

LPD 17 San Antonio Class

SPAWAR Systems Center Charleston (SSCC)

Outline

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Discussion

The LPD 17 USS San Antonio class ship ([Figure 9-1](#)) is one of twelve ships under construction, the first of which will begin sea trials in 2004. The LPD 17 class of ships will serve as one of the chief cornerstones for US forward presence and force projection well into the 21st century. LPD 17 will serve as a task component of Naval Expeditionary Forces, and will be part of joint war fighting efforts with other services in the littoral area. The LPD 17's role will be complex from an interoperability view due to its complement of equipment, systems, and various missions. It must operate in a Common Operating Environment (COE) and Collaborative Information Environment (CIE) which will demand a robust, precise and rapid information system for command and control. Since Network Centric warfare and information superiority are key to future naval operations, a baseline architecture design must include interoperability within own units, as well as joint and multi-national forces.

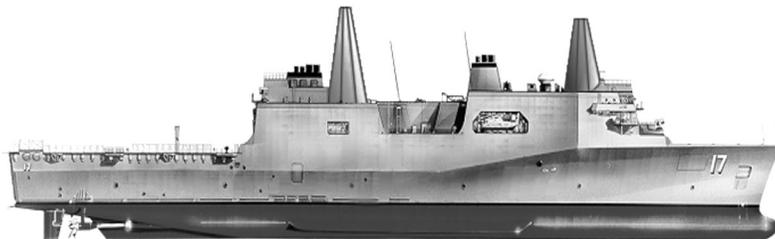


Figure 9-1.

The lengthy shipbuilding schedule when compared to the shortened technology transition time period creates a technology conflict (i.e., ensuring that the latest and most mature C4ISR technology is implemented onto each LPD ship). Three major technology and interoperability issues surround the LPD 17 program:

1. Maintaining technology and interoperability synchronization with the other ships in the Amphibious Readiness Group (ARG) or Carrier Battle Group (CVBG);
2. Maintaining harmonization within the family of LPD 17 class of ships that are developed over the decade; and
3. Maintaining control and technology harmony across each LPD's development period. Developing an LPD 17 technology transition and insertion plan becomes an item of major concern to management.

Developing a risk mitigation approach that provides the visibility into and control of shipboard C4ISR equipment becomes a key instrument for ensuring interoperability and supporting missions. How to select and ensure that the best-of-breed technology and systems are integrated into the LPD 17, and at the same time synchronized with the rest of the LPD 17 class of ships under construction are major issues that will have to be addressed if interoperability is to be accomplished successfully.

Objective of Case Study

SPAWAR Systems Center Charleston (SSC-C) is charged with ensuring the operability of the engineering, design, and integration aspects of the LPD 17's C4ISR operational architecture. LPD 17's C4ISR component interoperability is crucial between the ship and the ship-wide area network (SWAN) with other Naval Expeditionary Forces, as well as other services in a joint operations environment. A Phase I methodology was developed to aid the LPD 17 C4ISR Integration Program Manager to view the relationships of all major systems, subsystems, and their components. Because LPD 17 is in a Turnkey integration shipbuilding environment, the methodology chosen will be able to provide on-going insight into COTS/GOTS products for technology insertion and facilitate adherence to standards for those products installed.

A review of the DoD Technical Reference Model (TRM) and Joint Technical Architecture (JTA) initiatives revealed that the combination of the products resulting from them could be used to assist in the development of a viable technology transition and insertion plan. Furthermore, a harmonized approach could also possibly be implemented that would address the LPD 17's program concerns related to ensuring interoperability.

A case study was initiated, using the DoD TRM as the key instrument, particularly the TRM 3 Step Methodology to investigate the feasibility of developing a risk mitigation and interoperability assurance methodology for the LPD 17 program. Any architectural aids that could be brought to bear at this point in time in the LPD 17 program without disrupting the program activities would be of significant value to the C4ISR Program Manager and the LPD Program Manager.

Given the scale and complexity of the C4ISR Integration Plan, a typical command-control component of the LPD 17 was selected for analysis to establish viability of the TRM approach taken.. Using the DoD TRM, a mapping methodology was developed that will enable comparisons of initially planned, actual and delivered equipment and systems, and emerging technology and products to be captured and compared, as well as related standards. Though not the intent, a by-product that was also obtained was insight into JTA compliance (matching US Navy standards from the ITSG to the most recent JTA version). The mapping technique subsequently focused on domain controller components of the C2 system. For the case study, one example, IT Security Services, was chosen for the mapping methodology. Phase II will use all TRM Services to populate the database at a much larger scale.

LPD 17 Background

The LPD 17 program is a planned *12-ship procurement* that will integrate easily with the existing amphibious ship force structure. Ultimately, the LPD 17 Class program will be the *functional replacement for four Classes of amphibious ships* that have or will have reached the end of their service life.

LPD 17 primary mission: Amphibious Warfare

An amphibious operation is an attack launched from the sea by naval and landing forces embarked in helicopters, landing craft, and amphibious vehicles on a hostile shore. LPD 17 must be able to embark, transport, and land elements of a landing force in an assault by helicopters, landing craft, amphibious vehicles, and by a combination of these methods ([Figure 9-2](#)). The combat power of this ship is its embarked Marines and their equipment.

