

Emerging and Disruptive Modelling and Simulation Technologies to Transform
Future Defence Capabilities

Looking Back to Look Forward

Keith Ford

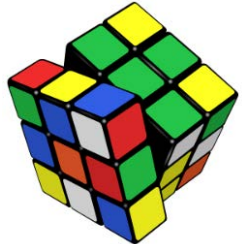
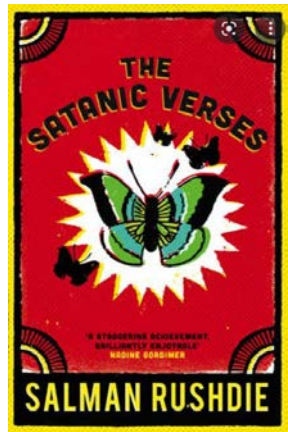
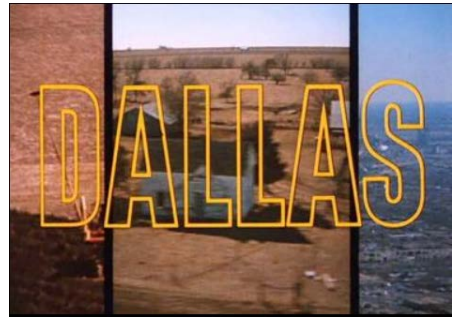
Thales UK



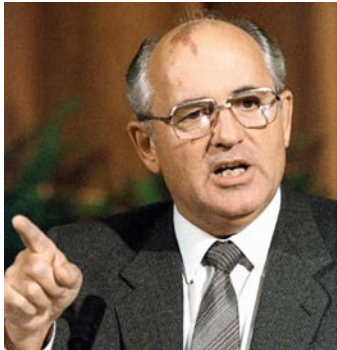
‘Those who cannot remember the past are condemned to repeat it’

George Santayana

1980s - Culture



1980s - Politics



1980s - Technology



```
C:\>dir

Volume in drive C is MS-DOS_6
Volume Serial Number is 40B4-7F23
Directory of C:\

DOS             <DIR>             12.05.20   15:57
