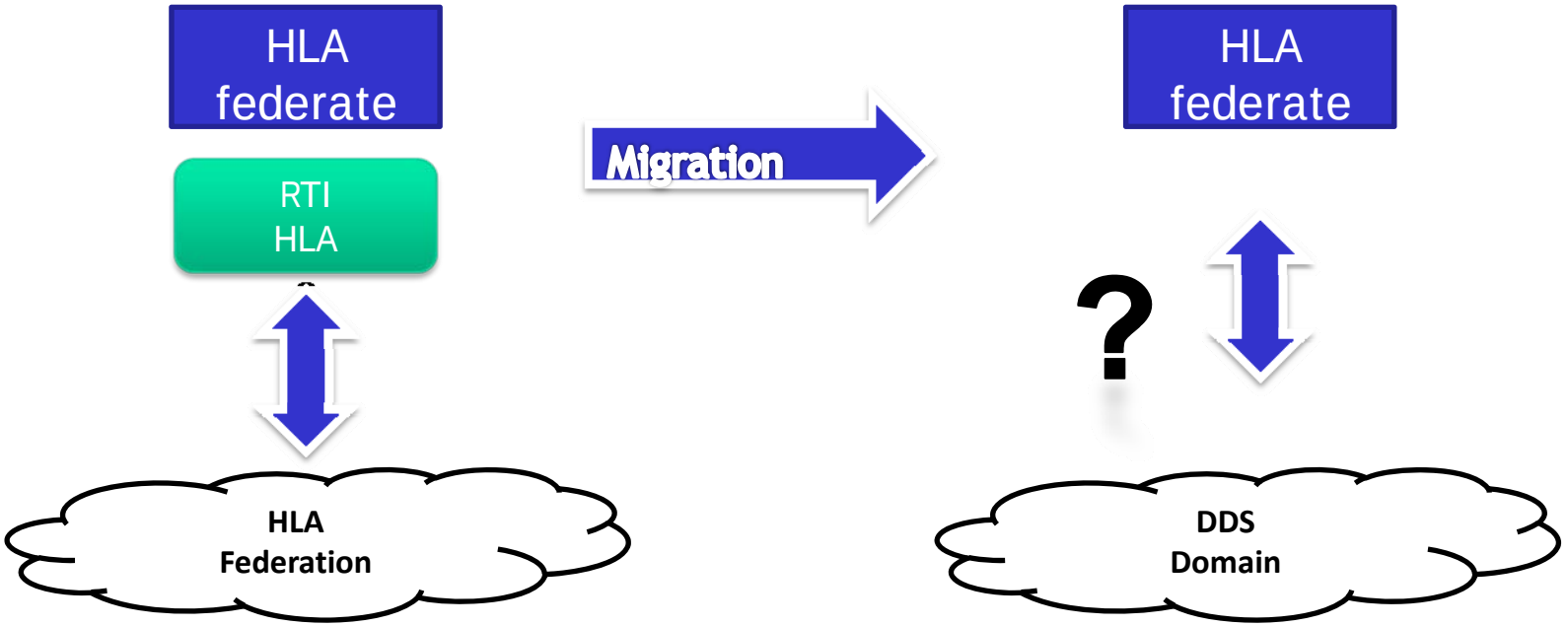
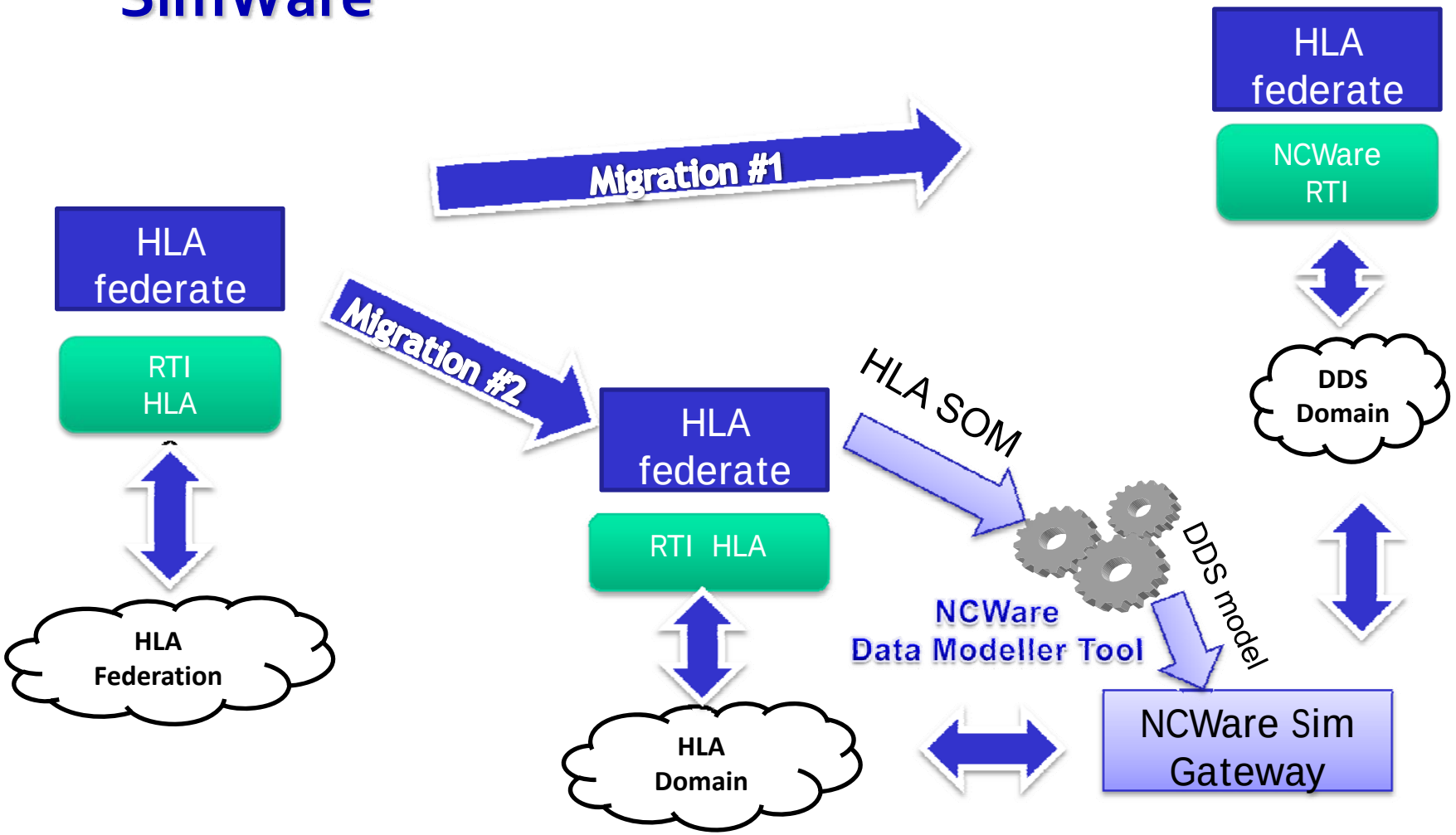
Somes use cases : A Federation of Sim Assets for the SP MoD



