Testing C2 Interoperability

Advancements in Testing of the MIP Baseline 3 Solution

Nico Bau, Michael Gerz & Michael Glauer
FGAN FKIE

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Outline

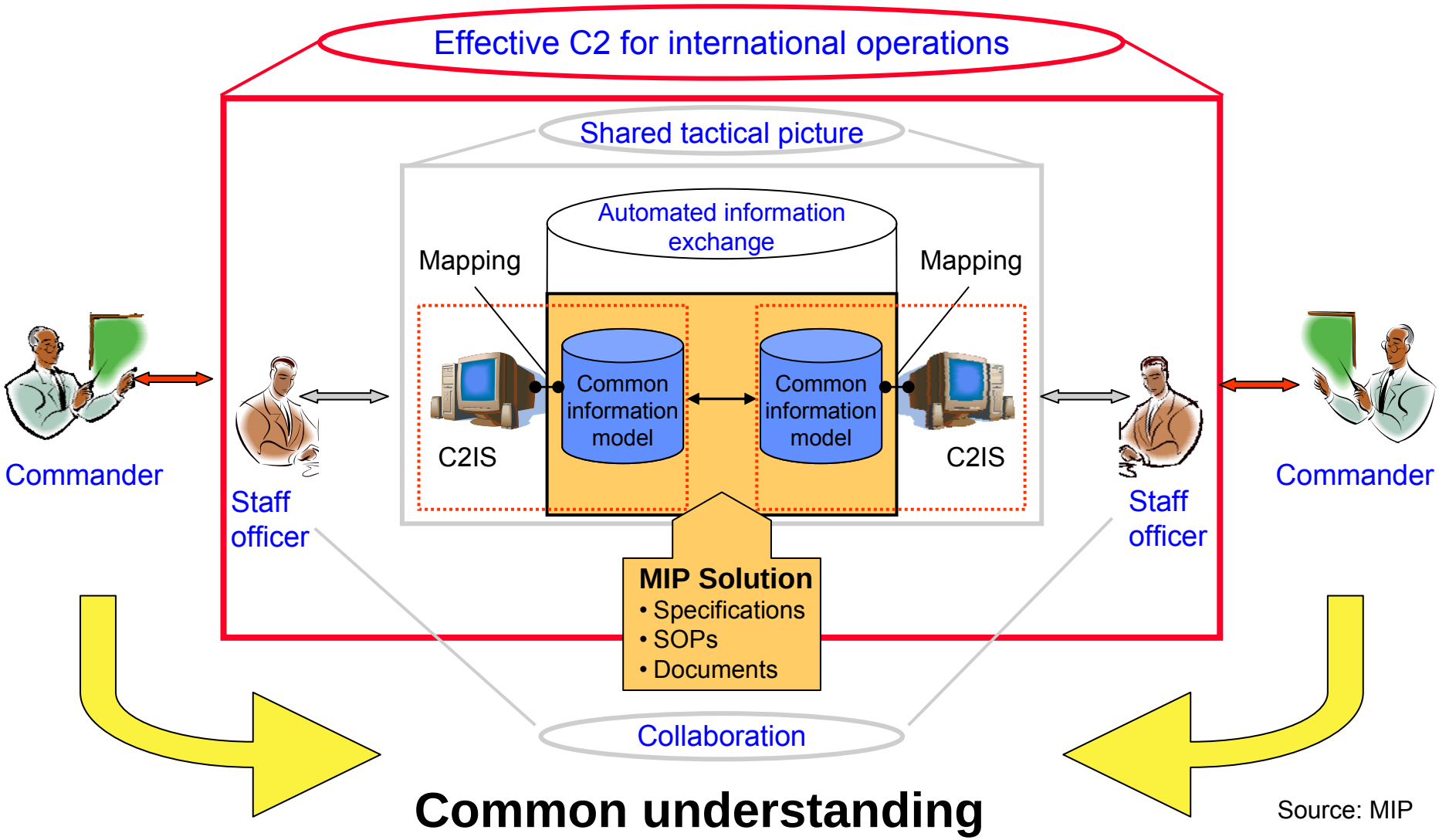
- Introduction to MIP
  - Goals & Organization
  - MIP Solution of Baseline 3
- MIP Tests
  - MIP Interoperability & Conformance Tests
  - MIP Test Reference System
  - SLT1 / SLT2 / SLT3
- Status Quo & Usage Statistics
  - MIP System Level Tests
  - Use of the MTRS
- Summary

Goals

- 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 battalion, or lowest appropriate level, in order **to support multinational (including NATO), combined and joint operations** and the advancement of digitization in the international arena.

- Voluntary Project of 26 Nations & NATO ACT
  - Technical specifications based on consensus
  - System-independent capabilities
  - No common funding

The MIP Solution



Source: MIP

MIP Baseline 3 – JC3IEDM

- JC3IEDM = **J**oint **C**ommand, **C**ontrol, and **C**onsultation **I**nformation **E**xchange **D**ata **M**odel

- MIP Baseline 3 available as **draft specification**
  - Current version of the data model: JC3IEDM 3.1c

- **Entity relationship model**
  - 271 Entities, 2005 attributes, »10.000 fixed domain values
- + **Semantic definitions**
- + **Business Rules** (Integrity & transformation rules)
  - Valid attribute value combinations
  - Valid associations
  - Modeling of geometry of objects and actions
  - Mapping onto APP6a symbols

MIP Baseline 3 – Data Exchange Mechanism

- **Automatic node identification**
  - Broadcast mechanism

- **Publish / Subscribe** technology
  - Partial replication of JC3IEDM data base content
  - Based on subscriptions to operational information groups
  - Taking into account
    - Referential integrity
    - Semantic completeness
  - DEM exchange format coupled with relational DB schema

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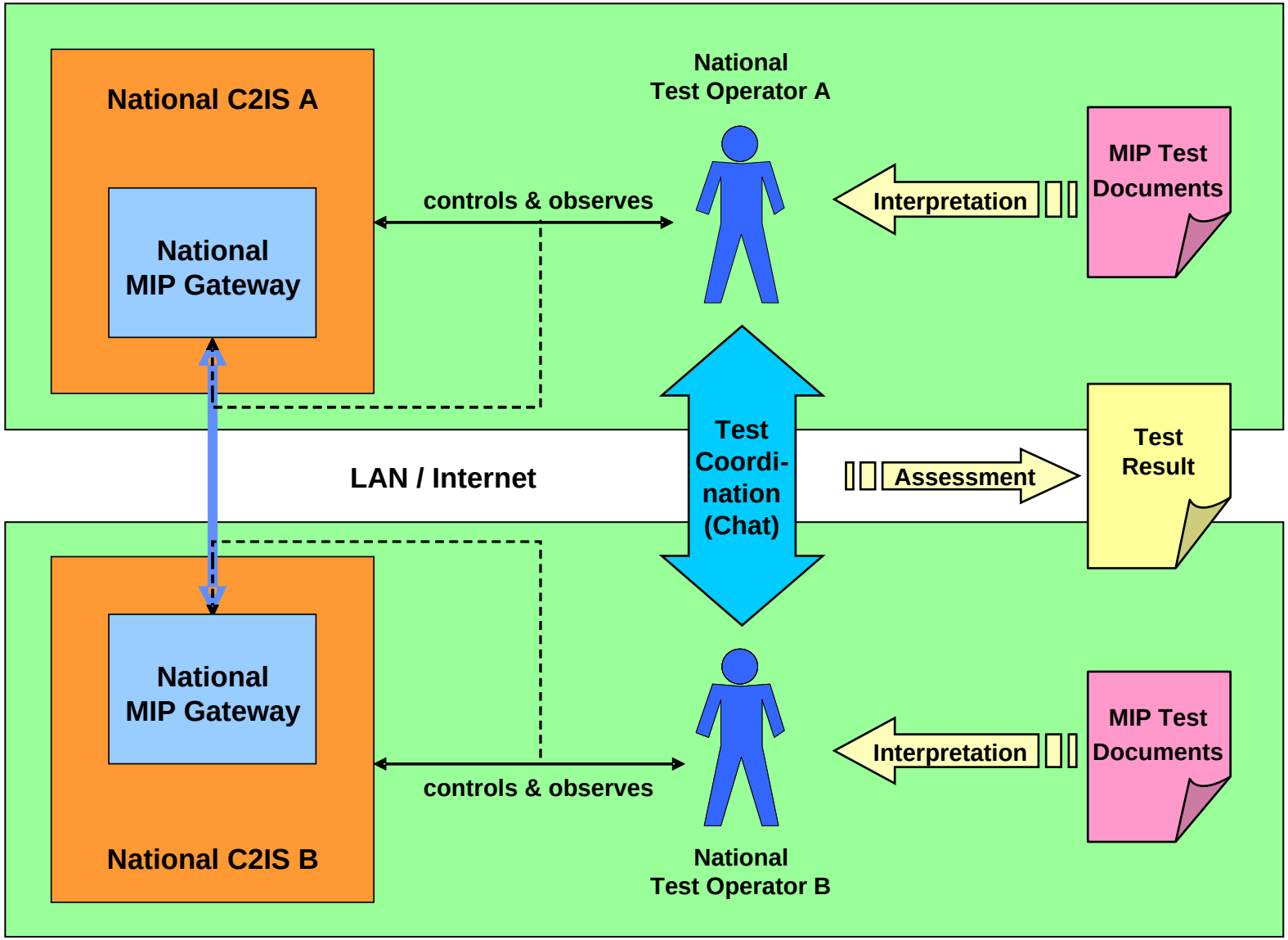
Testing the MIP Solution

