Improving Coalition Interoperability through Networking Military/Civil Air Traffic Control Systems

14 September 2004

Tom Thomas, Lead Systems Engineer
The MITRE Corporation, Bedford, MA
001-781-377-9075, tthomas@mitre.org

Approved for Public Release; Distribution Unlimited; Case 04-0774
©2004-The MITRE Corporation. All Rights Reserved.
Overview

- Air situation awareness (SA), safety of flight operations, and sovereignty are coalition goals
- Military and civil sharing of airspace is essential
- Cost of air surveillance remains high – cost of air data distribution is declining
  - COTS solutions and data/communications standards exist to enable interoperability
  - COTS-based networks are pervasive and provide broad area interoperable coverage
- Can we exploit expensive coalition surveillance assets to improve situation awareness and air sovereignty?
  - What are national and regional requirements?
  - What are the issues? What is the way ahead?
Regional Security and Air Sovereignty

- Overall security in NATO and Europe relies on regional security in the Central/Eastern European (CEE) area.
- CEE countries also need to ensure national and regional air sovereignty in support of Partnership for Peace (PfP) goals and international coalition operations combating global terrorism.

- PfP program goals include:
  - More open access to airspace (less reliance on “corridors”)
  - Improved air traffic detection, identification, assessment, and response.

- Coalition air operations centers must have complete and up-to-date knowledge of regional military and civil air operations – a “common air picture”
The Air Picture Objective

A timely and accurate Coalition Common Air Picture (CCAP) provides improved SA and the capability to better manage friendly air assets by;

- Integrating “standalone” assets, such as mobile radars, into the CCAP
- Enhancing detection and identification of “unknown” aircraft
- Providing military surveillance data to civil centers for sharing airspace

Widespread availability of data can enable and maintain more effective identification and control of air traffic across system boundaries without requiring additional long-range Air Traffic Control (ATC) surveillance and navigation systems

A CCAP could provide real-time dynamic airspace allocation, precision ingress and egress, reduction of overlapping sensors and associated errors, and open more available airspace

MITRE
In any global regional airspace, there are five phases of military and civil flight supported by ATC functions:

- Aircraft Launch and Recovery phases controlled by local tower and landing ATC systems
- Terminal phases at the departing and arriving airfields controlled by a Terminal Radar Approach Control (TRACON) facility
- Enroute and theater phase controlled by an Air Route Traffic Control Center (ARTCC) or an Area Control Center (ACC)

For an aircraft to transit this airspace safely and efficiently under effective control, several key capabilities are needed:

- Positive aircraft identification – done today using interrogators/transponders
- System-to-system data communication – mostly verbal today with some data
- Shared use of interrogators – overinterrogation, interference and errors today
- Build and maintain a CCAP – most systems today are standalone (no data sharing)
Phases of Flight

Launch
Tower and Landing Systems

Terminal
TRACON

Enroute, Oceanic, And Theater

Terminal
TRACON

Recovery
Tower and Landing Systems

DoD/FAA/Other CAA
DoD/FAA/Other CAA
DoD/FAA/Other CAA
Challenges

- Coalition partner ATC capability vary significantly
- Obsolete ATC system designs, proprietary designs and data formats, and doctrine limit data distribution and interoperability
- National approaches to ATC improvement may not provide for common air pictures
- National ATC implementations may not be common, interoperable, or meet NATO standards
- Funding sources may be limited for national radar data networks or cross-border exchanges
- Traditions or historical events may limit free exchange of information between coalition partners
Trends

Coalitions must be more dynamic and adaptable, be established rapidly, employ interoperable standards, and minimize system/personnel assets needed.

Coalition assets may also be widely distributed within a region or beyond.

Many CEE countries are replacing legacy ATC systems with ones that offer standardized, digital intranet capabilities. Internet Protocol (IP)-based nets provide the means to distribute ATC data beyond system boundaries.

Navoids and Regional Airspace Initiative studies conducted by US DoD in several PfP countries have resulted in regional radar data sharing systems such as BALTNET.
BALTNET Architecture

[Diagram showing the architecture of the BALTNET system, including nodes and data flows between NATO CRC, CAOC, ASOC, and national nodes in Lithuania, Latvia, and Estonia, with data flows for ATC Radar & Flight Plan Data and Military Radar Data.]
BALTNET Summary

BALTNET is a peacetime data/communications network infrastructure of radar sensors in 3 participating nations, national nodes and a regional airspace surveillance coordination center.

BALTNET is now integrated into the NATO CRC and CAOC architectures for operations in times of crisis.