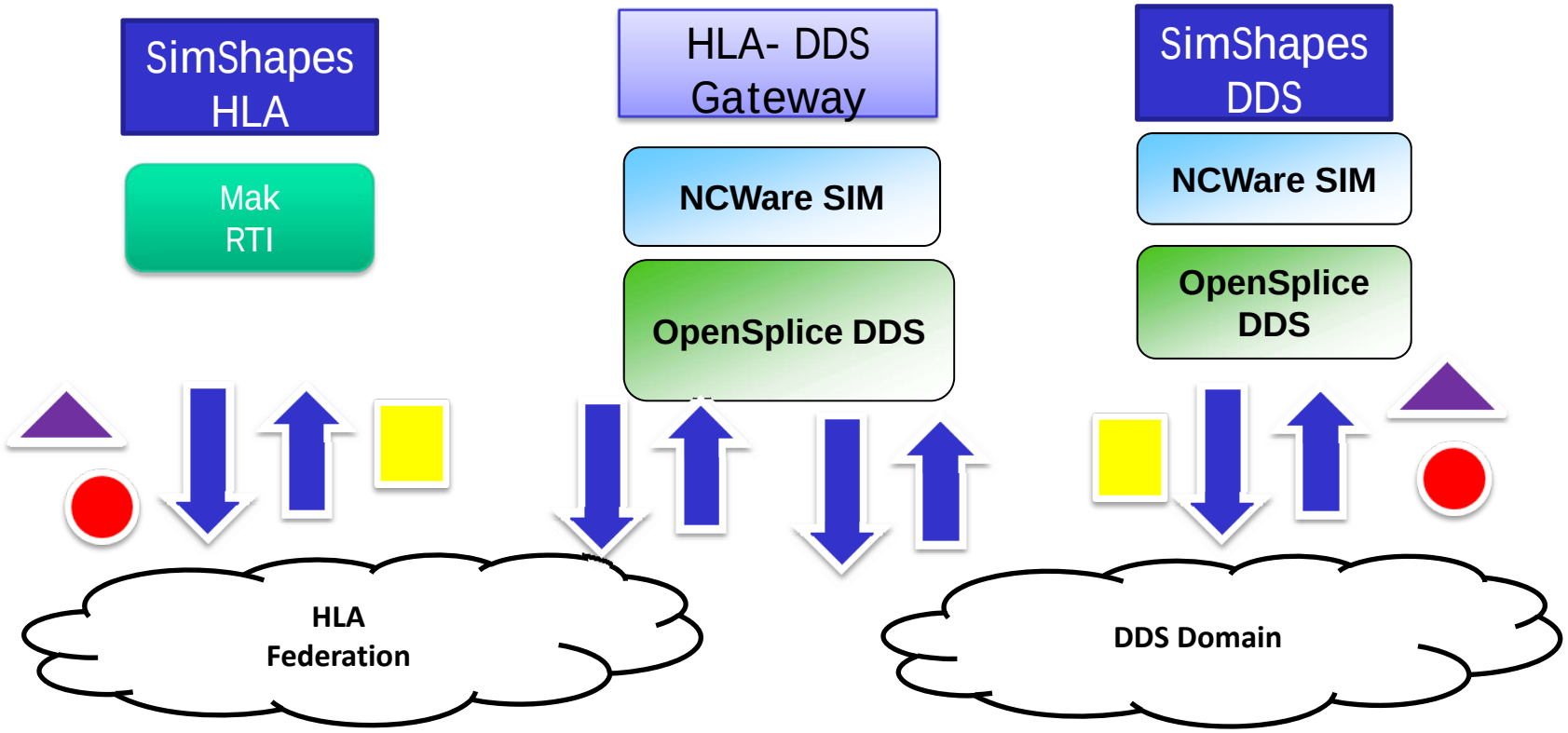
Interoperating HLA systems with DDS compliant systems