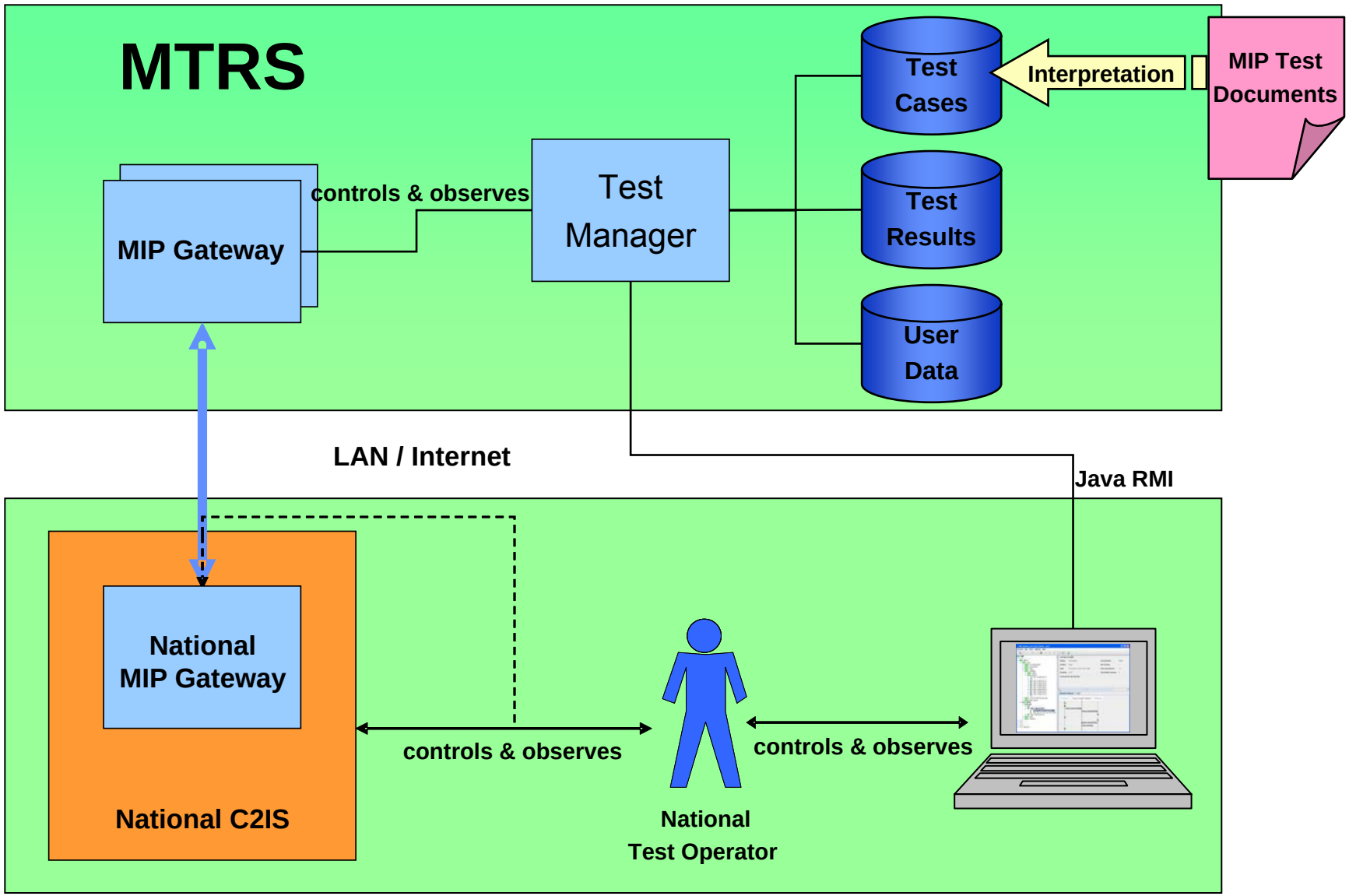
- Without MTRS
  - International test sessions in Greding (Germany)
    - Bilateral/Multilateral
  - C2ISs alternatively take role of
    - System Under Test
    - Test System
  - Semi-formal test documents

- Problems
  - C2ISs do not support all test phases
    - Specification, preparation, execution, evaluation
  - Testing (esp. test setup and coordination) is expensive
  - Legacy systems are not suitable as unbiased testers
  - Test specifications are subject to interpretation