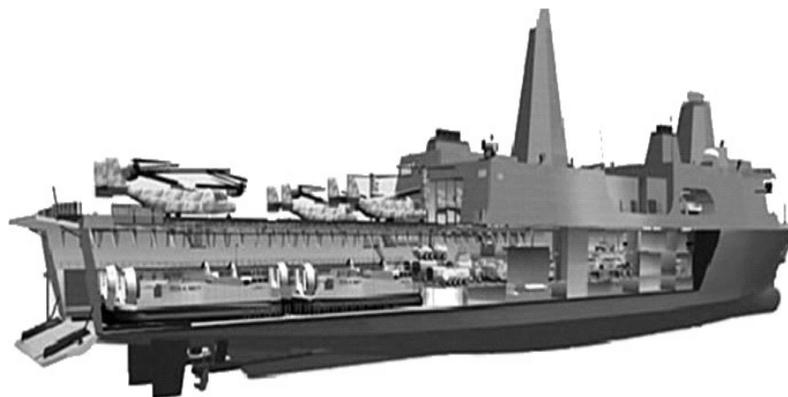


Figure 9-2.

LPD 17 MV-22/AAV/UAV Compatible

This is the first ship designed for compatibility with the MV-22 Osprey and the Advanced Amphibious Assault Vehicle. The V-22 is a joint service, multi-mission aircraft with vertical take-off and landing (VTOL) capability. It will also support Unmanned Aerial Vehicles.

The Advanced Amphibious Assault Vehicle (AAAV) is the primary combat vehicle for transporting troops on land and from ship to shore. LPD 17 can carry at least 15 AAAVs along with air cushion landing craft inside its well deck and vehicle stowage areas.

LPD 17 C4ISR Systems

The LPD 17 has a robust Command and Control system that includes: Global Command Control System—Maritime (GCCS-M), Ship Self-defense System MK 2, AN/USG-2 (V) Cooperative Engagement Capability AN/KSQ-1 Amphibious Assault Direction System, AN/UPX 29 IFF System Navigation Sensor System Integration, (NAVSSI) Naval Tactical Command Support System (NTCSS), and the AN/SPQ-14 (V) Radar Display Distribution System.

The LPD 17 Communications system includes: HFRG, UHF, VHF, EHF, SHF, DWTS, and Challenge Athena, Link 11, Link 16, JTIDS, SI Comms, ADNS, TADIX A and an Integrated Voice System.

LPD 17 C4ISR Interoperability

LPD 17 has several areas in which interoperability concerns must be addressed:

- Establishing and maintaining communications between joint services, multi-national forces, and synergism between the Navy-Marine team.
- Amphibious operations are the most complex of naval operations due to timing of events, multiplicity of players, and communications between the personnel and various equipment. For example: ship to shore movement will include communications between many platforms such as AAAVs, V-22s, Armored vehicles, AAAVs, Naval Fire Support (NFS) ships, etc.
- Turnkey integration methodology could impact on migration and technology insertion.
- Migration/technology insertion will impact on standards and standards' compliance (e.g., IT-21, ITSG, JTA) over time.

LPD 17 and Technical Reference Model (TRM)

The TRM therefore is being applied to LPD 17 for the following objectives:

- Assess the utility of TRM to LPD 17 interoperability management,
- Assist in future technical architecture development,
- Identification and validation of standards to use and their required application: IT-21; ITSG; and JTA, and
- Identification of technology insertion and transition aids.

TRM: Approach

Due to the multitude of systems, subsystems, and components in the LPD 17 C4ISR architecture, the TRM has been applied to a single subsystem and one component of such for further decomposition. The subsystem selected was a C2 component, chosen particularly for its Global tie and network-centricity. The C2 component was a processing domain element. A typical diagram is presented characteristic of such controllers. (Figure 9-3) .

