Current and Future MIP Capabilities for Coalition Interoperability

Msc. M.G. van der Meijden

SEAWG Deputy Chair
TNO-FEL, Oude Waalsdorperweg 63
P.O. Box 96864, 2509 JG The Netherlands
Telephone: +31 (0)6 51293739
Fax: +31 (0)70 3740652
vandermeijden@fel.tno.nl; c2sc.mip@rnla.mindef.nl

ABSTRACT

The aim of the Multilateral Interoperability Programme (MIP) is to achieve international interoperability of Command and Control Information Systems (C2IS) at all levels from corps to the lowest appropriate level, in order to support combined and joint operations; and pursue the advancement of digitization in the international arena, including NATO.

The MIP programme is tightly focused on delivering capability in an incremental manner based upon a rolling 2-year delivery cycle, while in parallel the previous baselines are sustained, new operational requirements are analysed, new capabilities are agreed, and emerging technologies are explored. The MIP is an operational requirement driven programme with a schedule constraint. The overall MIP Calendar is divided into 'Blocks' or evolutionary solutions, each block will take three years of developing and will remain 'in-service' for two years. The first MIP solution (block I) became available at the end of 2003, after the Integrated Operational Test & Evaluation (IOT&E). This will be the interoperability solution for allied armies in 2004 and 2005. Meanwhile, the second iteration of the MIP solution is under developed and will become 'in-service' in 2006 and 2007, and so on.

The MIP specification consists of a common data model and exchange mechanisms to exchange information between co-operating but diverse C2 systems. The common interface is the C2 Information Exchange Data Model, C2IEDM[1]. It is a product of the analysis of a wide spectrum of allied information exchange requirements. It models the information that allied land component commanders need to exchange (both vertically and horizontally). It serves as the common interface specification for the exchange of essential battle-space information.

This paper briefly describes the MIP Programme and background. First an overview is given of the current MIP Block I specification and the operational capabilities it provides. Than a summary is given of the evaluation of the Block I specifications at the Initial Operational Evaluation & Testing (IOT&E). The evaluation results of the IOT&E are being addressed by the MIP Block II specification currently under development of which a preview of work in progress is given.

The MIP program appears well on track to provide an operational fieldable interoperability solution. Results from testing and evaluation indicate that end-to-end interoperability can only be achieved when national C2ISs and SOPs are aligned with the information exchange standard.

In order to allow a better requirements driven approach, the MIP programme has been adopting a RUP (Rational Unified Process) based System Engineering process since 2002.This will allow MIP to identify,

[1] MIP owns the C2IEDM, which was transferred from the ATCCIS Programme in accordance with the Statement of Intent in April 2002.

Paper presented at the RTO IST Symposium on "Coalition C4ISR Architectures and Information Exchange Capabilities", held in The Hague, The Netherlands, 27-28 September 2004, and published in RTO-MP-IST-042.

prioritize and schedule capabilities for future MIP blocks well in advance, facilitating nations to incorporate the MIP solution in their national C2IS and acquisition cycles.

1.0 MIP BACKGROUND

The Multilateral Interoperability Programme [1] was established by the Project Managers of the Army Command and Control Information Systems (C2IS) of Canada, France, Germany, Italy, the United Kingdom and the United States of America in April 1998 in Calgary, Canada. MIP replaced and enhanced two previous programmes: BIP (Battlefield Interoperability Programme) and QIP (Quadrilateral Interoperability Programme). The aim of these programmes was similar to the present MIP but each was active at a different level of command.

In 2002 the Army Tactical Command and Control System (ATCCIS) programme merged with MIP. ATCCIS was founded in 1980 to see if interoperability could be obtained at reduced cost and developed according to technical standards agreed by Nations and prescribed by NATO. The programme sought to identify the minimum set of specifications, to be included within national C2 systems that would achieve interoperability. With the publication of ATCCIS Baseline 2 the programme's mandate was complete. By 2002 the activities of ATCCIS and MIP were very close, expertise was shared, and specifications and technology was almost common. The merger of ATCCIS and MIP was a natural and positive step and this was recognised by the almost immediate publication of a NATO policy that endorses MIP. MIP has a strong NATO buy in reinforced by the recent signing of a Memorandum of Agreement (MOA) between the MIP and NATO Data Administration Group (NDAG) stating their intent to collaborate data modelling efforts in order to produce a Joint Consultation Command & Control Information Exchange Data Model (JC3IEDM) in 2008.