COMMAND.COM    54 645 94.05.31   6:22
UTMA20.BIG     9 349 94.05.31   6:22
CONFIG.SYS    144 12.05.20   15:57
AUTOEXEC.BAT  108 12.05.20   15:57
5 file(s)      64 326 bytes
24 760 320 bytes free

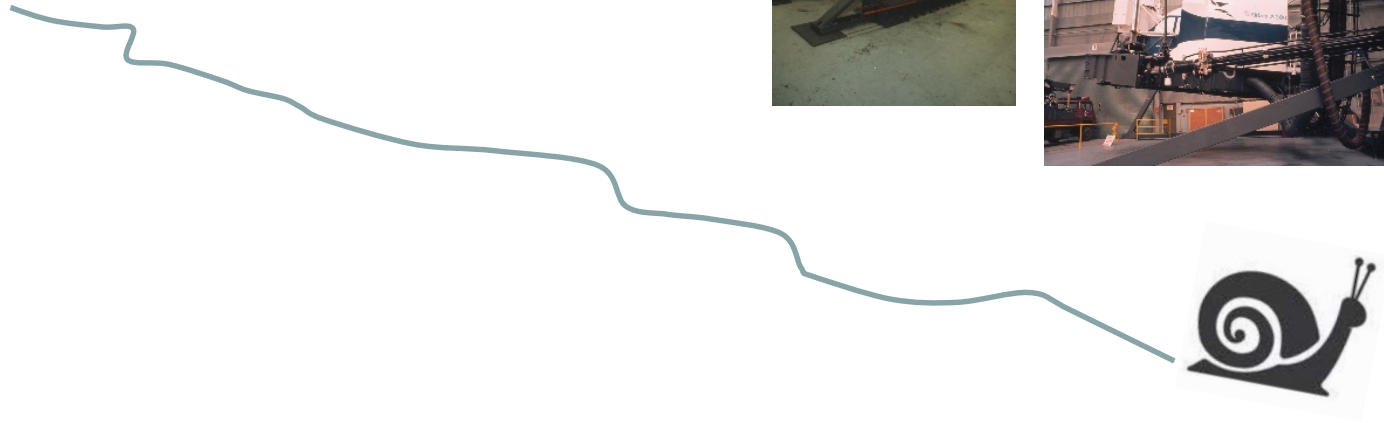
C:\>_
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Simulator Development

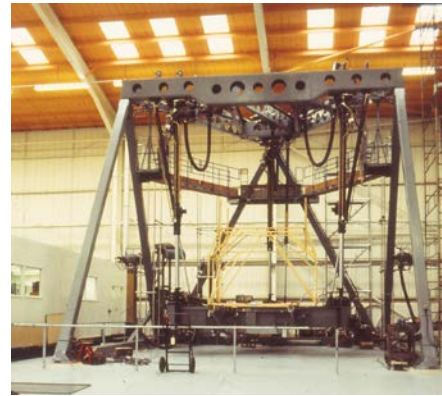


Patents



Motion Cuing

A Frame



G-Seat

G-Suit



3 Degrees of Freedom

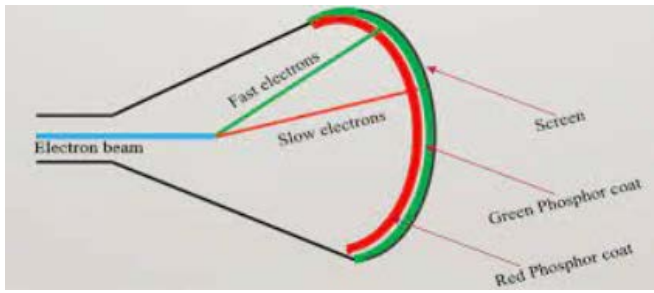


Hexapod / Stewart Platform

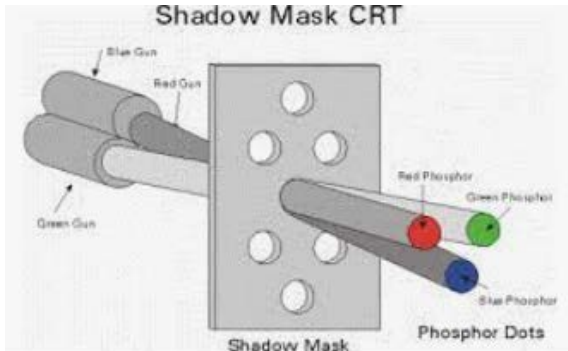


Research Motion Platform

Display Systems