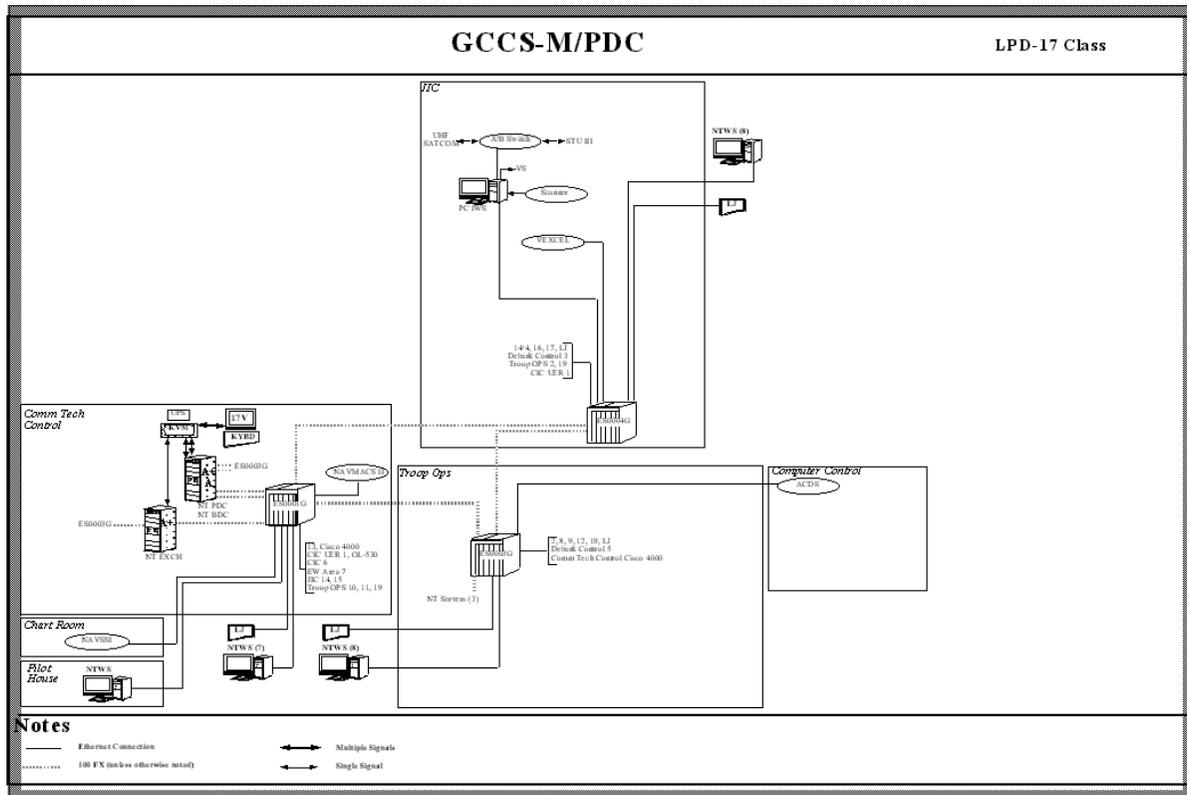


Figure 9-3. GCCS-M/PDC Interface Diagram

LPD 17 C4ISR Generic Controller

The C2 system is located throughout the ship in places such as RCS, CIC, Communications Tech Control, JIC, SSES, Troop Ops, CO cabin, etc. The Radio Communication Suite (RCS) consists of different terminals, switching capabilities, and RF sections available to process data off the ship. The C2 system is located in the terminals' section. By itself, the C2 processes data within itself, but it requires input from an antenna or a path to an antenna to emanate or receive the processed data. For connectivity, digital data is developed at a terminal (C2) and then flows through a digital patch panel to either HF, UHF/VHF Line of Site (LOS), UHF SATCOM, EHF SATCOM, SHF SATCOM exciters. The exciters convert the digital data to audio and then to IF (Intermediate Frequency) data and then to RF (radiated frequency) data emitted by an antenna.

The Primary Domain Controller (PDC) component of this subsystem was selected primarily for its role in joint services operations, network centric warfare, as well as for its importance in acting as a gateway to other systems onboard the LPD 17. The PDC's functions are gateway for communications and performing administration. [Figure 9-4](#) (PDC: "as-is") and [Figure 9-5](#) (PDC: "to-be"—LPD 17) illustrate technology transition and the impact on functional flow.

Functional Flow Block Diagram : As Is

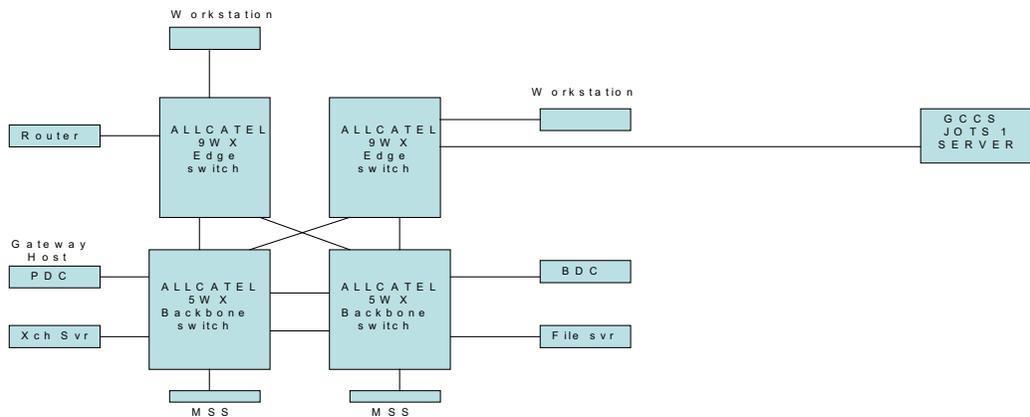


Figure 9-4. Current PDC Diagram

Functional Flow Block Diagram - TO BE

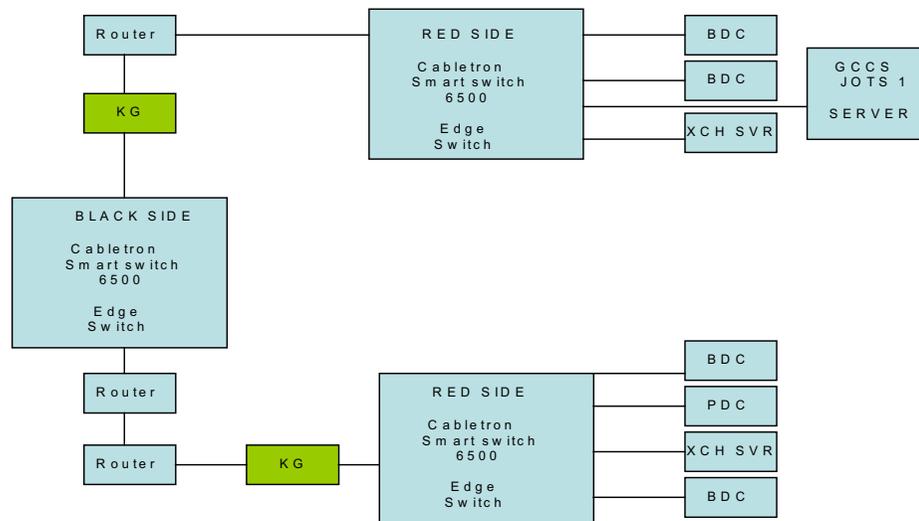


Figure 9-5. Future PDC Diagram

TRM Case Study: Process

The specific process which derived from the study follows.