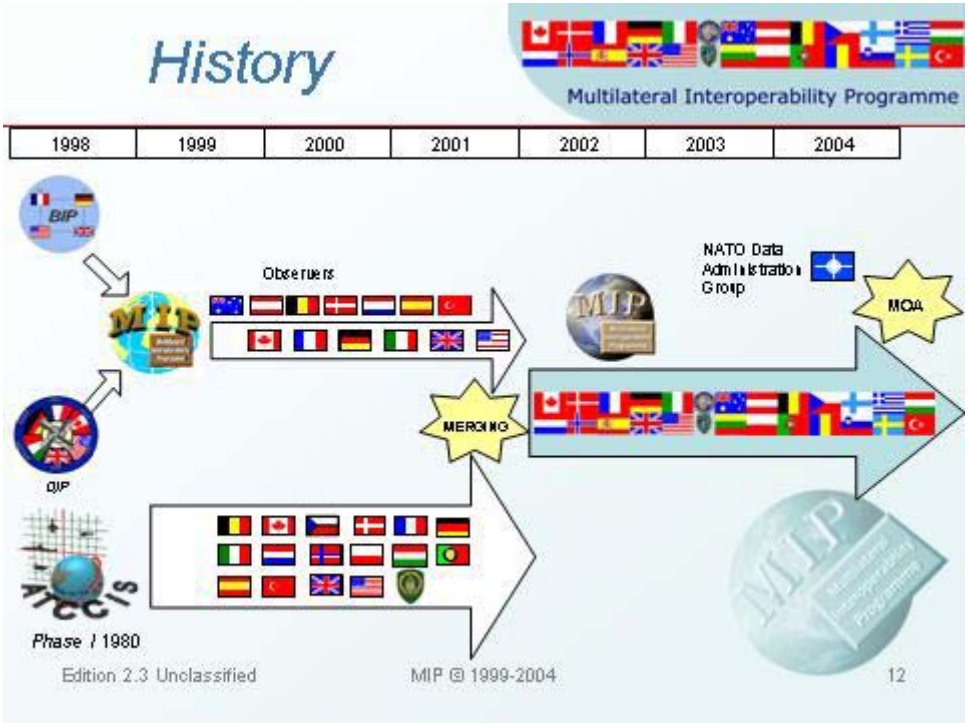

Figure 1: MIP History

The programme is tightly focused on delivering capability in an incremental manner based upon a rolling 2-year delivery cycle (Figure 2), while in parallel the previous baselines are sustained, new operational requirements are analysed, new capabilities are agreed, and emerging technologies are explored. The overall MIP Calendar is divided into 'Blocks' or evolutionary solutions, each block will take three years of developing and will remain 'in-service' for two years. The first MIP solution (Baseline 1) became available at the end of 2003, after the Integrated Operational Test & Evaluation. This will be the interoperability solution for allied armies in 2004 and 2005. Meanwhile, the second iteration of the MIP solution is under development and will become 'in-service' in 2006 and 2007.