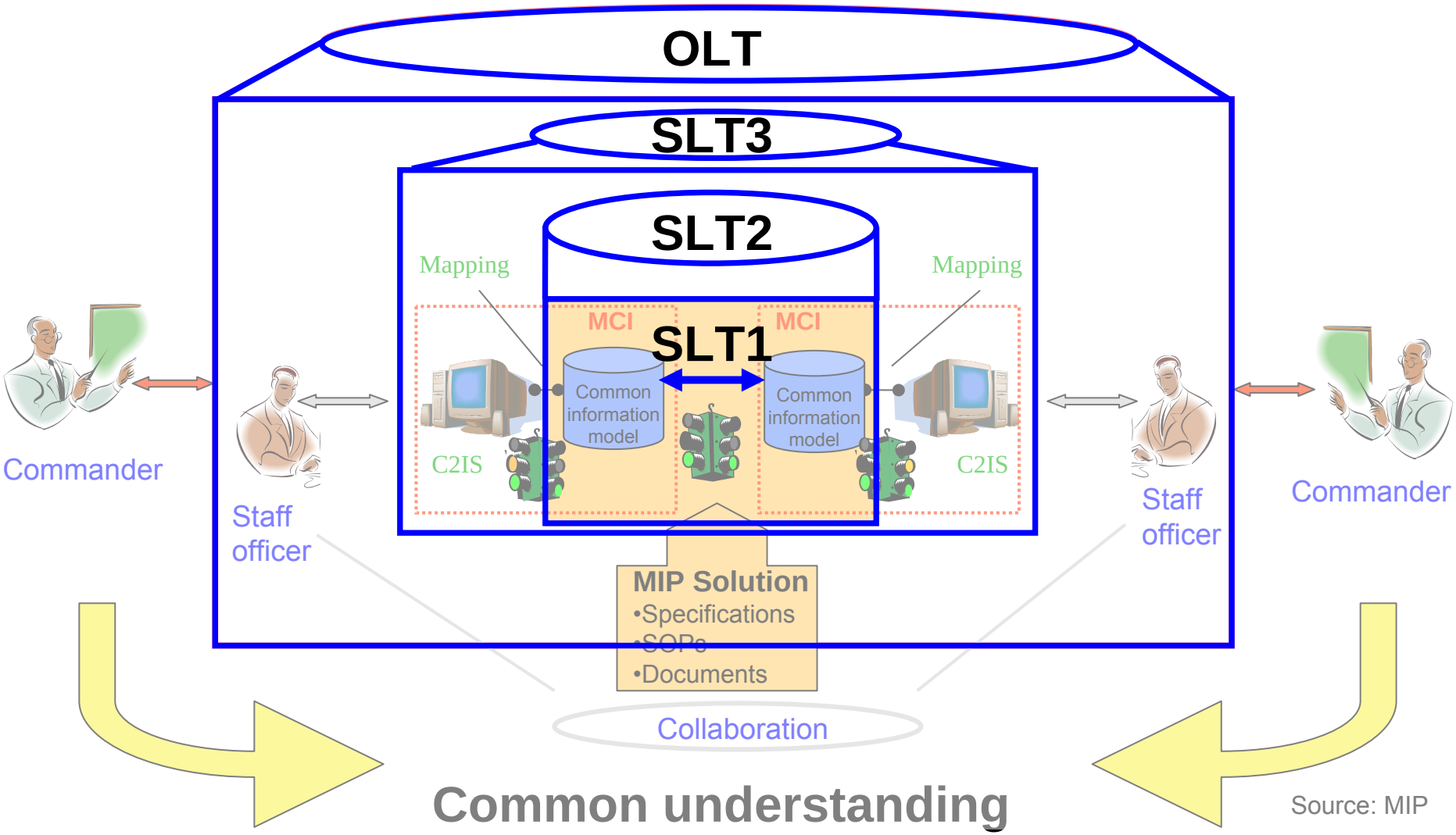
Bilateral MIP Interoperability Tests



MTRS MIP Conformance Tests

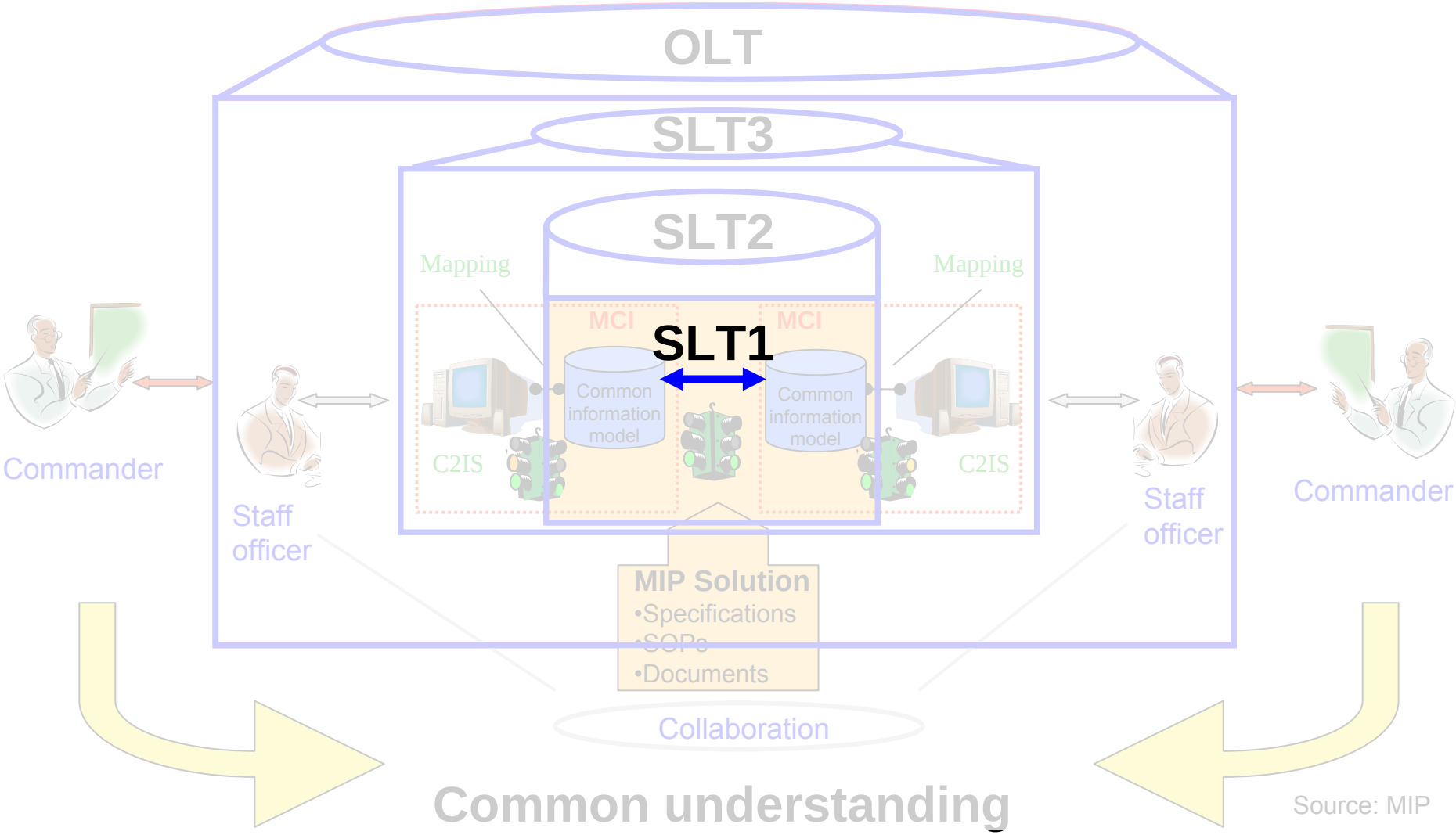


Testing the MIP Solution



Source: MIP

Testing the MIP Solution



Source: MIP

SLT1 (Protocol Tests)