- A. Identify LPD 17 services and interfaces, and map validated services to TRM services.
- B. Map IT21 components (products & standards) to TRM services.
- C. Map ITSG and JTA standards to TRM services.
- D. Analyze and assess common interoperability points for preliminary findings.
- E. Provide recommendations for interoperability solutions.

The results of this process and concluding study (Phase I and Phase II) will provide insight to the Program Manager/Contractor on technology insertion and transition times, as well as facilitate adherence to standards for products installed and future products yet to be installed.

TRM Mapping

The selected methodology allows for a one-to-one mapping of capabilities, services, components and standards. [Figure 9-6](#), the mapping foundation below establishes intersecting points for further analysis.

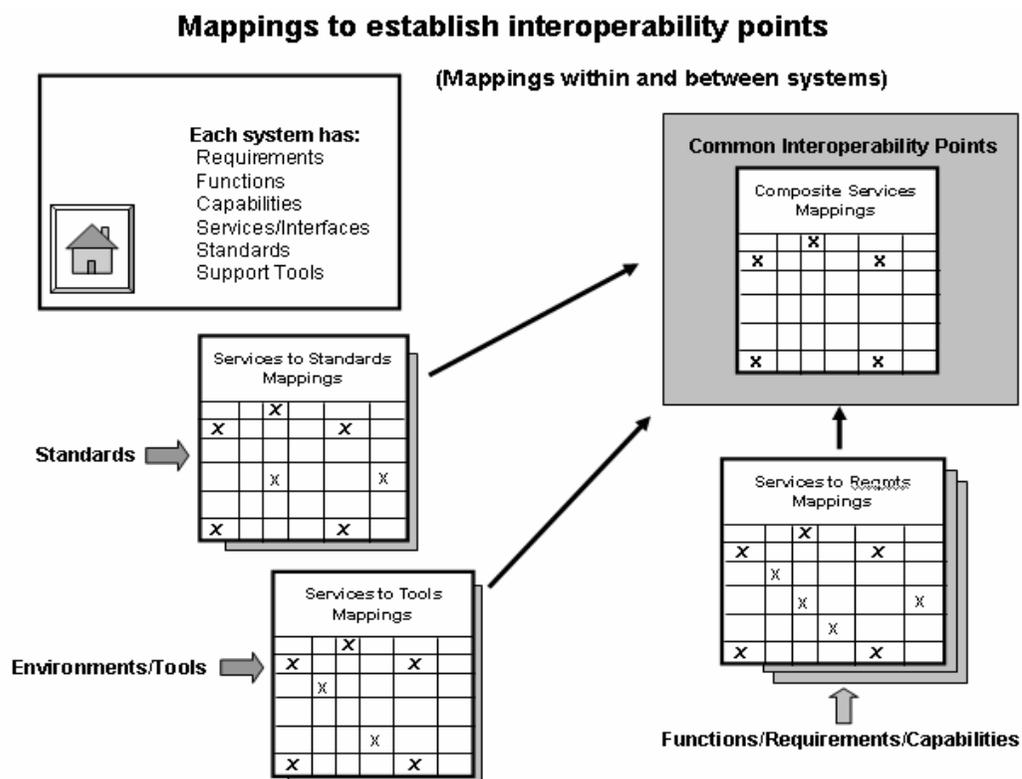


Figure 9-6. Mapping Foundation

LPD 17 Mapping

The mapping foundation was used as a baseline for the development of the LPD 17 mapping process in four levels, see [Figure 9-7](#). In this case, the possible interoperability points were identified as: TRM services, LPD 17 services, IT21 components, ITSG and JTA standards. Once these categories had been identified, one-to-one mapping then can take place. The methodology establishes an initial deriving of TRM services that are applicable to LPD 17, the matching of those services to existing standards, the viewing of “as-is” and “to-be” configurations, and the merging of the previous mappings in which interoperability areas can be highlighted. Further analysis then can be made for technology insertion, standards compliance, capabilities meeting requirements, etc.