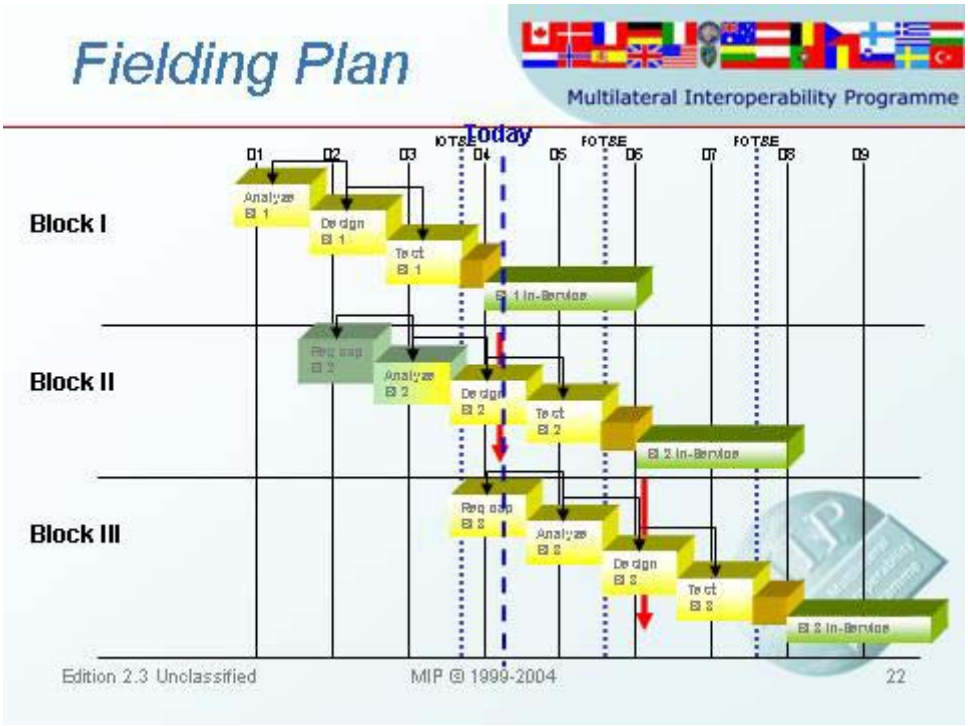

Figure 2: MIP Fielding Plan

2.0 CURRENT MIP BLOCK 1 BASELINE

Baseline I, in service from 2004 to 2005, consists of (Figure 3):

- Data Exchange Mechanism (DEM). The DEM is based on the ATCCIS Replication Mechanism and provides automatic push replication between C2IEDM compliant databases. A typical DEM gateway consists of a local C2IEDM database and implementation of the replication protocol. Information is generally automatically translated between the National C2IS and the local database of the DEM gateway that automatically replicates it to other gateways.
- Message Exchange Mechanism (MEM) for structured data exchange. The MEM consists of a suite of formatted messages that conform to AdatP-3 Part 1 that have been extended to contain C2IEDM data. A typical MEM Gateway implementation consists of a local C2IEDM database and implementation and the message exchange protocol. Information is generally automatically translated between the National C2IS and the local database of the MEM gateway. At the MEM Gateway, an operator directs the creation of a MEM Message and sends it to another Gateway via mail. The receiving gateway applies the contents of the message to the local C2IEDM database of the MEM Gateway either automatically or after operator approval.

- Message Exchange Mechanism for unstructured information exchange. Using the same SMTP based message exchange protocol, a selected set of non-database able AdatP-3 NBC messages and human readable message with attachments can be exchanged