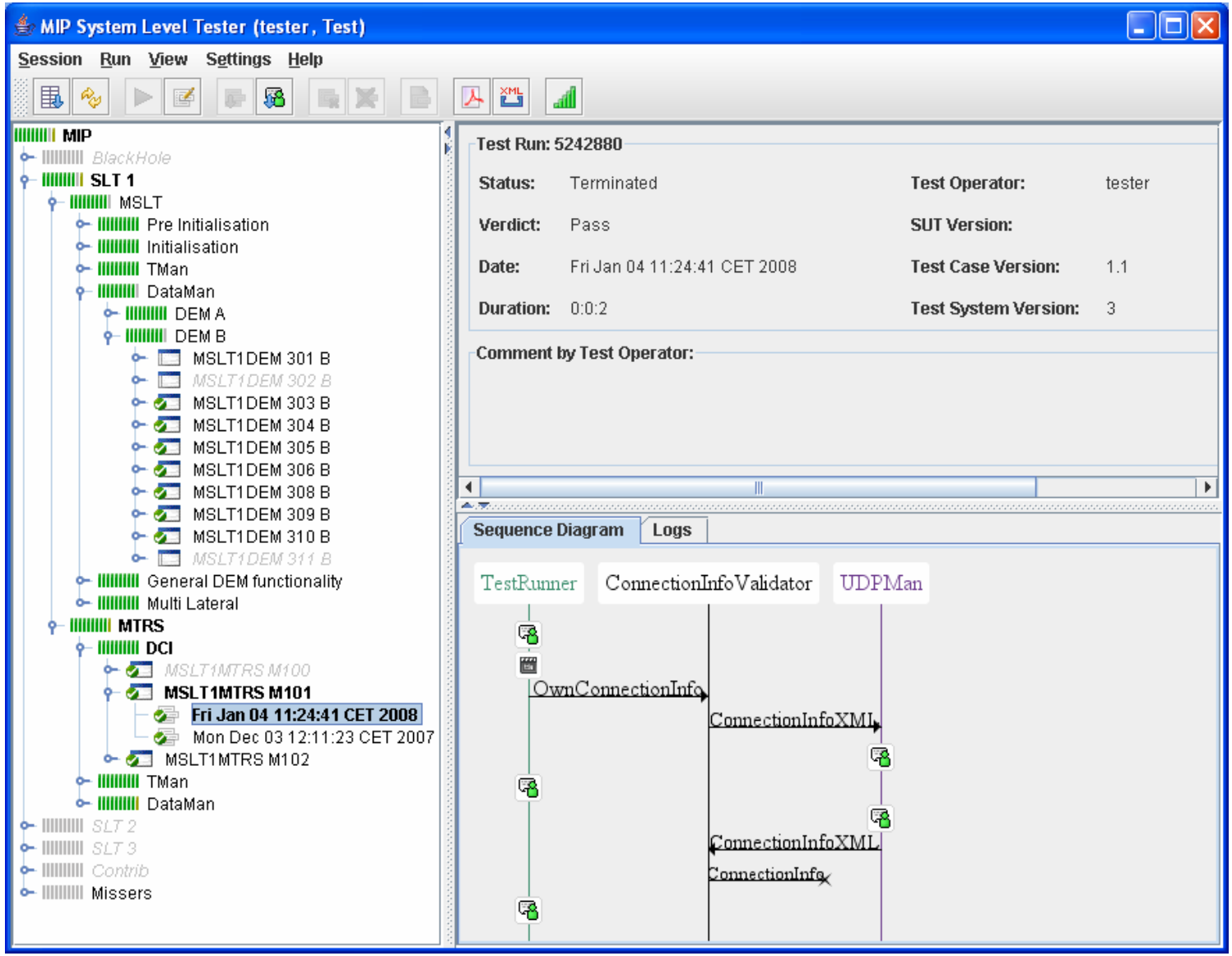
Data

```
00000022T1|449000001|180550001
00000093T2|D1|{10003008130201000001|BLK3 SLT1 DEM A RESP ORG OIG_1|GLBSGN|BLK3 SLT1 DEM
    A RESP ORG|0}
00000022T1|180550001|449000001
00000093T2|D1|{10003008140301100003|BLK3 SLT1 DEM B RESP ORG OIG_3|GLBSGN|BLK3 SLT1 DEM
    B RESP ORG|0}
00000031T2|D2|{10003008130201000001||H}
00000510T2|D4|10003008130201000001|0|3085|x?½VÛr? ý ¾ Ã? }Äx?SE h§yê??ü{Á??u@jlëøà?...
00000031T2|D2|{10003008140301100003||H}
00000237T2|D4|10003008130201000001|0|826|x? ?Q?0 Do$³  õÓª ¡¨X?z ·wo¢Öb J 0ÈËÎÎdó...
```

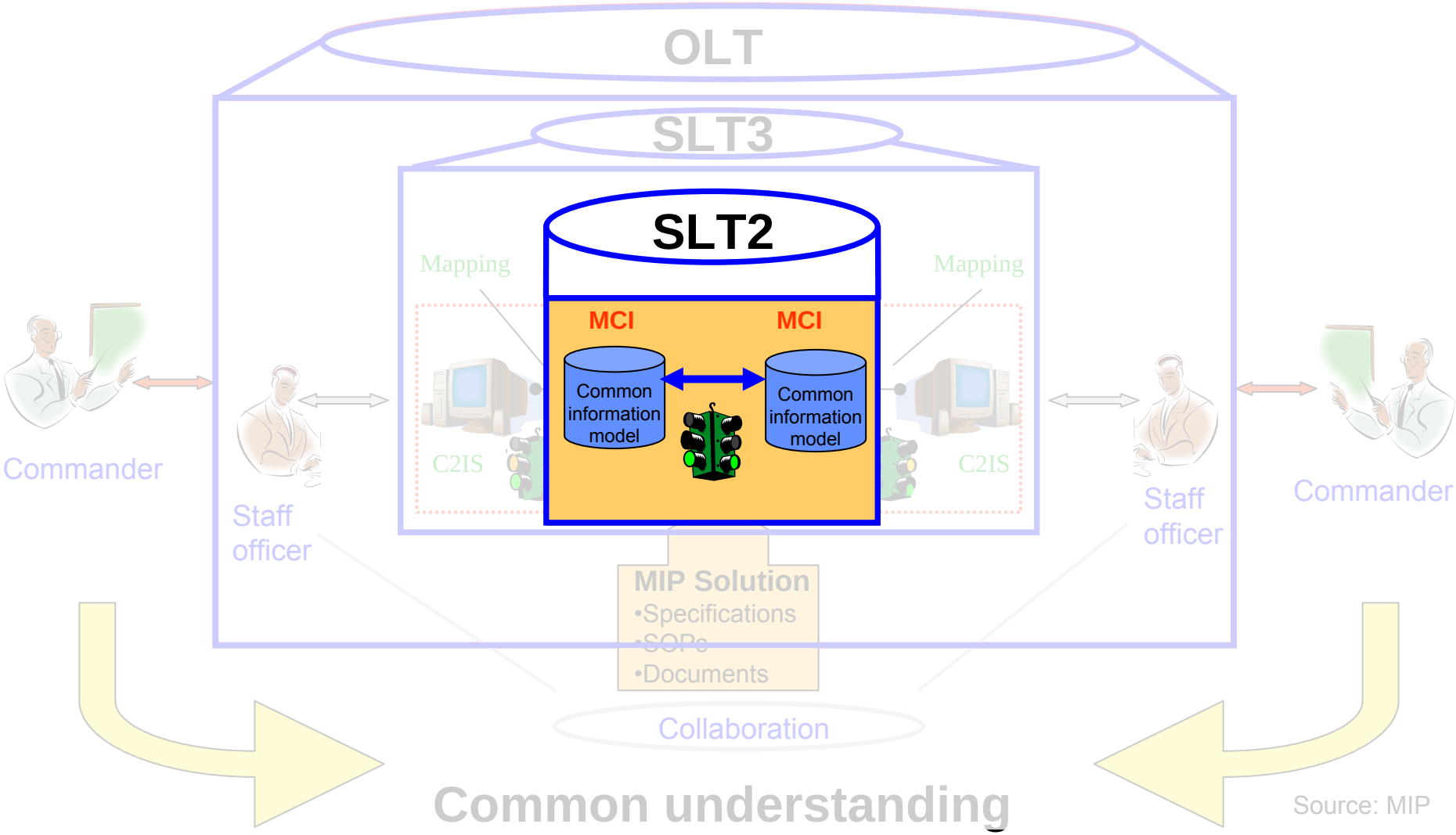
Test Script

```
01 testcase MSLT1MTRS_M101 {
02    request("Please start your C2IS.");
03    //send our own DEM Connection Information
04    OwnConnectionInformation ownDCI = getOwnConnectionInformation();
05    [!] send(ownDCI) to validator;
06
07    //now we want to receive a reply
08    [?] receive(ConnectionInfo dci) from validator in 15000 {
09        //check whether all fields are set correctly:
10        assertEquals("NodeId", getSut().getNodeId(), dci.getNodeId());
11        assertEquals("IpAddress", getSut().getIpAddress(), dci.getIpAddress());
12        assertEquals("TcpPort", getSut().getTcpPort(), dci.getTcpPort());
13        if (dci.getScope() == Scope.ANNOUNCE) repeat;
14    }
15 }
```