Beam Penetration Monitors



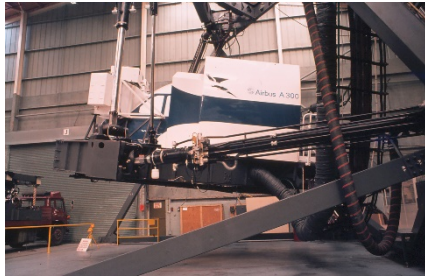
Shadow Mask CRT



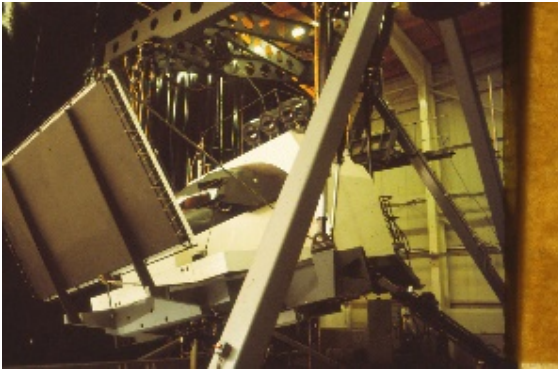
CRT Projector



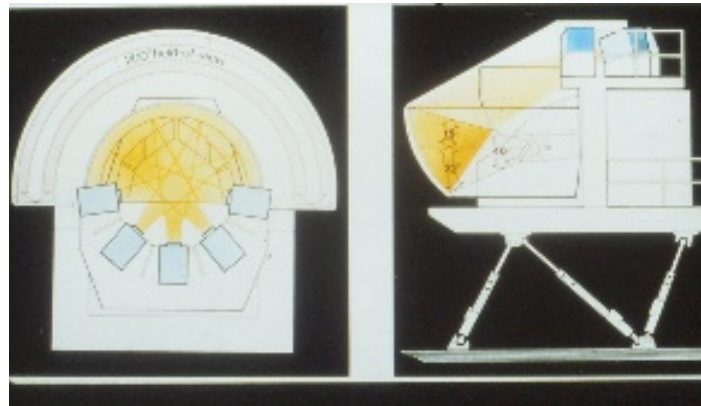
LCD/DLP/LCOS Projectors



Monitors

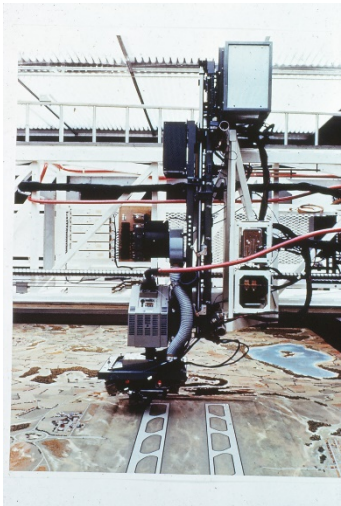


Duoview

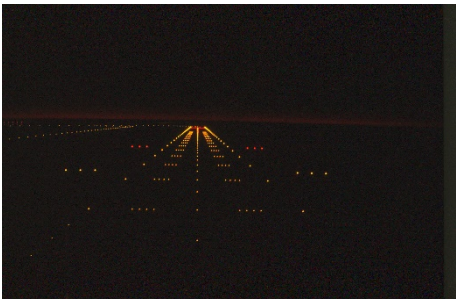
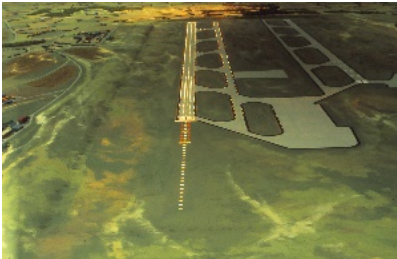


WIDE

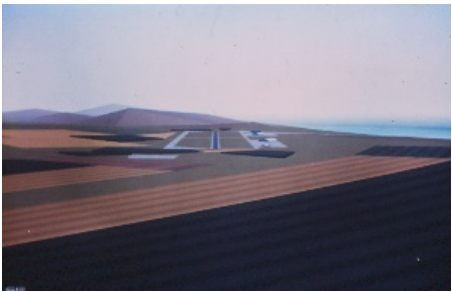
Image Generation



Model Boards



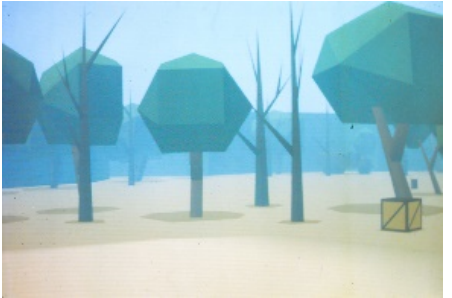
Novoview SP1



Novoview SP2



Novoview SP3




Area of Interest projectors



Computing



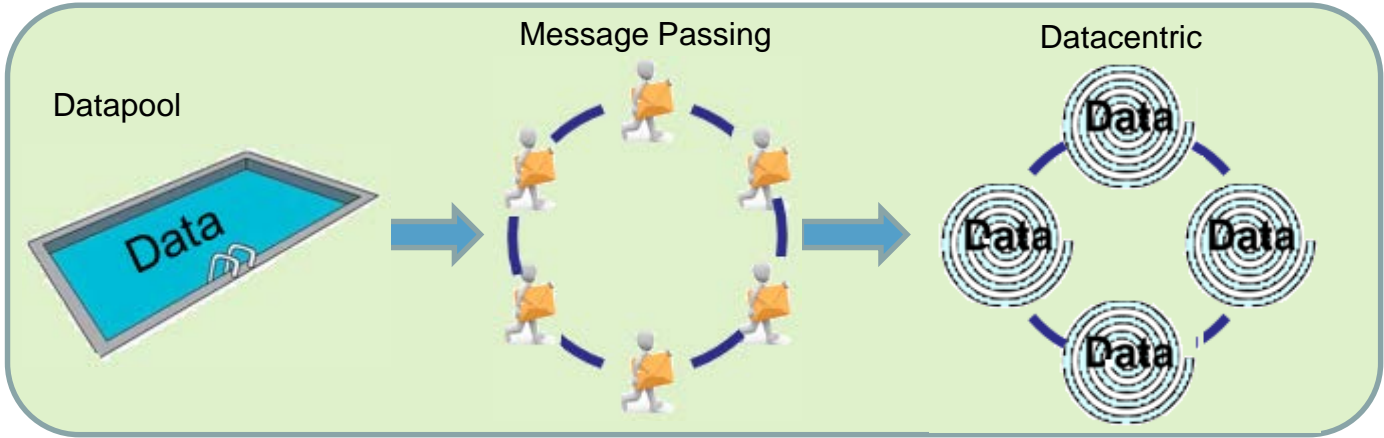