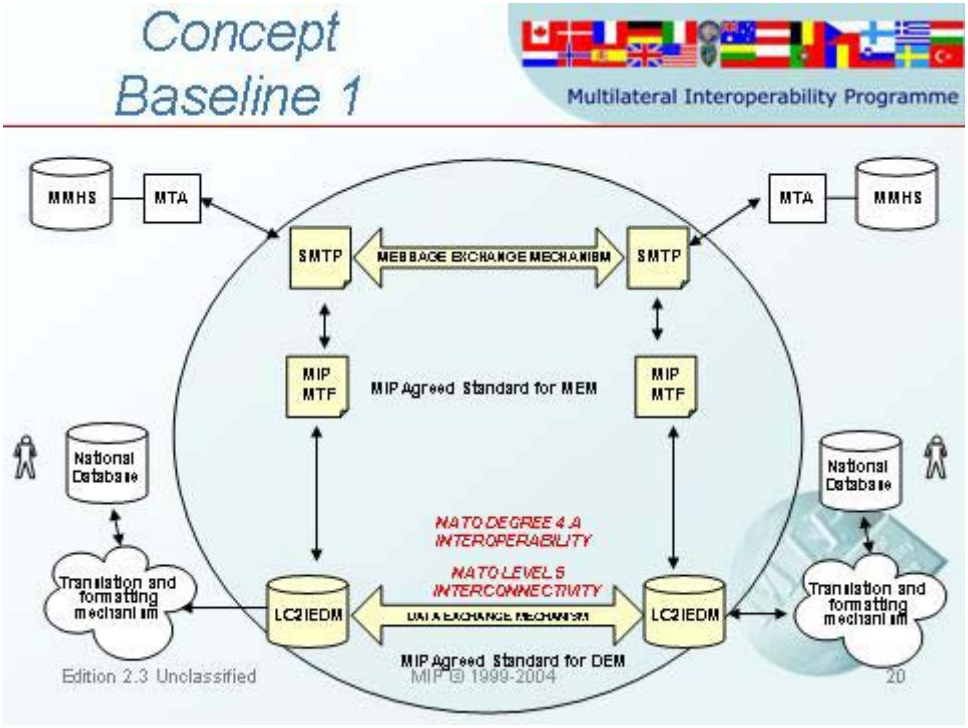

Figure 3: MIP Block I concept

As can be seen in Figure 3, the MEM and DEM essentially provide two alternative replication mechanisms between C2IEDM databases. In Block II, the MEM will no longer be used for data replication and only for unstructured writer to reader messages. With this prospect, the MEM will only be fielded by a limited number of Nations whereas the majority of Nations will support the DEM solution.

The DEM solution is shown in more detail in Figure 4. Included in the specification is the 'MIP LAN', A MIP LAN is set up in a secure area of a Tactical Operating Centre (TOC). Multiple DEM Gateways can be connected on the MIP LAN. Data Exchange is determined through bi-lateral contract establishment. In principle, each nation is required to provide a liaison team equipped with a MIP interface to the appropriate TOC in compliance with STANAG 2101[2]. Alternative deployments such as using a central MIP LAN are also possible. From a technical perspective, connectivity between MIP Gateways across a WAN is possible using TC/IP but is not supported in Block I and thus not covered by procedures or testing although some nations employ it nationally.

[2] STANAG 2101 requires liaison teams to be provided from super unit to subordinate and to the flanking unit from left to right.

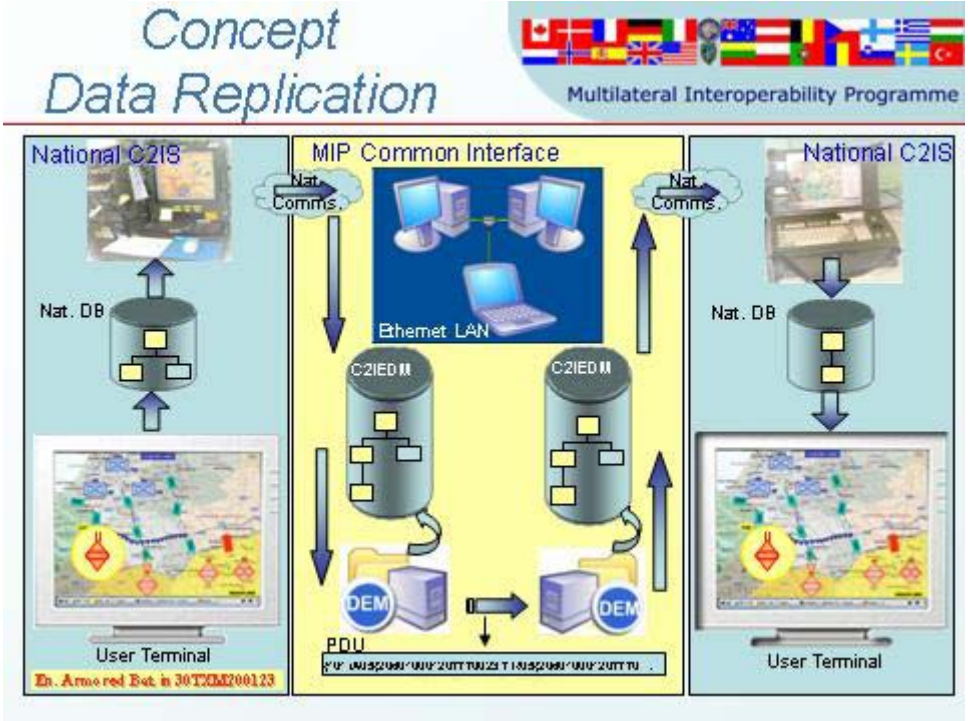

Figure 4: DEM Data Replication

From the operational perspective, the MIP Baseline 1 specification provides nations equipped with MIP-enabled C2 systems the ability to share:

- Situational awareness (own and enemy information) through use of the DEM and MEM.
- Plans and Orders through the use of formatted messages exchanged by MEM.
- NBC alerts and critical messages through the use of formatted messages exchanged by MEM

Although the C2IEDM is part of Baseline 1, its use is scoped to a part of the data model. The extent of the C2IEDM is in generally larger than National C2ISs are able to cover[3] currently. This factor and MEM DEM coexistence were the reason the limitation of scope.

3.0 INITIAL OPERATIONAL TESTING AND EVALUTION

The Integrated Operational Test and Evaluation (IOT&E) was conducted in Ede, The Netherlands, in the period from 8 September to 26 September 2003. The IOT&E involved the deployment of representative HQ's by each nation to exercise the Communications and Command and Control Information Systems (C3IS) at levels of command from battalion to Corps. Nations deployed actual or prototype C2IS's. The goal for the IOT&E was to confirm the operational fieldability of the MIP Solution in accordance with MIP Tactical Interoperability Requirements (MTIR) Version 1.1.

The summary of the findings is that the MIP solution and all of its sub systems are working reasonably well for all nations and is as an information exchange tool sufficient to support conducting battle. Therefore the majority of the systems could become fieldable systems. Operational relevant information is

[3] In other cases national C2ISs cover more or more detailed information.

disseminated and mostly received in a timely manner in horizontal exchange at same level of command. The information exchanges have been useful to the staffs working in the TOCs and are enhancing the ability for the nations to conduct battle. However there is room for improvement in the areas of information exchange procedures, SOP's, order handling, planning capability and handling enemy situation. Minor fixes to the MIP Specification were incorporated into the MIP Baseline 1 released Dec 2003. In next sections an overview is given of the issues that were identified in the evaluation the IOT&E [2] that are being addressed for Block II.

3.1 IOT&E evaluation results

3.1.1 Initialisation

The initialisation process remains too long – 4 days on average, and has a high risk of failure. This applies specifically to the MEM. It is not fully operational today and too many contractor staffs are still involved in that process. The current procedure is not sufficiently robust to be deployed, used, and maintained by average organizations. Provision of bad data fill contributed to the length of time to complete initialisation and thus remains a significant operational concern.

3.1.2 Enemy

Enemy information exchange rules and procedures are not mature and synchronised against national doctrine

3.1.3 SOP

There is a strong need for a set of MIP Standard Operating Procedures. Current MIP operational procedures are too generic. The MIP current operational procedures for information exchange over the MIP interface needs to be further defined agreed and incorporated into national SOPs.

3.1.4 Liaison teams

Even if the TOCs operated a few metres from each other for exercise reasons, it proved that physical coordination in a multinational environment remains absolutely necessary. This means that the need for liaison teams remains relevant.

3.1.5 Flow of information and Tailorability

The MIP Block 1 requirements specified that a unit must see **"at a minimum"** one up, two down, one on the flank and one down. Most part of the time, this rule was interpreted as a *maximum* and created misunderstanding. If the tactical situation requires more details, it is obvious that the commander should have the opportunity to show other units affecting his own operation.

3.1.6 Aggregation

The operational evaluation emphasized the fact that aggregation of lower units by higher level - i.e. the brigade icon was operated by the division based on battalion locations - was not functional. It is therefore recommendable that every unit is in charge of its own information (i.e. the brigade commander operates its own brigade icon).

3.1.7 Robustness

Robustness represents the sum of the factors of Reliability, Availability, and Maintainability. During the duration of the IOT&E, 120 total errors, anomalies, or other incidents were reported. The table below gives an overview of the distribution of incident reports over issue categories.