SLT1 (Protocol Tests)



Testing the MIP Solution



Source: MIP

SLT2 (DB to DB)

Data

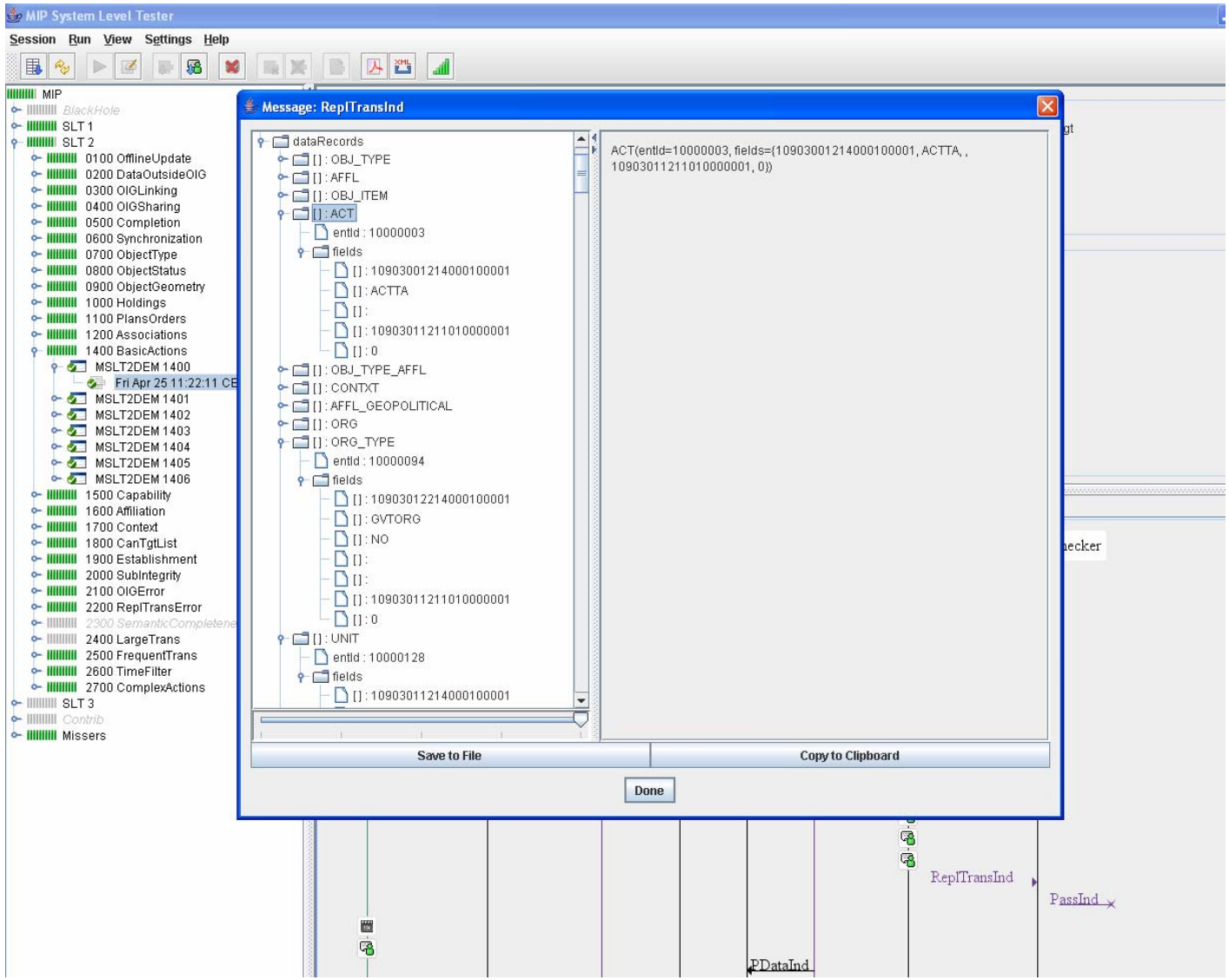
X0110000082{{1090301221201000001|OR|NO|MECHANISEDINFANTRYCOMPANY|1090301120100000001|0}{1090301221201000002|FE|NO|CtrlFeatBoundaryOrg/TC1201_01|1090301120100000001|0}}10000254{{1090300321201000001|AFLGEO|1090301120100000001|0}}10000076{{1090301121201000001|OR|BLK3SLT2DEMARESPORG|1090301120100000001|0}{1090301121201000002|FE|Feature/TC1201_01|1090301120100000001|0}}10000051{{1090301221201000002|CF|1090301120100000001|0}}10000049{{1090301121201000002|CF|1090301120100000001|0}}10000261{{1090301221201000001|1090300321201000001|1090301120100000001|0}}10000094{{1090301221201000001|GVTORG|NO||MECHINFCOY|1090301120100000001|0}}10000085{{1090301121201000001|UN|1090301120100000001|0}}10000258{{1090300321201000001|FRA|1090301120100000001|0}}10000032{{1090301121201000002|NOS|1090301120100000001|0}}10000201{{1090301221201000001|MILORG||1090301120100000001|0}}10000128{{1090301121201000001|BLK3SLT2COYA||1090301120100000001|0}}10000035{{1090301221201000002|BDYOR|1090301120100000001|0}}10000137{{1090300821200000001|1090301121201000001|INCLDE|1090301120100000001|0}{1090300821200000001|1090301121201000002|INCLDE|1090301120100000001|0}}10000157{{1090301621201000001|1|REP|NO||A|20070528112900.000||RDABST|||1090301121201000001|OITYPE|1090301120100000001|0}{1090301621201000002|1|REP|NO||A|20070528112900.000||RDABST|||1090301121201000001|OISTAT|1090301120100000001|0}{1090301621201000003|1|REP|NO||A|20070528112900.000||RDABST|||1090301121201000001|OIHSTS|1090301120100000001|0}{1090301621201000004|1|REP|NO||A|20070528112900.000||RDABST|||1090301121201000001|OITYPE|1090301120100000001|0}{1090301621201000005|1|REP|NO||A|20070528112900.000||RDABST|||1090301121201000001|OIASST|1090301120100000001|0}{1090301621201000006|1|REP|NO||A|20070528112900.000||RDABST|||1090301121201000001|OISTAT|1090301120100000001|0}{1090301621201000010|1|REP|NO||A|20070528112900.000||RDABST|||1090301121201000001|OIHSTS|1090301120100000001|0}}10000154{{1090301621201000001|20070528112900.000||1090301120100000001|0}{1090301621201000002|20070528112900.000||1090301120100000001|0}{1090301621201000003|20070528112900.000||1090301120100000001|0}{1090301621201000004|20070528112900.000||...