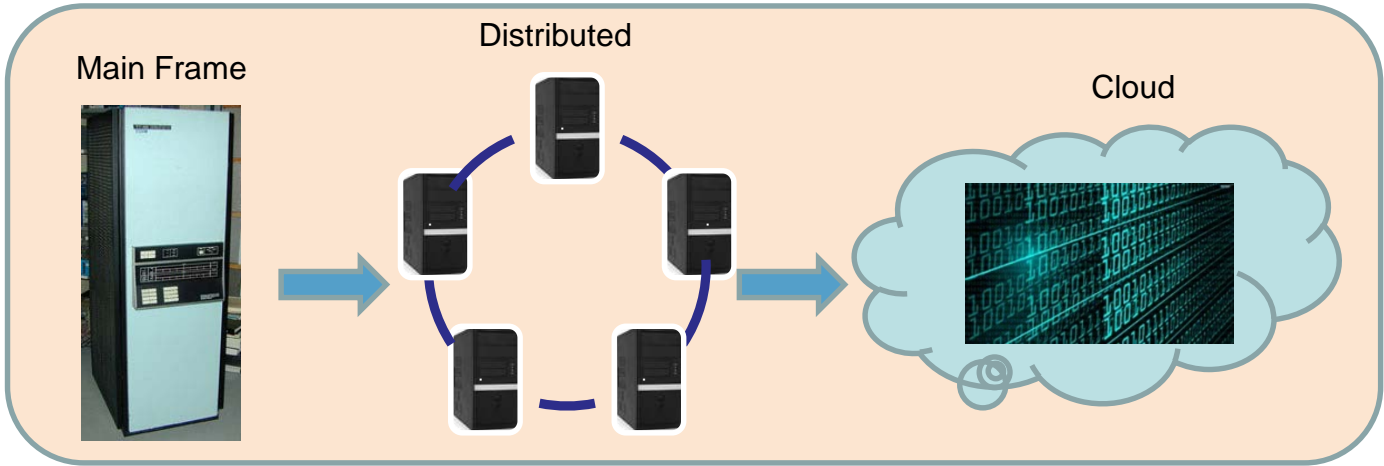
Punch Card



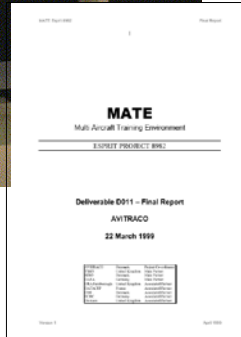
Paper Tape



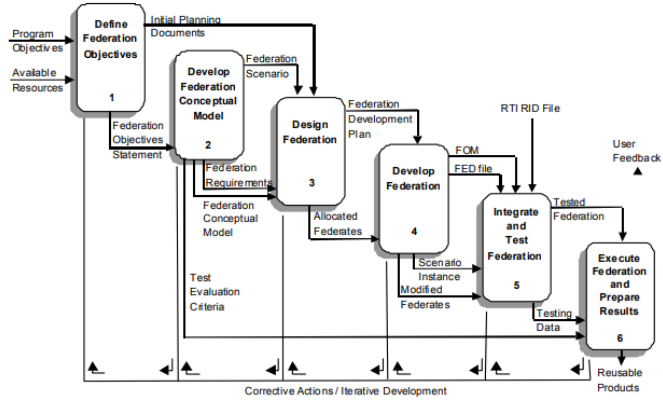
Disc



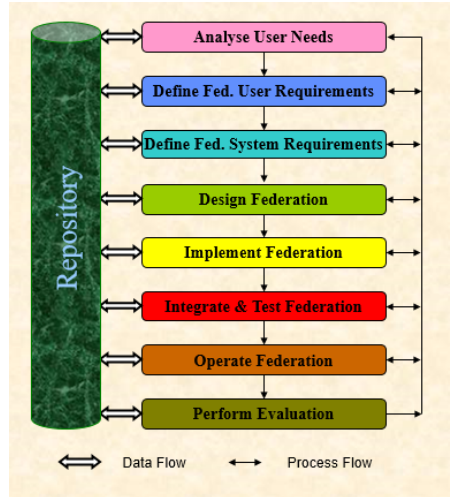
Innovation – Virtual Controls



The Emperor's Clothes (1)

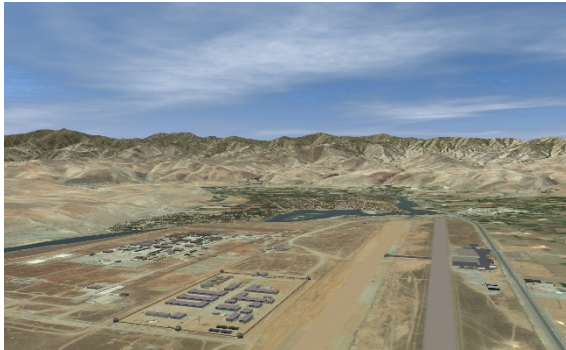


FEDEP



SEDEP

The Emperor's Clothes (2)



Synthetic Environments

	Taxonomy	Structure	Connectivity	Processes	Behaviour	Information	Constraints	Roadmap
Concepts	C1 Equilibri...	C2 Economic...	C3 Capabilit...	C4 Business...	C5 Objecti...	C6 Performance...	C7 Physical...	C8 Economic...
Service Specifications	S1 Service...	S2 Service...	S3 Service...	S4 Service...	S5 Service...	S6 Service...	S7 Service...	S8 Service...
Logical Specifications	L1 Logic...	L2 Logic...	L3 Logic...	L4 Logic...	L5 Logic...	L6 Logic...	L7 Logic...	L8 Logic...
Physical Resource Specifications	P1 Resource...	P2 Resource...	P3 Resource...	P4 Resource...	P5 Resource...	P6 Resource...	P7 Resource...	P8 Resource...
Employed Resources	E1 Human...	E2 Engin...						E8 Engin...
Architectural Meta Data	A1 Meta-...	A2 Archite...	A3 Archite...	A4 Meta-...	A5 Archite...	A6 Archite...	A7 Archite...	A8 Archite...