Issue Category	% of IRs
Operator errors	22%
C2IS to C2IEDM mapping	18%
C2IS fixes	11%
Differences in C2IS capability	8%
New types	3%
Initial datafill issues	5%
Total of National implementation and operator related incidents	**67%**
WG issues	11%
MEM/DEM coexistence issues	6%
FOT&E issues	5%
Specification issue	5%
Dissemination rules	2%
High latency	2%

Table 1: Incident Reports per issue category

Reducing the operator's interaction with the Gateway Operation and automating those procedures will eliminate 22% of all errors. A further 29% of the errors are related to errors in implementation such as the mapping of national objects to MIP objects that are related to human design decisions, when corrected, together with reduced operator errors, will account for more than 50% of all errors, and result in a predictable and reliable capability for fielded units.

3.1.8 National C2IS compliancy

National C2IS differ in capability and therefore some systems are not able to utilise all exchanged data at the present time. Some nations implemented different interpretations of the MIP specification (business rules) within their national C2IS leading to inconsistencies in data exchange. Unless this is addressed the risk remains high that operators will remain suspicious of the credibility and reliability of the data that is exchanged between nations.

3.1.9 Planning & Coordination

The MIP IOT&E showed international limitations in the areas of planning, collaboration and coordination. The systems must provide tools to give the commander the ability to do a proper coordination and synchronization towards all levels where it could be a need. MIP must reinforce the need for Planning, Requests, and Co-ordination applications. The program has to continue providing development and better means for coordination and synchronization of effort in a multinational environment.

3.1.10 Timeliness

The timely and reliable provision of friendly and enemy unit information, including not only their locations but also their disposition, proved most valuable. However, frequently this information was not exchanged in a timely manner, and therefore lost its operational relevance. This was especially visible with exchanges between more than one level of command using the MEM.

With DEM, information is processed immediately on receipt and the DEM solution is hugely impressive with instant dissemination. Updates are processed immediately, which is very relevant for blue forces

tracking. With MEM, information processing is dependent on speed of response when the MEM operator opens and processes updates.

4.0 BLOCK II

The main changes of MIP Block 2 compared to Block 1 will be:

- C2IEDM v6 with included support for Operations Other than War (OOTW) and alignment with APP-6(A). Inclusion of APP-6(A) will greatly enhance the end-to-end interoperability as it allows the many nations that support APP6a in their systems to fully exchange that data without any loss in translation and removes many ambiguity in the display of exchanged information.
- In Block 2, the MEM will no longer be used for data replication and only used for unstructured information exchange. The MEM is extended to support Subject Indicator Codes (SIC)[4] in the message headers.
- Improved technical and procedural specifications that address issues identified in the IOT&E.

At the time of writing this paper, work was still is progress on the Block 2 technical and procedural specifications. The Block 2 preview presented in the next section is therefore subject to change. Final Baseline 2 specifications will be released December 2005 after the Follow-on Testing and Evaluation (FOT&E) in September 2003.

4.1 Block 2 preview based on work in progress

4.1.1 Initialisation

Block 1 initialisation procedures required each nation to provide an initial data-fill to a lead nation that distributed the combined data-fills to all nations before the start of an operation. After that Gateway initialisation was performed top-down through the complete task-organisation and a lot of errors occurred at this stage. In Block 2, initialisation is defined as a bilateral procedure that can occur at any time in the deployment process whenever units are ready to deploy their MIP Gateway. Overall initialisation is the result of bilateral initialisation that occurs in any order. Furthermore, initialisation will be performed as much as possible in an automatic way.

4.1.2 Enemy

Enemy information exchange rules and procedures are defined. Each unit has the ability to generate both a correlated and uncorrelated enemy picture that is distributed throughout the task organisation following default dissemination rules.

4.1.3 SOP

Block 2 includes an operational handbook where procedures are defined on how users are to use their national systems in a MIP compliant way. Aspects as aggregation and enemy handling are covered here.

4.1.4 Flow of information and Tailorability

Information flows in Block 1 could only be defined by the organisation that created the information. In Block 2, the information that is provided by each organisation is divided in operational information groups. These groups correspond to a set of pre-defined to categories such as ‘own-information’, ‘enemy correlated information’, ‘enemy uncorrelated information’, ‘plan-information’ etc.

[4] Information on NATO Subject Indicator System can be found in APP-3.

For these categories default information flows are defined as well as procedures that allow the commander to tailor these information flows. The DEM is extended with replication contracts that determine which information groups are replicated.