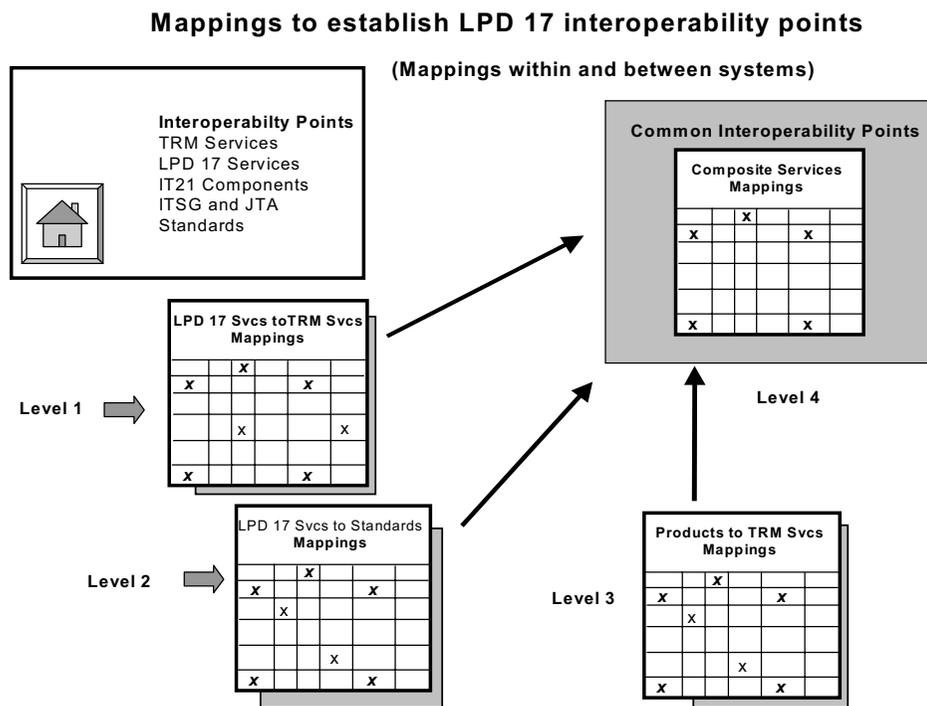


Figure 9-7. LPD 17 Interoperability Map

The following section is the specific TRM case study process as applied to the LPD 17 mapping. A matrix format was used in a Microsoft Excel database format.

In the initial steps, a list of services in [Figure 9-8](#), was generated from the DoD TRM version 2.0. The services were located in Appendix D of the TRM. Listed were the:

- Entities (note 4.4.1.2 on the slide close up),
- Services (note 4.4.1.2.1 on the slide close up), and
- Sub services (note bulleted items seen on close up of the slide)

Functionality TO Services Matrix	
Case Study: LPD-17	
System: PDC	
Doc Verison: 1.0	
Date: 8 July 2002	
1	Support Application Services (4.4.1.2)
2	DOD Version 2.0 TRM SERVICES
4	Support Application Services (4.4.1.2)
5	Multimedia (4.4.1.2.1):
6	• Audio Processing
7	• Document Processing
8	• Electronic Publishing
9	• Image Processing
10	• Map Graphics
11	• Multimedia Processing
12	• Video Processing
13	• Text Processing
14	Communications Applications (4.4.1.2.2):
15	• Broadcast
16	• Communications Conferencing
17	• Enhanced Telephony
18	• Organizational Messaging
19	• Personal Messaging
20	• Shared-Screen Teleconferencing
21	• Video Teleconferencing
22	Business Processing (4.4.1.2.3):
23	• Calendar
24	• Calculation
25	• Project Management
26	• Spreadsheet
27	Environment Management (4.4.1.2.4):
28	• Batch Processing

Figure 9-8. TRM Services

In [Figure 9-9](#), SSCC then derived the TRM services utilized by the LPD 17 for the C2 and domain controller system. In doing so, a baseline for systems and their capabilities can then be matched to standards under the ITSG and JTA. This allows for the tracking of technology insertion which can maintain, delete, or add services or capabilities and thus provides for a methodology to assess if compliance is being made to existing standards.

Functionality TO Services Matrix		IT 21 DERIVED SERVICES USING DOD TRM 2.0
Case Study: LPD-17		
System: PDC		
Doc Verison: 1.0		
Date: 8 July 2002		
1	Support Application Services (4.4.1.2)	
2	DOD Version 2.0 TRM SERVICES	
4	Support Application Services (4.4.1.2)	
5	Multimedia (4.4.1.2.1):	
6	• Audio Processing	
7	• Document Processing	
8	• Electronic Publishing	✓
9	• Image Processing	
10	• Map Graphics	
11	• Multimedia Processing	
12	• Video Processing	
13	• Text Processing	
14	Communications Applications (4.4.1.2.2):	
15	• Broadcast	
16	• Communications Conferencing	
17	• Enhanced Telephony	
18	• Organizational Messaging	
19	• Personal Messaging	✓
20	• Shared-Screen Teleconferencing	✓
21	• Video Teleconferencing	
22	Business Processing (4.4.1.2.3):	
23	• Calendar	
24	• Calculation	
25	• Project Management	
26	• Spreadsheet	
27	Environment Management (4.4.1.2.4):	
28	• Batch Processing	✓

Figure 9-9. Derived LPD 17 Services

Once the TRM services were identified, these items were separated into a unique column in [Figure 9-10](#), to record the services without extraneous information. This second column also assisted in identifying differences in nomenclature and terminology from system to system, and contractor to contractor. The elements are identified in yellow here in the close up.