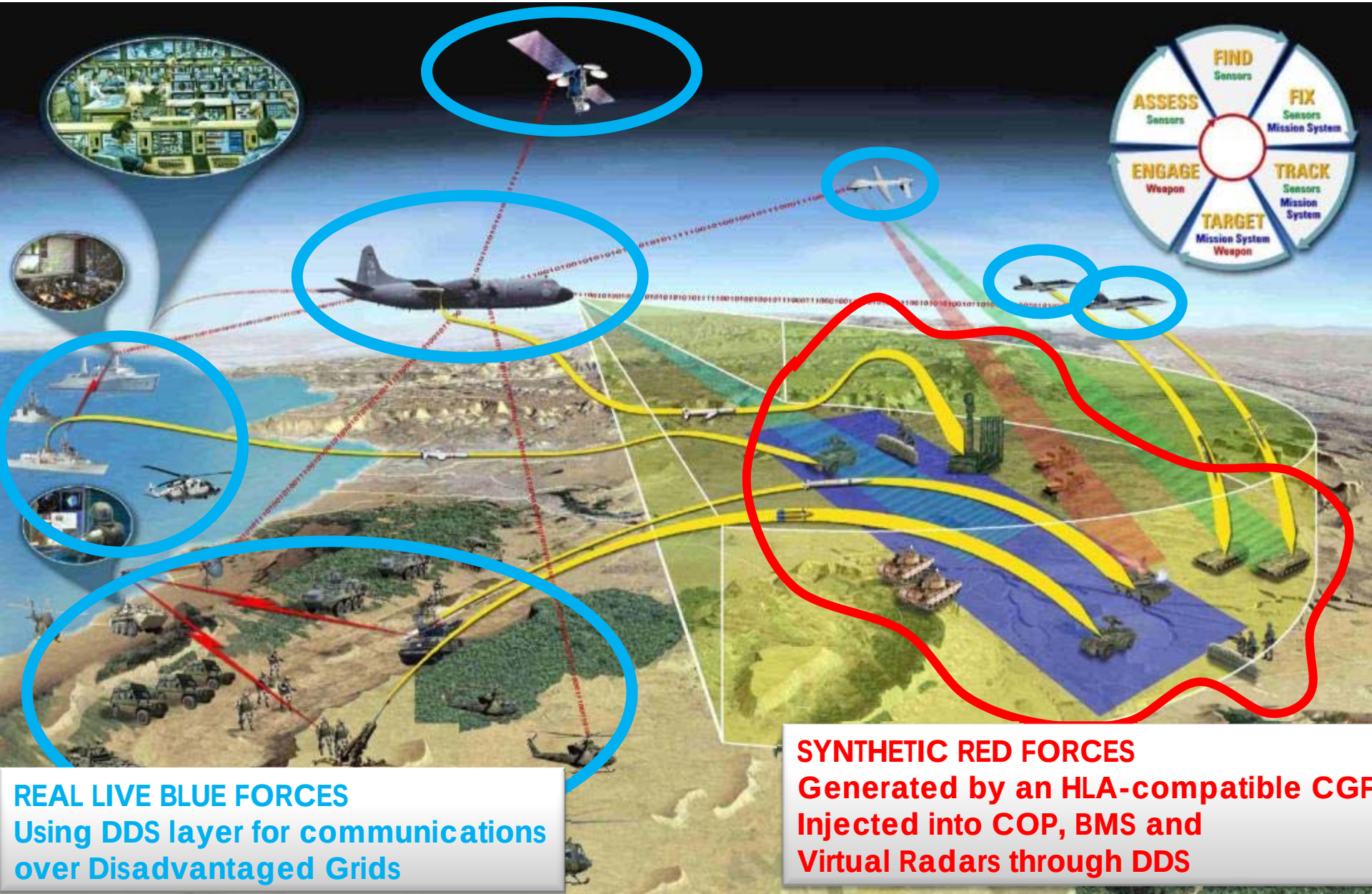
Interoperating DDS and HLA systems with SimWare