4.1.5 Aggregation

Following the IOT&E recommendation, every unit is in charge of its own information (i.e. the brigade commander operates its own brigade icon). Associated to this is the capability to forward data received from other nations without modification. This means that the brigade data is only created by the brigade and is never changed or duplicated when this information is forwarded through the task organisation. This ensures integrity of the Common Operational Picture.

4.1.6 Robustness

In Block 2 additional requirements are stated on the performance and robustness of the overall MIP Solution a nation provides. Additional test cases and test procedures were created. The MIP organisation has established a Testing and Evaluation Working Group (TEWG) to enforce a more test regime.

4.1.7 National C2IS compliancy

In Block 2 requirements for the National C2IS are explicitly stated that indicate which capability a National C2IS is required to support in order to leverage the information exchange capabilities provided by the Gateway and support the SOPs. Additional test cases are defined for system to system interoperability.

4.1.8 Planning & Coordination

Planning in Block 2 is supported in two ways:

- Textual attachment exchanged through MEM.
- Exchange of a combined plan ‘overlay’ through DEM.

Full exchange of plans through the DEM is in scope for Block 3. Although the C2IEDM v6 has support for plans, the mapping of national implementations of planning to the C2IEDM is not defined well enough[5] yet to provide consistent results when plans are exchange between nations.

Requirements have been identified for functionality that enables improved coordination and synchronization of effort in a multinational environment and these will be considered for future blocks.

4.1.9 Timeliness

In Block 2, specific requirements on the exchange and initialisation times are stated and these will be part of testing. As the DEM solution doesn’t require operator intervention for information exchange after initialisation, the Block 2 specification should pose no limitations on a nations ability to implement the MIP solution in accordance with the performance.

4 FUTURE BLOCKS

In order to allow a better requirements driven approach, the MIP programme has been adopting a RUP (Rational Unified Process) based Software Engineering process since 2002. As MIP doesn’t deliver an

[5] For example the use of multiple overlays or the way the synchronization matrix are modeled in the C2IEDM.

actual software system but only a system specification, the engineering process mainly involves requirements engineering and systems modelling. Requirements engineering is currently focused on creating a fully traceable requirements repository from the operational user to the systems and specification level. This will allow MIP to identify, prioritize and schedule capabilities for future MIP blocks well in advance.

