This report is a product of the United States Air Force Scientific Advisory Board Study Committee on Technology for Machine-to-Machine Intelligence, Surveillance, and Reconnaissance Integration. Statements, opinions, findings, recommendations, and conclusions contained in this report are those of the Study Committee and do not necessarily represent the official position of the United States Air Force or the United States Department of Defense.
Executive Summary

As modern warfare evolves, the value of pervasive awareness and rapid response on the battlefield increases. Current Air Force systems are highly capable, and within individual domains, are highly automated. If the real-time machine-to-machine interactions that facilitate the presentation of actionable, decision-quality information to the warfighter in an intuitive form is assured, then many manual steps can be eliminated.

The focus of this study was to understand the underlying reasons for the current lack of broad-based machine-to-machine intelligence, surveillance, and reconnaissance integration (MTMISRI), discover available actions to remove technology as an obstacle, and construct specific suggestions on how the Air Force might move toward more pervasive MTMISRI.

In the process of the study, ten hypotheses on the origins of the problem were posed:

1. Requirements: Needs were not identified when systems were acquired.
2. Acquisition – Either the wrong technology was purchased or the needed technology could not be purchased.
3. Technology – Key technologies were not available.
4. Resources – The solution is known but unfunded.
5. Training – The capability exists in current systems but is unused.
6. Communications – The data cannot get to where it is needed.
8. “Tribal” Issues – Cultural and/or political barriers impede success.
10. ROE – Manual action and/or decision is a required process step.

While evidence to support each of these hypotheses as elements of the problem was found, consensus was reached on an eleventh hypothesis – that the lack of an overarching architecture for intelligence, surveillance, and reconnaissance (ISR) severely inhibits integration and is the major obstacle to widespread MTMISRI.

Many disparate efforts are successfully integrating ISR systems to realize high priority machine-to-machine connectivity. For the most part, these efforts should not stop! However, these activities, while useful individually, will make it harder to achieve the vision of quickly integrating new and pre-existing systems to take advantage of shared information.

There are three major findings of the study:

1. The Air Force has no commonly accepted architectural framework to achieve MTMISRI.
2. The Air Force must revise security policy to achieve a better balance between “protection” and “usability.”
3. The Air Force should make sensor data from unconventional sources readily available as part of the ISR-data stream.
Making machines “talk” to each other is difficult, especially since competing companies designed them independently, to divergent requirements, with less-than-crisp interface specifications, and in different eras. Each domain (“stove-pipe”) is currently doing its best to integrate its systems by identifying deficiencies, prioritizing them, and funding fixes to as many deficiencies as it can locally afford. This has produced collections of high value, locally (pair-wise) connected systems that are globally disconnected and difficult to integrate.

The end result is that there is no single ISR architecture, but rather many architectures that evolved to meet specific requirements and remain largely incompatible.

The Study Committee believes there are four basic architecture options to correct the MTMISRI deficiencies. In all cases, the cost to retrofit and integrate existing systems into a new architecture drives the total ownership cost.

The Study Committee makes five recommendations:

1. Fund a program to achieve ISR/Operations integration. Include as part of the program:
   a. Building a modern technical architecture and the associated enterprise services infrastructure;
   b. Validating the architecture and associated infrastructure through experiments;
   c. Authority over other programs to enforce compliance with the architecture;
   d. Central funding for infrastructure and retrofit/integration of existing systems;
   e. Development of a test and certification capability to support the compliance mandate;
   f. Support for revisions of concepts of operations (CONOPS) and doctrine that result from program successes;
   g. Development of a program schedule that supports an initial operating capability (IOC) no later than that of the Air Force Distributed Common Ground System (AF DCGS) Block 10.2 Program and demonstrates an interim reference architecture at the Joint Expeditionary Force Experiment 2006(JEFX-06); and
   h. A definition of an IOC that will assure the ability to seamlessly exchange information among a specific set of domains.

2. Establish a policy that mandates compliance with the architecture. Use experimentation as the route to confidence-building demonstrations prior to enforcing the policy.

3. Engage the Intelligence Community (IC) to:
   a. Focus on CONOPS, doctrine, and policy for strategic and operational information sharing and collection management;
   b. Review and revise classification and releaseability guidelines while striving to achieve a balance between “protection” and “usability”; and
c. Integrate Air Force MTMISRI activities with the Horizontal Integration Initiative proposed by the Transformational Space and Air Program (TSAP).

4. Institute enterprise data management in each of the Air Force’s major domains (the Air Mobility Command provides a good example), to focus on:
   a. Semantic agreement;
   b. Metadata registry;
   c. Data ownership/sharing; and
   d. Data management across domains.

5. Incorporate responsive access to non-traditional sources as part of ISR/Operations integration.

The Study Committee found that while some technological challenges exist to MTMISRI, they are not insurmountable. Significant changes in program management of MTMISRI will make it a reality for the Air Force.
Study Charter

- **Understand** the evolution, current state, and capabilities of existing and planned ISR systems and their interfaces and integration with Command and Control (C2) systems that are relevant to the real-time combat environment.

- **Provide insight into technology and process steps that the Air Force should take** to achieve real-time information integration into a single real-time product across system, geographic, and cultural boundaries.