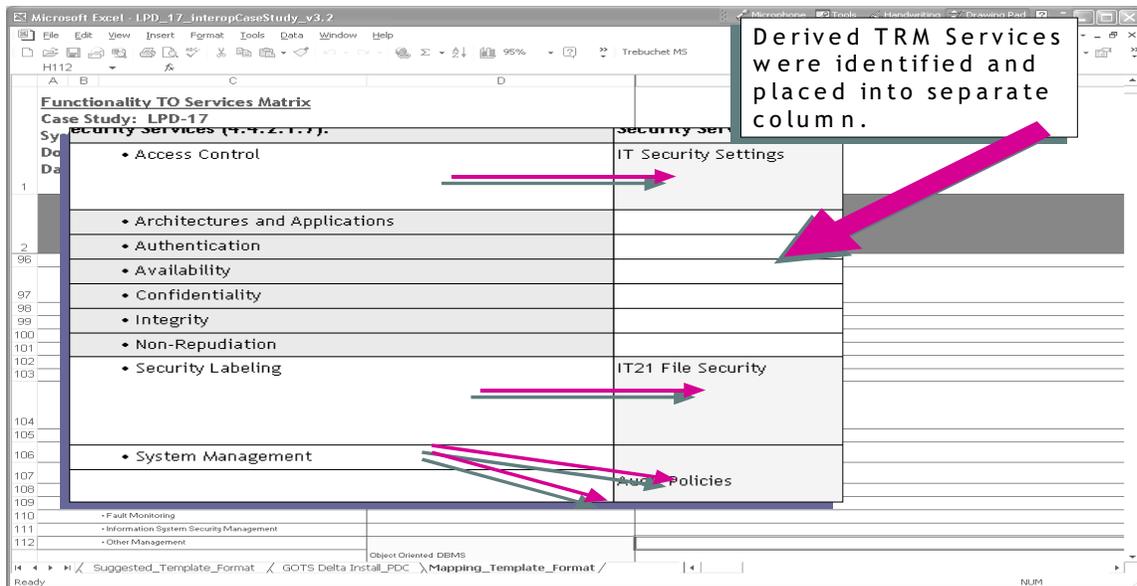


Figure 9-10. TRM Services Identified

Once the derived services were recorded, capabilities required by the LPD 17's command and control system were listed in [Figure 9-11](#). To exploit the hypotheses that the TRM may assist in discovery and early notification of interoperability issues, these capabilities were drawn from the services definitions in the TRM. (v. 2.0). A later on verification will need to be performed on the analysis of this information to ensure accuracy of capability to service mapping.

Microsoft Excel - LPD_17_interopCaseStudy_v3.2

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Functionality TO Services Matrix

Case Study: LPD-17

System: PDC

Doc Version: 1.0

DOD TRM 2.0

1	Security Services (4.4.2.1.7):	
2	IT Security Settings	<i>Capability to prevent the unauthorized use of information system resources and prevent the use of a resource in an unauthorized way.</i>
9		
9		
10		
10		
10		
10		
10	IT21 File Security	<i>Capability to ensure senders and recipients Capability of managing access and privileges, which are managed for all entities, whether they are individual users, groups of users, resources, or processes.</i>
11		
11		
14	Audit Policies	<i>Capability to maintain the security functions of</i>

Derived System capabilities were determined and recorded.

Figure 9-11. LPD 17 Capabilities

From here, the methodology illustrates the mapping of the LPD 17's command-control capabilities. Note: To do so, the DoD TRM version 2.0 services (and their sub services) were duplicated and moved to the top, along the horizontal axis per [Figure 9-12](#). The original services and subservices on the left side, were hidden from the matrix view due to space limitations as the matrix continues to extend from the left to the right. The DoD TRM services are really in both axis (along the top and the left side) and therefore provide a true one-to-one correspondence.

Functionality TO Services Matrix		IT 21 DERIVED SERVICES USING DOD TRM 2.0		REQUIRED SYSTEM CAPABILITIES	
IT Security Settings	Capability to prevent the unauthorized use of information system resources and prevent the use of a resource in an				
IT21 File Security	Capability to ensure senders and				
Audit Policies	Capability to maintain the security functions of an operationally secure system.				
System Management Services (4.4.2.1.8)					
Object Oriented DBMS	Capability to provide facilities and interfaces to manage databases and object-oriented databases.				
Hard Drive Setup	Capability to substitute the source of software packages or to verify that software packages are authentic.				

Figure 9-12. TRM Services Remapped

LEVEL 1 of the matrix mapping is shown in [Figure 9-13](#): by mapping the LPD 17 services and capabilities on the vertical axis TO the TRM services (which you now see on the horizontal axis), the LEVEL 1 Matrix essentially becomes a one-to-one complement mapping.

Functionality TO Services Matrix		CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CG	CR	CS	CT	CU	CV	CW	CX	CY	CA	CB	CC	CD
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LEVEL 2 of the matrix is shown in [Figure 9-14](#): FIRST the services and capabilities of the LPD 17 are matched to applicable JTA STANDARDS and added in their own column to the VERTICAL axis of the matrix, THEN the applicable JTA STANDARDS (on the VERTICAL axis) are mapped to the TRM Services on the Horizontal axis.

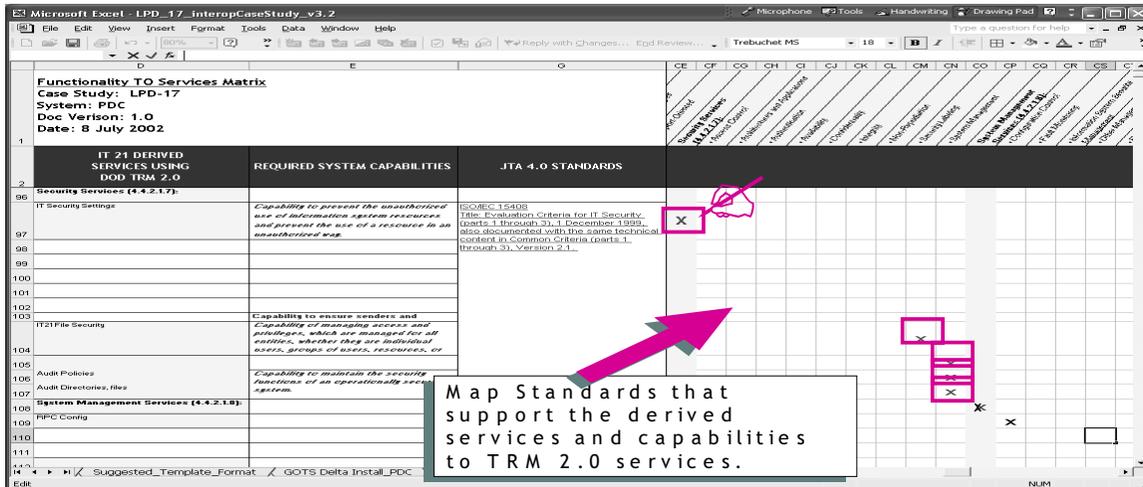


Figure 9-14. Level 2 Mapping

In [Figure 9-15](#), LEVEL 2 mapping continues with the insertion of standards which were present at contract awarding. This indicates the evolution of standards during the course of the project AND may assist in identifying conflicting or changing standards.