„Test Script“

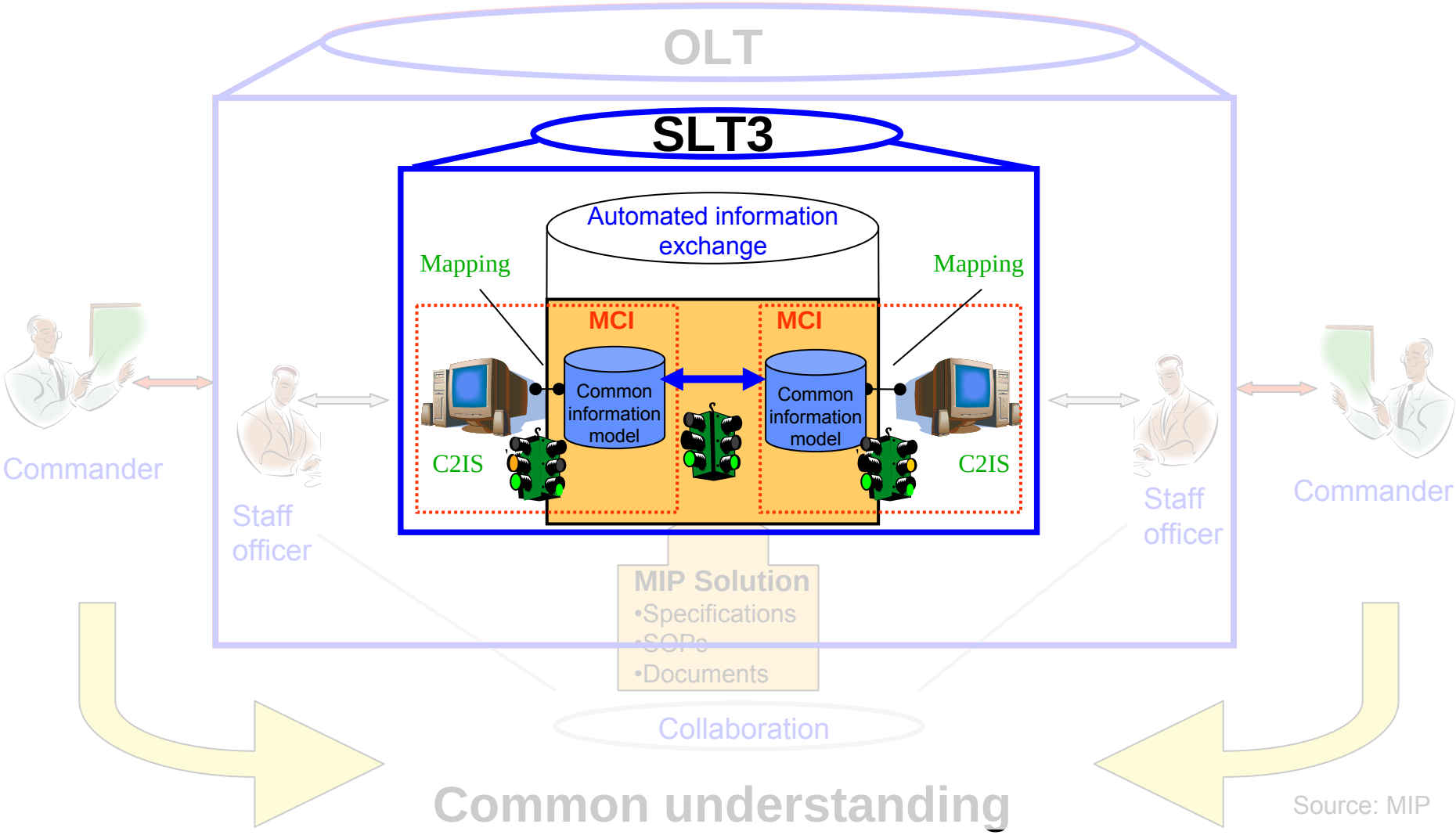
```
--@0200_01
INSERT INTO CONTXT_ELMT_STAT (contxt_id, contxt_elmt_ix,contxt_elmt_stat_ix, cat_code, effctv_dttm,
estblng_org_id, creator_id, update_seqnr)
VALUES (1090300820200000001, 1090002000000000001, 10900
1090301120200000001, 1090301120200000001, 0);

-- Link the elements to the OIG: HOSTILITY
INSERT INTO CONTXT_ELMT (contxt_id, contxt_elmt_ix, rptd_
VALUES (1090300820200000001, 1090002000000000003, 10903

--@0200_01
INSERT INTO CONTXT_ELMT_STAT(contxt_id, contxt_elmt_ix, contxt_elmt_stat_ix, cat_code, effctv_dttm,
estblng_org_id, creator_id, update_seqnr)
VALUES (1090300820200000001, 1090002000000000003, 1090002000000000007, 'ADDITN', '20070920100000.000',
1090301120200000001, 1090301120200000001, 0);-- CONTEXT part
--@!!0200_01
INSERT INTO CONTXT(contxt_id, cat_code, name_txt, security_clsfc_id, creator_id, update_seqnr)
VALUES (1090300820200000002, 'OIG', 'OIG_Subgroup_0200_2', NULL, 1090301120200000001, 0);
```

Identify records that shall (not) be replicated

SLT2 (DB to DB)


MIP System Level Tester
Session Run View Settings Help
MIP
BlackHole
SLT 1
SLT 2
0100 OfflineUpdate
0200 DataOutsideOIG
0300 OIGLinking
0400 OIGSharing
0500 Completion
0600 Synchronization
0700 ObjectType
0800 ObjectStatus
0900 ObjectGeometry
1000 Holdings
1100 PlansOrders
1200 Associations
1400 BasicActions
MSLT2DEM 1400
Fri Apr 25 11:22:11 CE
MSLT2DEM 1401
MSLT2DEM 1402
MSLT2DEM 1403
MSLT2DEM 1404
MSLT2DEM 1405
MSLT2DEM 1406
1500 Capability
1600 Affiliation
1700 Context
1800 CanTgtList
1900 Establishment
2000 SubIntegrity
2100 OIGError
2200 ReplTransError
2300 SemanticCompletene
2400 LargeTrans
2500 FrequentTrans
2600 TimeFilter
2700 ComplexActions
SLT 3
Contrib
Missers
Message: ReplTransInd
dataRecords
[] : OBJ_TYPE
[] : AFFL
[] : OBJ_ITEM
[] : ACT
entId : 10000003
fields
[] : 10903001214000100001
[] : ACTTA
[] :
[] : 10903011211010000001
[] : 0
[] : OBJ_TYPE_AFFL
[] : CONTXT
[] : AFFL_GEOPOLITICAL
[] : ORG
[] : ORG_TYPE
entId : 10000094
fields
[] : 10903012214000100001
[] : GVTORG
[] : NO
[] :
[] :
[] : 10903011211010000001
[] : 0
[] : UNIT
entId : 10000128
fields
[] : 10903011214000100001
ACT(entId=10000003, fields={10903001214000100001, ACTTA, , 10903011211010000001, 0})
Save to File
Copy to Clipboard
Done
ReplTransInd
PassInd
PDataInd

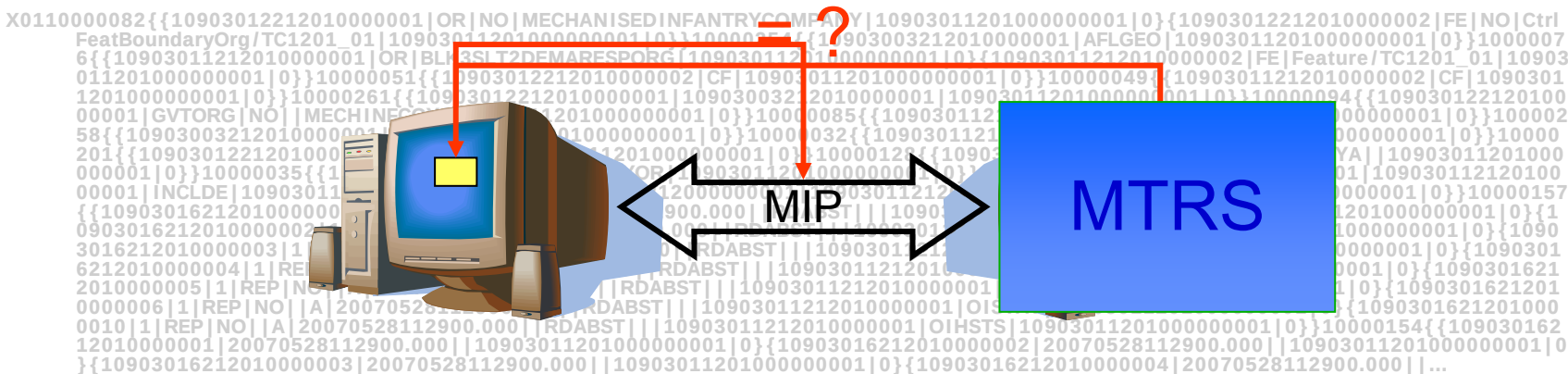
Testing the MIP Solution



Source: MIP

SLT3 (C2IS Level)