Although BALTNET is a highly capable system, there are some limitations;

- Not designed for dynamic environments
- Complexity limits wide deployment
- Defense budget restrictions and priorities in many CEE countries limit acquisition of systems like ASOCs and BALTNET

A simpler, less expensive option is proposed as “the way ahead”. 
The Way Ahead

- Implement the equivalent of civil aviation’s “launch to recovery” airspace coverage;
  - Provide better prediction, planning and execution of C2 and ATC for military aircraft
  - Share military surveillance data and ATC coordination with civil aviation facilities
- Leverage technologies and standards provided by some COTS systems.
- Explore low cost ways to expand system data distribution.
- Look for innovative, non-proprietary solutions to interface challenges such as legacy analog systems and non-standard or obsolete data formats.
Data and Data Formats

Often there is information common to all systems, e.g., position, Mode-A (identity) and Mode-C (altitude)

All Purpose Structured Eurocontrol Surveillance Information Exchange (ASTERIX)

- Formatting of the surveillance-related data exchanged between sensors and processing systems, and between surveillance data processing systems
  - Allows a meaningful transfer of information between two application entities using a mutually agreed representation of the data to be exchanged.
- Continuously refined and extended, is being adopted as a de facto world-wide surveillance data standard
- For more info: http://www.eurocontrol.int/asterix/
CCAP Architectures

A high-level notional architecture is proposed which;
- Is conceptual in nature and uses a hypothetical 3-country region
- Is further broken down into conceptual national airfield, national center, and partial CAOC sub-architectures
- Does not address national, regional or CAOC CCAP detailed requirements

National military or civil airfields are connected to national centers, national centers are interconnected, and one or more national centers are connected to a regional CAOC
- Via landlines, microwave links, or mobile satellite communications
- National ATC centers could also be connected to the network
Notional Regional CCAP Architecture

Country A

Country B

Country C

National Center

National Center

National Center

CAOC
National Airfield CCAP Sub-architecture

This notional sub-architecture includes;

- A large, fixed airfield Airport Surveillance Radar (ASR) with a range of approximately 100 nautical miles (nm) including a Secondary Surveillance Radar (SSR) with a range of approximately 200 nm
- A fixed/transportable Ground Control Approach (GCA) system which includes a Primary Surveillance Radar (PSR) with a range of approximately 40 nm and a SSR with a range of approximately 120 nm

- Both the ASR and GCA operators communicate with enroute and approaching aircraft via VHF and UHF voice radios.
- ASR and GCA PSR/SSR processed data is provided to the control tower for display and could be distributed from there to a national center via landline, microwave relay, or mobile satellite communications systems.
National Airfield CCAP Architecture

- Fiber Optic Cable
- UHF Radio
- VHF/UHF Radio
- Primary & Secondary Surveillance Radars
- GCA System
- Airport Surveillance Radar
- Landline or Microwave Link
- To other National Centers
- To other airfields
National Center CCAP Sub-architecture

- Could be set up as part of an existing ASOC, or in any secure location with access to communications.
- National Air Picture (NAP) workstations get ATC data from a database, router/server, and communications interface via a local area network (LAN).
- NAP workstations could also get data from (and share their data with) other country National Centers, ASOCs, or a CAOC.
- NAP workstation operators would review, annotate and filter data before sending it to other recipients.
National Center CCAP Architecture

National Center

NAP Position

NAP Position

Database

Router & Server

Comm Interface

LAN

To Airfields

To other National Centers

To CAOC
Partial CAOC CCAP Sub-architecture

- This architecture is highly notional and would only involve a portion of a CAOC.
- National Centers and/or ASOCs could provide ATC data to a CAOC to become part of the Common Air Picture (CAP).
- National workstations could be set up for each member country, connected to a common LAN;
  - National operators could review, annotate and filter data before sending it to other national workstations or to the CAOC CAP – data “push”
  - National operators could “pull” data from the CAP
- A communications interface would also have to be provided to support receipt of regional information and to translate formats, if needed.
CAOC CCAP Architecture

Country A  Country B  Country C

LAN

CCAP Positions

Comm Interface

To National Centers
CCAP support requires a set of essential national capabilities determined by a definition of requirements and achieved through system acquisition.

Three architectural elements have been identified for implementation: a national airfield, a national center, and a portion of a CAOC.

The proposed roadmap consists of basic phases needed:
- To initiate the requirements definition process
- To acquire, install, and test the necessary sensor systems and communications network components

The following roadmap chart details the steps and milestones needed to implement the architectures.
Proposed CCAP Roadmap

National Airfields
Define CCAP Requirements
Create ATC Tower Hub

National Centers
Define NAP Requirements

Acq HW/SW, Install & Test

CAOC

Evaluate Current Capabilities
Determine Residual Reqs

Acq HW/SW, Install & Test
Identify Comm Media, Install & Test

Define Regional Rqmnts
Identify Funding Sources
Acq HW/SW, Install & Test

Program Def Mtg
Start Reqs Phase
Start Acq Phase
Complete Reqs Phase

IOC
Recommendations

Establish a multinational working group to:
- Determine key air picture requirements
- Determine essential national capabilities to meet requirements

Obtain funding for an architectural research and design tradeoff effort

Develop a detailed architecture

Develop an associated system and component acquisition roadmap

Work with coalition partners to develop Letter of Request (LOR) documents (statements of national requirements) if Foreign Military Sales (FMS) initiative