- **Identify new opportunities** to take traditionally unrelated information sources and integrate them in ways that exploit the power of the machine at the digital level while requiring little or no human intervention.

- **Propose a near term experiment** using existing Air Force systems that can demonstrate MTM integration and serve as a beginning to a longer term process.
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The Problem

- We can do much to eliminate manual steps by assuring that real-time MTM interactions facilitate:
  - Presentation of actionable decision quality information
  - to the warfighter
  - in an intuitive form
  - as it is needed

- We have sought:
  - The underlying reasons for the current lack of MTMISRI
  - Available actions to remove technology as an obstacle
  - Specific suggestions on how to move toward MTMISRI
10 Hypotheses Why We Don’t Currently Have MTMISRI

1. Requirements – needs not identified when systems were acquired
2. Acquisition – bought the wrong stuff; couldn’t buy the right stuff
3. Technology – key technologies are not available
4. Resources – the solution is known but unfunded
5. Training – capability exists (unused) in current systems
6. Communications – can’t get the data to where it is needed
7. Security Policy – security policy barriers prevent success
8. “Tribal” Issues – cultural/political barriers impede success
10. ROE – manual action/decision is a required process step

What is the relative importance of each hypothesis?
Things We Didn’t Address

- Joint / Coalition issues
- Acquisition system
- Adequacy of communications
- Adequacy of collection assets
There is no commonly accepted architectural framework on which to hang machine-to-machine ISR integration

If you want to fix this problem, treat it as a program!
One Preliminary
The MTM problem exists across many domains, e.g.:

- Defense suppression, ISR,
- Air Defense, Combat Ops,
- Mobility, Logistics, ...

Within each of the ISR domains, we found people:

- Identifying deficiencies
- Prioritizing them
- Funding as many as they can locally afford

The result is collections of high value, locally (pair-wise) connected systems that are globally disconnected and increasingly difficult to integrate.

Domains: Collaborative groups of users who must exchange information in pursuit of their shared goals, interests, missions, or business processes, and who therefore must have shared definitions for the information they exchange.
The Core of The Problem
There is no overarching ISR architecture, but rather many architectures

- Evolved to meet specific requirements
- Remain largely incompatible
- Will not converge on their own

Control mechanisms are disparate and fragmented

We believe there are four basic options:

Note: Retrofit and integration of existing systems into a new architecture drives total cost
Unifying the Tribes: Exploit the Existing Domains

A Federated Network Organized by Domain

Network/Information Sharing Infrastructure
Example of a Transaction: SOF Request Situational Awareness

Position and Time Comprise a Common Frame of Reference

- U2, GH, Predator, National, Commercial
- ISR Management
- Exploited Image
- Raw Images
- IMINT Index and Directory
- SOF Request Situational Awareness
- ISR Management
- Exploited Image
- Raw Images
- IMINT Index and Directory
- X, Y, Z, T
- Data Request: X, Y, Z, T
- Network/Information Sharing Infrastructure
- Data
- Data
- Data
- SOF DA
- Wx + Topo
- SIGINT + HUMINT
- Imagery + MTI
- DataAssembler
- Or “Agent”
Recommendations
Recommendation 1 (in two parts):
Commit

In order for MTM interaction to drive ISR/Operations integration:

- CSAF must commit to -
  
  ✓ Fund a program to include implementing an architecture and the associated infrastructure
  
  ✓ Establish a policy that mandates compliance with the architecture
Centrally fund

- Enterprise services-based architecture and infrastructure
- Retrofit and integration of existing systems

Include authority over other programs to enforce compliance with the architecture

Build a test and certification capability to support the compliance mandate

Validate the architecture and associated infrastructure through experiments

Support revision of CONOPS and doctrine that result from program successes

Develop a program schedule that supports an IOC no later than DCGS 10.2 and demonstrate an interim reference architecture at JEFX-06

- Define IOC as the ability to seamlessly exchange information among a specific set of domains
Publish a policy to provide advanced notice that architecture compliance will be required

Validate the architecture before enforcing the policy:

- Define the technical architecture
  - Leverage popular commercial standards
- Get industry buy-in
- Build the infrastructure needed to validate the architecture
- Perform experiments which validate the architecture
- Assure that a capability exists to perform certification testing of products that claim they conform to the architecture

Enforce the policy
Recommendation 2: Engage

CSAF & SecAF engage the Intelligence Community (IC) to:

- Focus on CONOPS, policy, and doctrine for strategic and operational information sharing and collection management
- Review and revise classification and releaseability guidelines
  - Strive to achieve balance between “protection” and “usability”
  - Educate the IC on warfighters’ modus operandi – now and in the future
- Integrate AF MTMISRI activities with the HI Initiative proposed by the Transformational Space and Air Program (TSAP)
Institute enterprise data management in each of the Air Force’s major domains (AMC provides a good example)

- Semantic agreement
- Metadata registry
- Data ownership/sharing

Develop data management across domains

- Hierarchical communities of interest
- Data mediation
As Modern warfare evolves, the value of pervasive awareness and rapid response on the battlefield increases. Current Air Force systems are highly capable, and within individual domains, are highly automated.