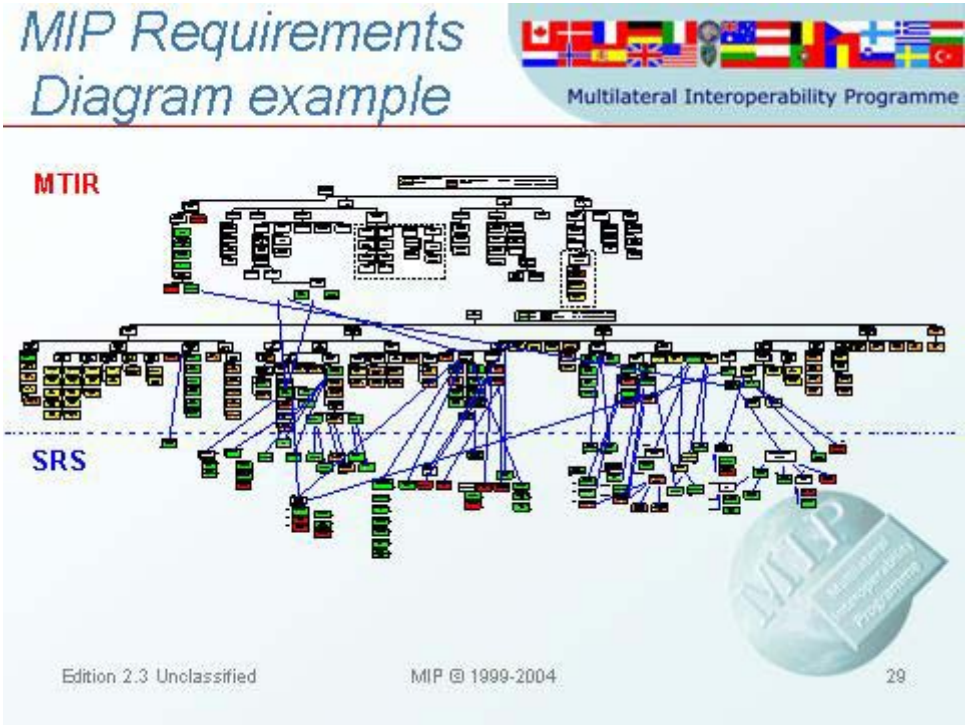

Figure 5: Example of the MIP Requirements Repository

5.0 CONCLUSION

The MIP program appears well on track to provide an operational fieldable interoperability solution. Results from testing and evaluation indicate that end-to-end interoperability can only be achieved when national C2ISs and SOPs are aligned with the information exchange standard. Where the original scope of ATCCIS and MIP was limited to technical Gateway-to-Gateway interoperability, the MIP programme has expanded its scope in recent years to include national procures and national systems in its specification (Figure 5). Mapping issues in the translation between national C2IS and MIP Gateway, lack of National C2IS support for C2IEDM data and common SOPs are being identified as the major bottlenecks instead of the gateway to gateway exchange. From a technical perspective the DEM specification appears quite mature. Efforts on robustness specification and national implementation testing will continue to get high priority for the next blocks however. The C2IEDM v6 and future JC3IEDM are covering more of the C2 domain than many national systems fully support. By having the data model being well ahead of national implementations, it allows nations to converge on a common model within their C2IS.

In future MIP blocks, this will mean that systems specifications are developed to support commonly agreed upon data models, operational processes and national systems capabilities. By explicitly stating the

associated required capabilities of national C2IS, it facilitates nations to incorporate the MIP solution in their acquisition cycles.

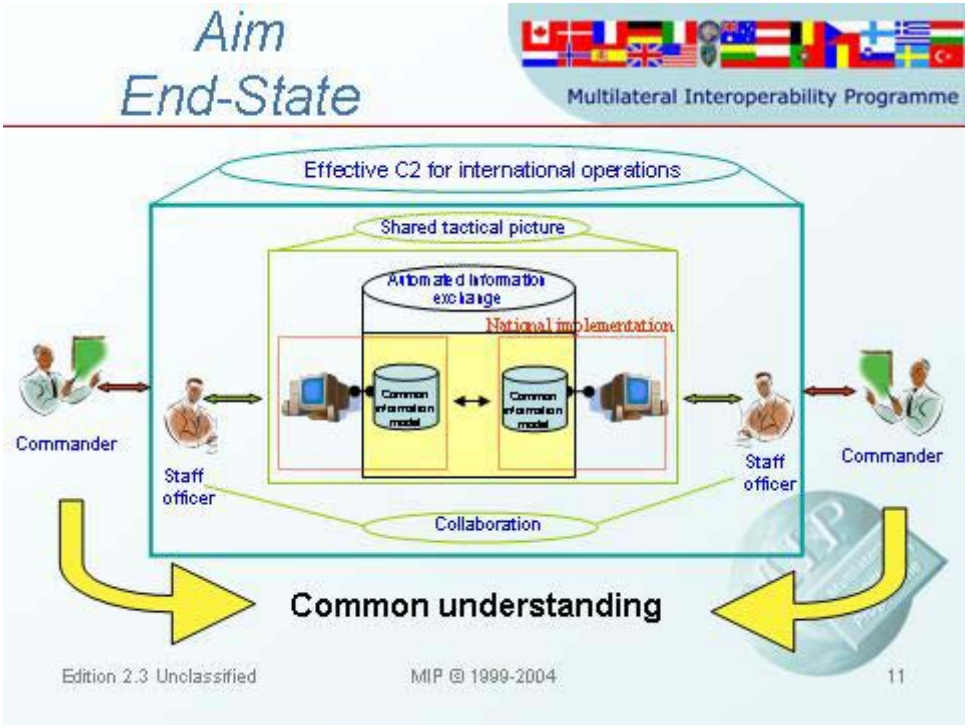

Figure 5: Context diagram showing the scope of MIP

REFERENCES

[1] www.mip-site.org

[2] IOT&E Report v1.0[6]

[6] Part of this publication is secret and can only be obtained through national channels.