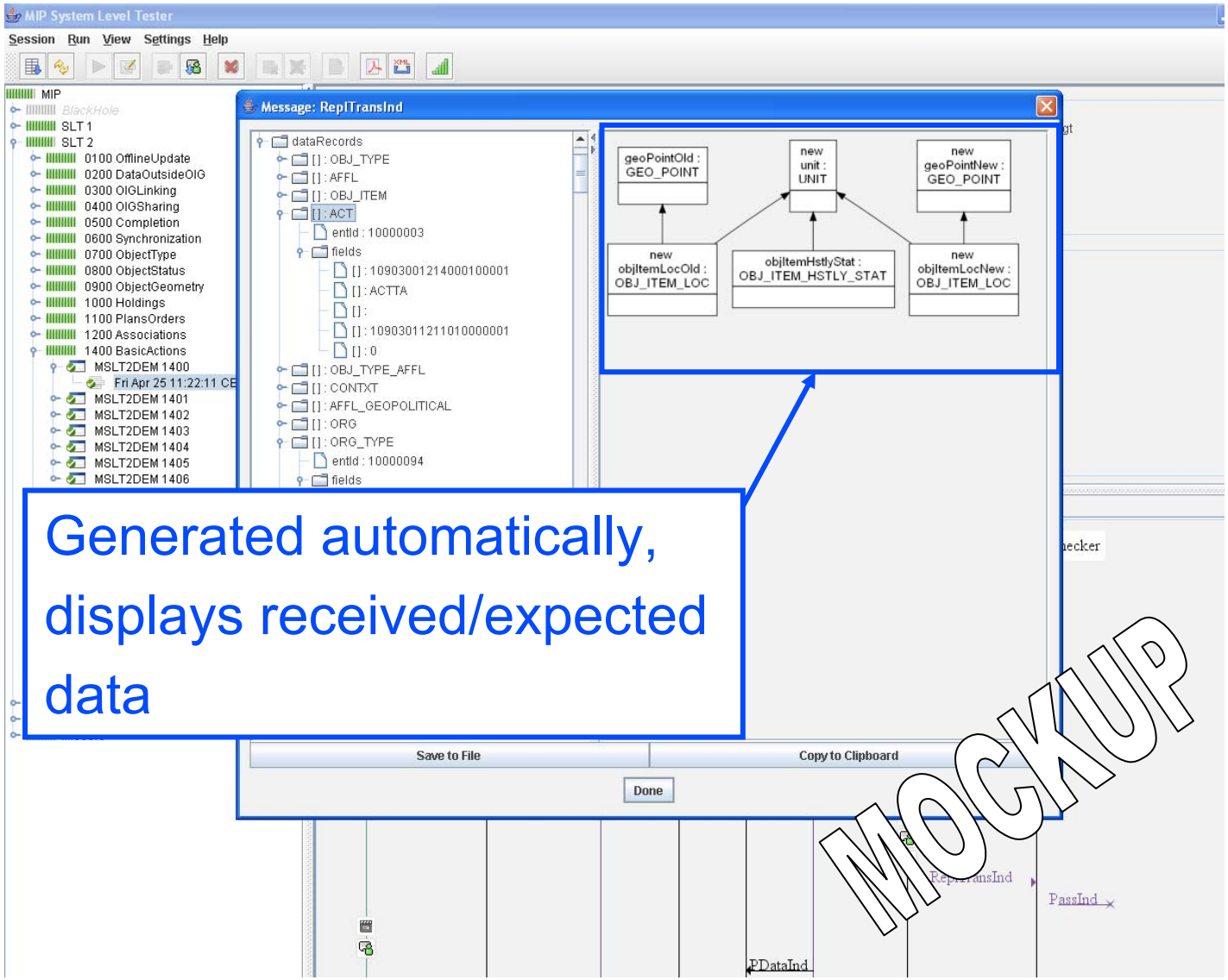
Data



„Test Script“

```
01 prompt 'Please create a friendly unit with some location.';
02 oig FRDNEU {
03        UNIT unit;
04        OBJ_ITEM_LOC objItemLocOld;
05        GEO_POINT geoPointOld;
06        objItemLocOld -> unit;
07        objItemLocOld -> geoPointOld;
08 }
09 prompt 'Please change the location of the unit.';
10 oig FRDNEU {
11        new OBJ_ITEM_LOC objItemLocNew;
12        new GEO_POINT geoPointNew;
13        objItemLocNew -> unit;
14        objItemLocNew -> geoPointNew;
15        assert:   geoPointNew.lat_coord <> geoPointOld.lat_coord
16                  OR geoPointNew.long_coord <> geoPointOld.long_coord;
17 }
```

SLT3 (C2IS Level)



Generated automatically, displays received/expected data

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Status Quo – System Level Tests

- Available test cases
  - 107 formal test cases for SLT1 (protocol stack)
  - 166 test scripts for SLT2 (replication mechanism)
  - > 240 MTRS test scripts under development for SLT3 (C2IS-JC3IEDM mapping)

  - Compare to 17 SLT1 and 20 SLT2 test cases in MIP Baseline 2!