A small demonstration of the Gateway



Could the future be like this?



REAL LIVE BLUE FORCES
Using DDS layer for communications over Disadvantaged Grids

SYNTHETIC RED FORCES
Generated by an HLA-compatible CGF
Injected into COP, BMS and Virtual Radars through DDS

Open Architecture

Interoperability

DDS

Real systems & Simulators Blend

QoS

HLA

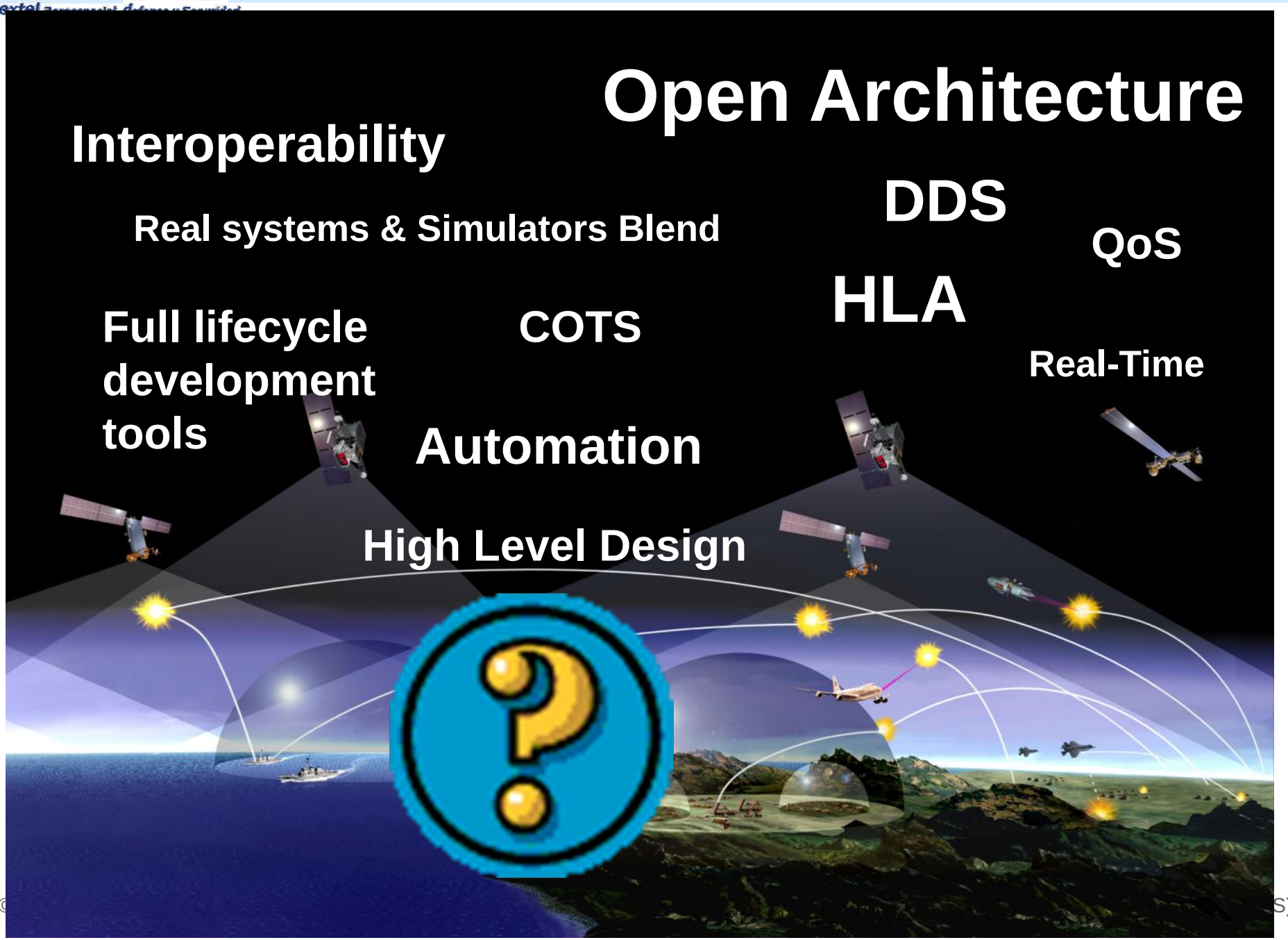
Full lifecycle development tools

COTS

Real-Time

Automation

High Level Design



For more information…

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