Enterprise Architecture

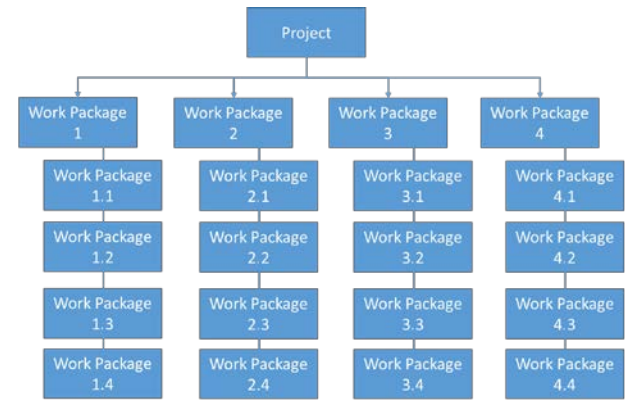
Modelling & Simulation as a Service



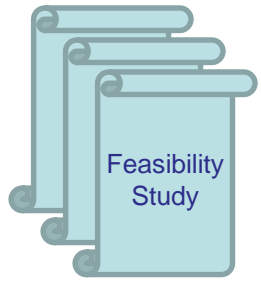
Digital Twins



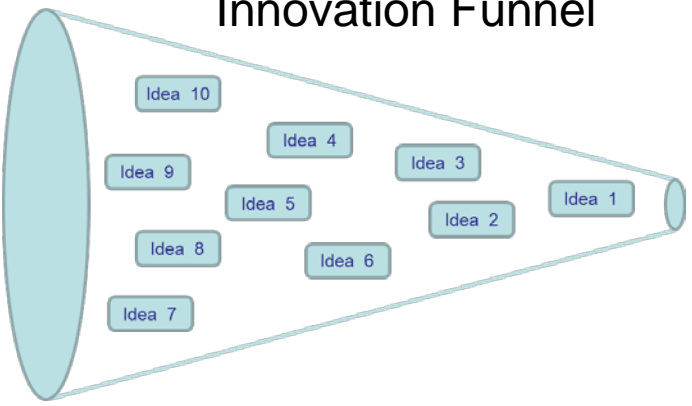
R&D Projects (1)



Work Breakdown Structure



Innovation Funnel



R&D Projects (2)

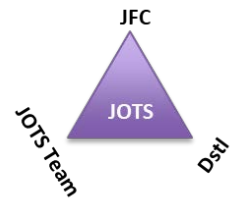
- **UK Defence And Security Accelerator (DASA) criteria for rapid impact projects (TRL>6)**
 - Desirable: strategic fit, end user support/pull
 - Feasible: technical credibility, innovation, risk, expertise of team/capability
 - Viable: costs and value for money, project delivery/plan

NMSG Projects

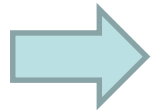
- **Use of Exploratory teams is good**
- **Projects need to be more dynamic**
 - Speed-up production of outputs
 - Wartime mentally require
 - Get commitment from participants and obtain appropriate funding?
 - Progress should be continuous not just at workshops
 - Limit size of working groups?
 - Hold special observer events?