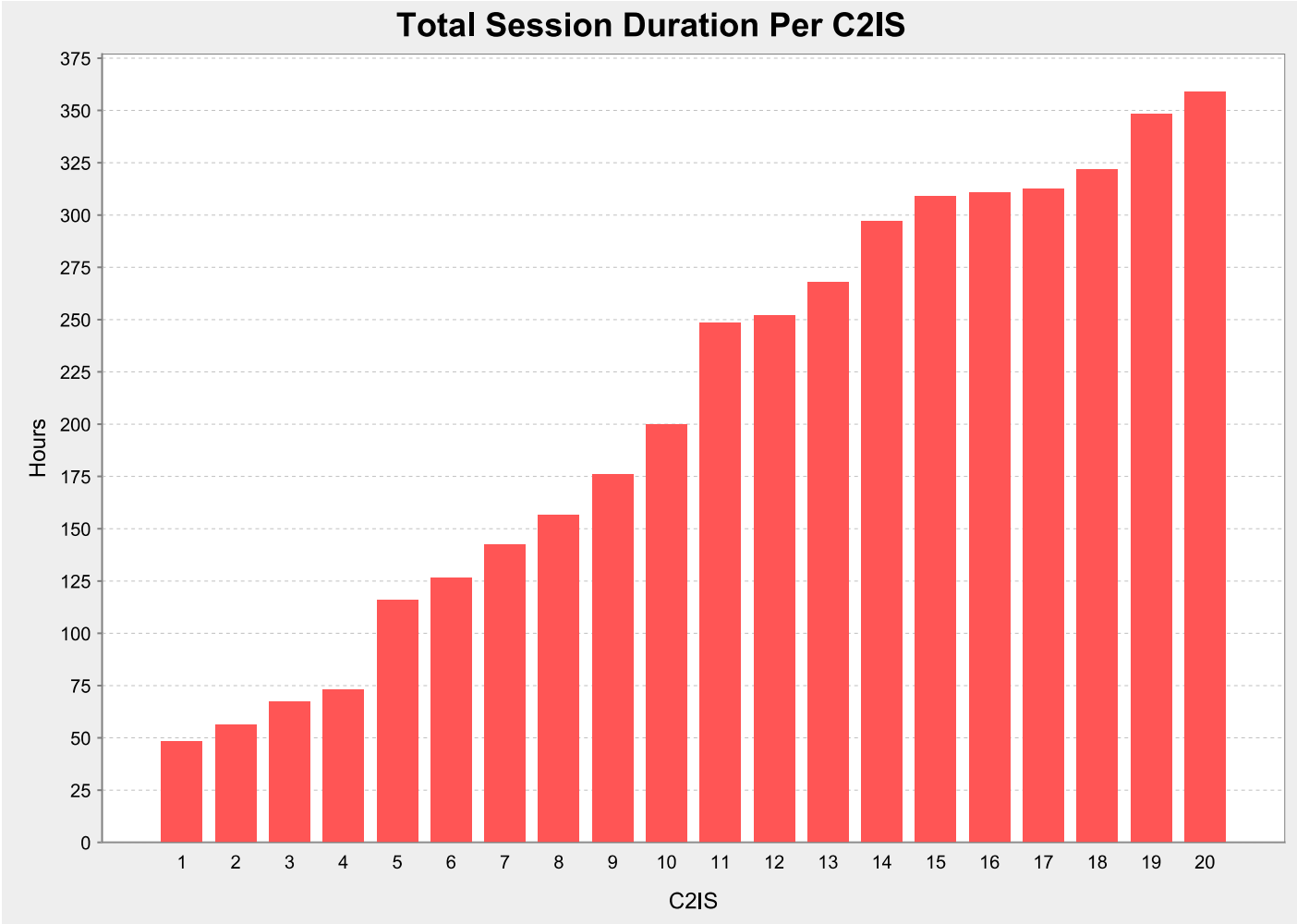
Usage Statistics (1)

- MTRS used for 20 systems of 17 nations + NATO

- Tremendous testing activity ... even during weekends!
  - 100 - 300 tests each day (with a peak of 500+ tests)
  - More than 26,400 test runs as of 05 May 2008

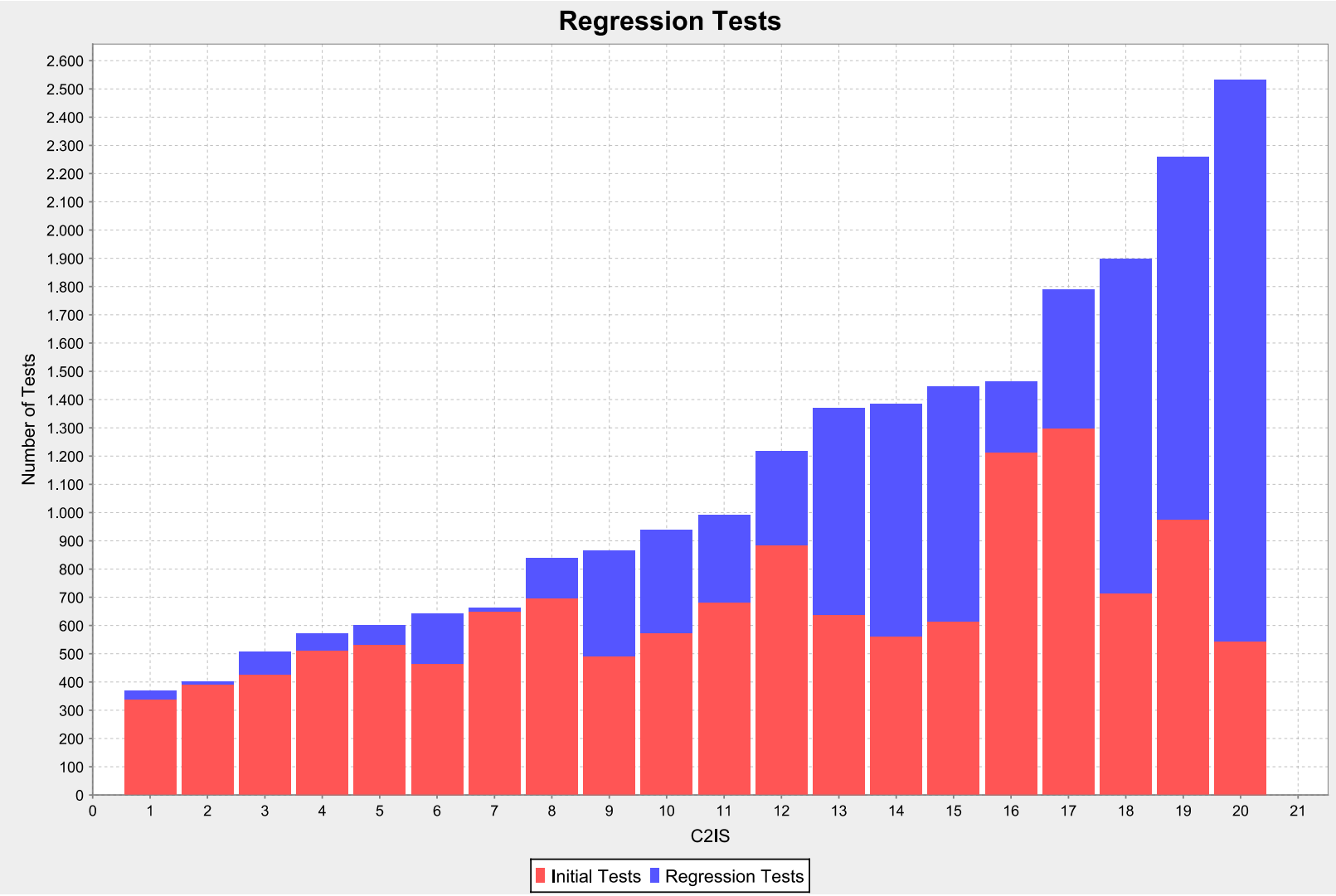
  - SLT1: 99,9% completed
  - SLT2: about 75% completed
  - SLT3: starting in June 2008

Usage Statistics (2)



Total testing time: 4191 hours ≈ 524 man days

Usage Statistics (3)



Usage Statistics (4)

- Test executions

Verdict	Count	Duration	Avg. Duration
Pass	11864	401:14 h	2:02 min
Fail	9646	471:56 h	2:56 min
Inconclusive	4893	476:16 h	5:50 min
Total	26403	1349:27 h	3:04 min

- Test execution takes about 32% of total test time
- Successful tests are executed fastest

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Summary (1)

- MIP Test Reference System
  - Functional black box testing
  - Tests conformance to MIP specification
  - Automated test execution

- Flexible Test Execution
  - 24 x 7 Availability over the Internet
  - No need for test coordination
  - Support for multilateral tests
    - Different test configurations thanks to modular test gateways
  - Parallel use by multiple C2IS without interference

- Simplified Test Evaluation
  - Error analysis by means of detailed logs

- MIP Project Management Group "*strongly supports the goal and use of MIP Test Reference System*"

Summary (2)

- Client-Server Architecture with alternative MTRS clients
  - Graphical user interface
  - Java API for test automation on the nations' side
  - MTRS Website incl. test repository, ticketing system...

https://trac.fkie.fgan.de/MTRS

- MIP Baseline 3 Roadmap
  - System Level Test started in September 2007
  - Expected to be completed by January 2009

- Significant improvement to MIP test specification process
  - All MIP test documents put under version control
  - Significant increase in quantity and quality of tests
  - Tool support to keep test artifacts consistent

Thank you very much for your attention