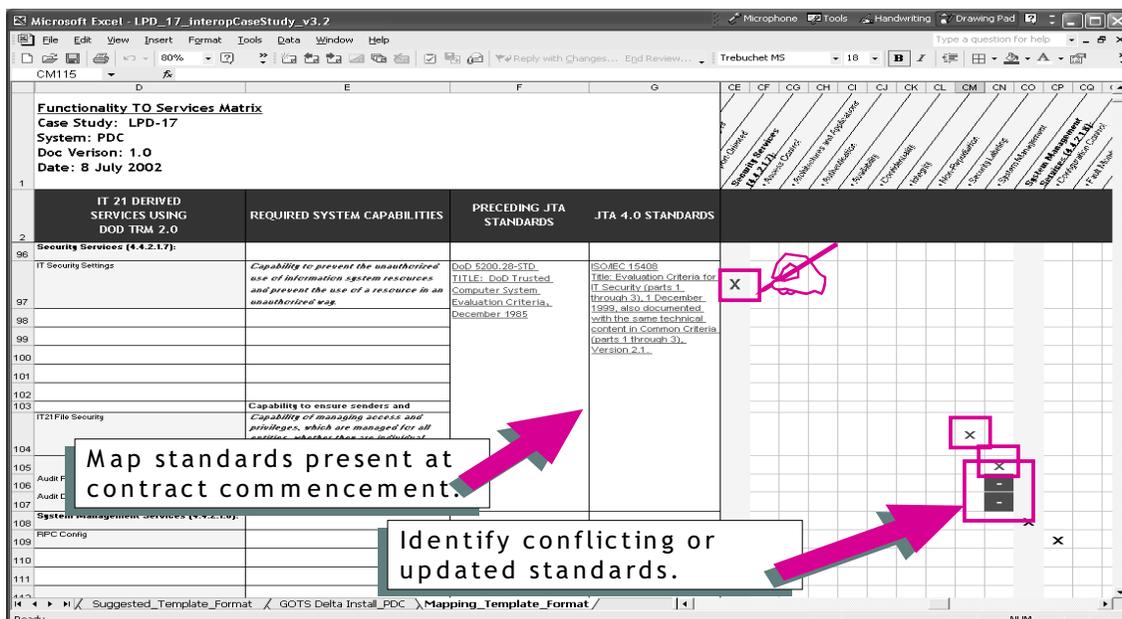


Figure 9-15. Level 2 Mapping Continues

LEVEL 2 Mapping as shown in [Figure 9-16](#), continues with additional standards mapped to project requirements. Here you will see that the LPD 17 was subject to ITSG standards in the initial requirements specification.

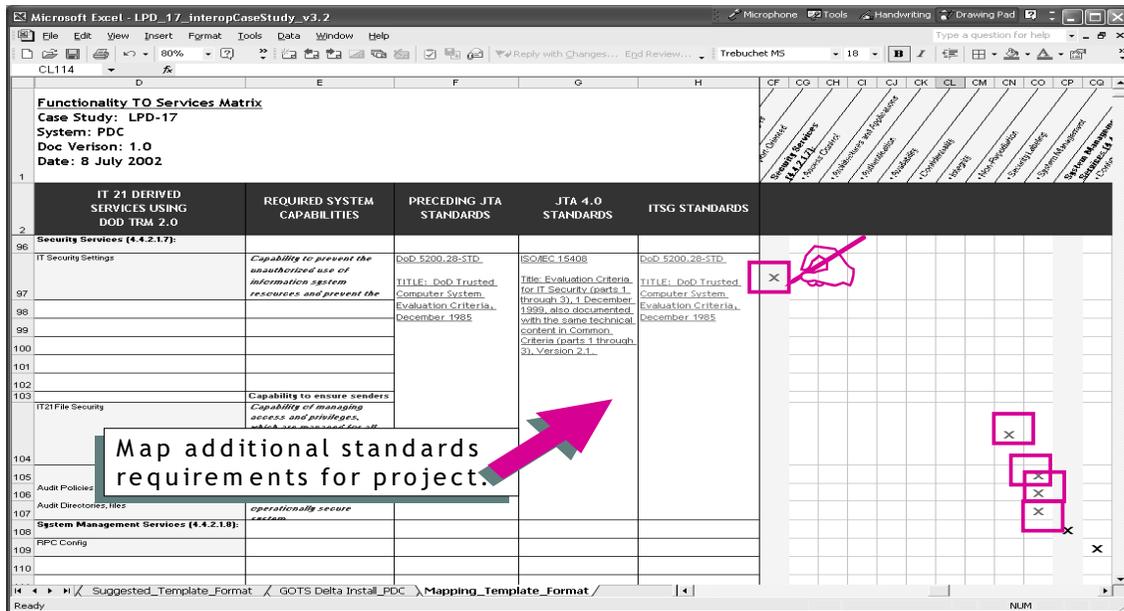


Figure 9-16. Level 2 Mapping Continues

In [Figure 9-17](#), LEVEL 3 mapping shows documents hardware/software products and configurations of an initial or “as-is” configuration. Products are first aligned on the vertical axis to correspond to services and capabilities. Then (as in the standards mapping) the products are mapped to TRM Services on the horizontal axis.