- **Should lower TRL research be conducted?**
- **Need to consider exploitation at start of project**



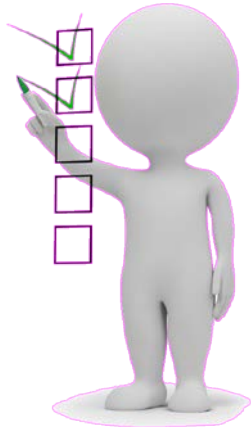
Exploiting R&D



SERAPIS SSE



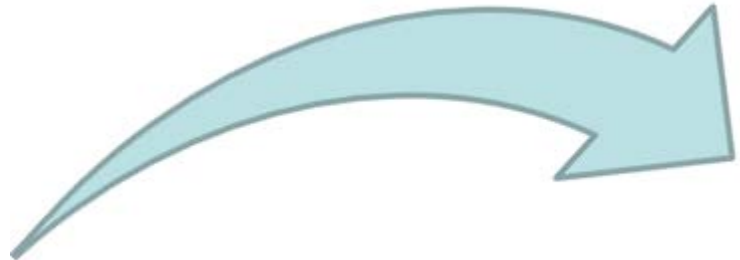
Exploitation Manager



Exploiting R&D – Concept Capability Demonstrators



JOTS



JFires



JFX1

Standards

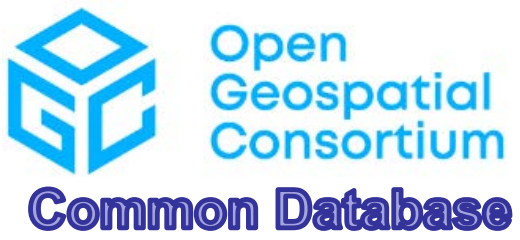


WebLVC



SEDRIS Standards

Describing the Full Spectrum of Environmental Data



Successful standard development requires:

- Need / Champion
- Funding
- Breadth of experience
- Industry/Government/Academia involvement
- Recognised organisation to develop and maintain it

Knowledge





Reuse

Reuse

<2000



0%

2022

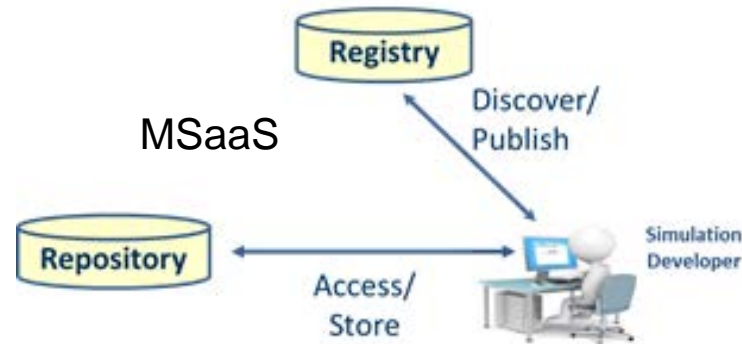


15%

>2022

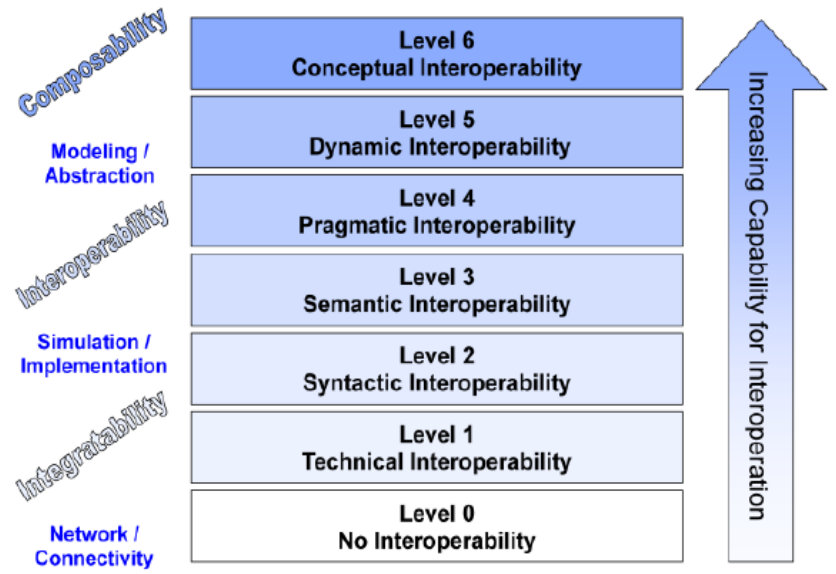
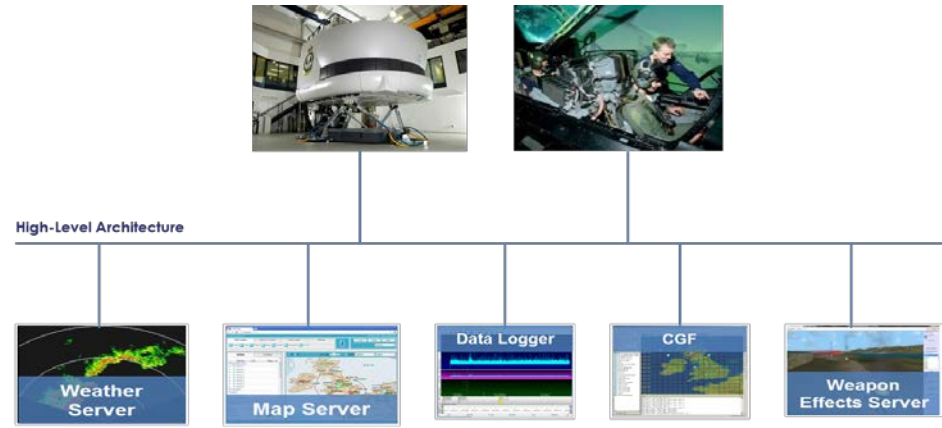


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Simulator Functions

Grand Challenges - Composition



Levels of Conceptual Interoperability Model

Grand Challenges – Verification & Validation

NMSG
Integration, Verification
& Certification Tool
(IVCT)

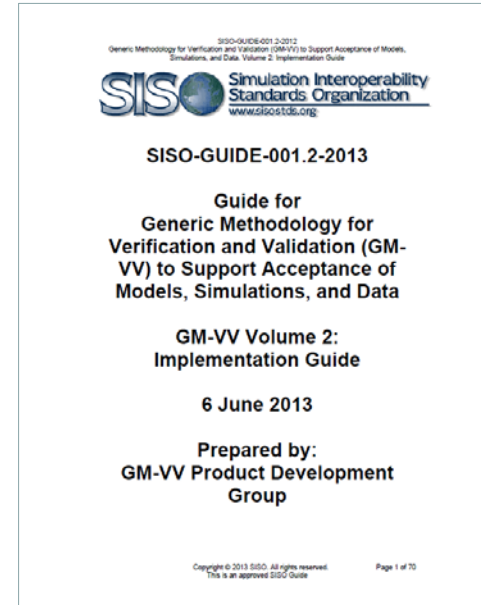
Verification - Have you built the thing right?

- Potential for automated testing from requirements and design data
 - make use of conceptual models

Validation - Have you built the right thing?
(to the degree needed for the model's intended purpose
or application)

- Plethora of different uses of simulation
- How to capture the user's intent?

V&V of AI systems



Grand Challenges – Simulation of non-kinetic effects



Interactions



Infrastructure



Information



Populace

Grand Challenges – Security



Fair Fight



Culture?

Politics?

JANUARY 2062						
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2	3	4	5	6 Resolve timesheet issues	7
8	9 Book teleportation to Glasgow	10	11 Get brain upload for V&V meeting	12	13	14
15	16	17 Petarverse NMSG workshop	18	19 Get HLA 12 working	20	21
22	23 Medical scan & upgrade	24	25	26	27	28 Cut grass
29	30	31	1 Mars trip	2	3	4

Technology?

Key Take-Aways

- Timelines and outcomes for NMSG Working Groups should be more ambitious
- Development of standards needs to be appropriately planned, resourced and funded
- Exploitation of a research programme's outputs should be considered at the planning stage

“We learn from history that we do not learn from history”

Georg Hegel



“Those who don’t study history are doomed to repeat it.
Yet those who *do* study history are doomed to stand by
helplessly while everyone else repeats it.”