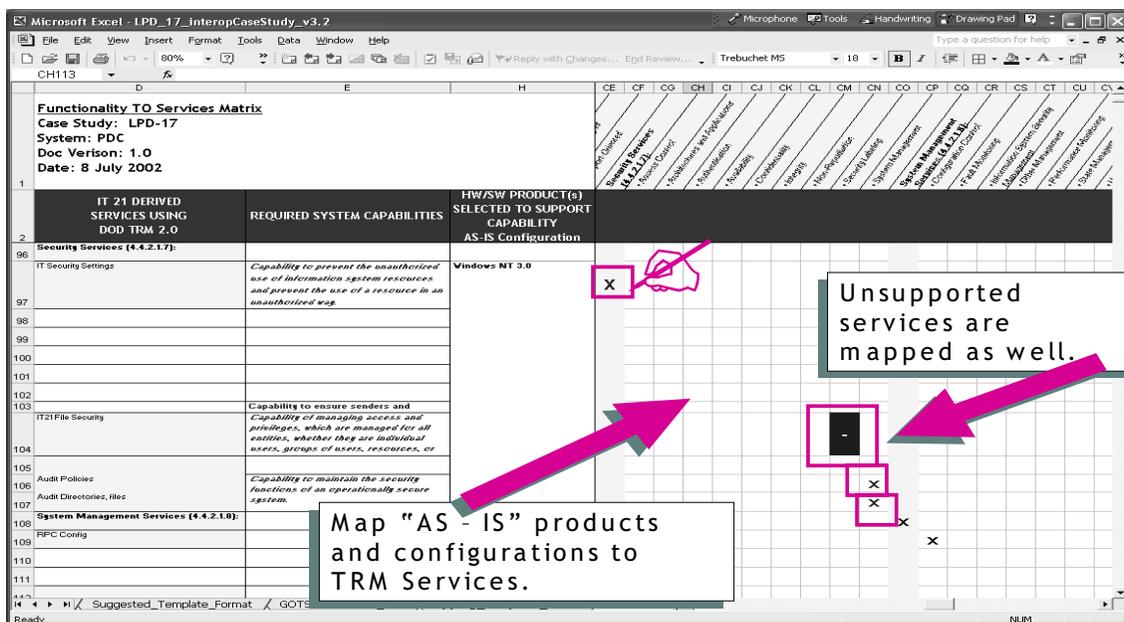


Figure 9-17. Level 3 Mapping

LEVEL 3 continues the mapping in [Figure 9-18](#) with the planned/“end state” or “to-be” products. Products are aligned on the vertical axis and mapped to the TRM services on the horizontal. This column is representative of a “Point-in-time” view and additional columns can be added to view transitions over the course of the technology insertion.

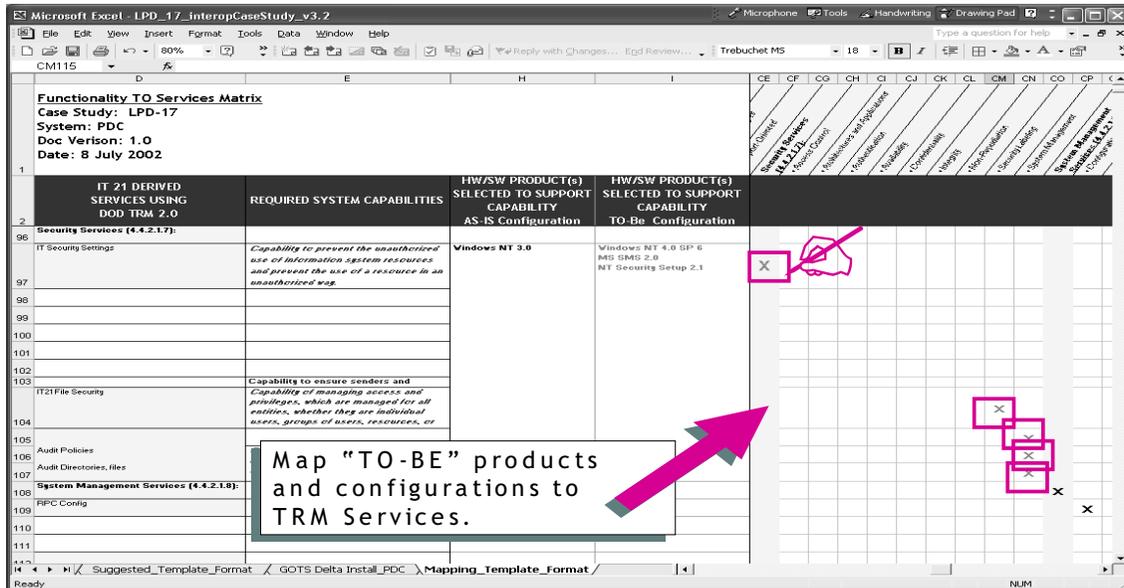


Figure 9-18. Level 3 Mapping Continues

LEVEL 4 mapping as shown in [Figure 9-19](#), is the alignment that is achieved as a result of merging the previous mappings. Points of interoperability are noted with the following:

- P denotes products issues with interoperability
- S denotes standards issues with interoperability
- U denotes unsupported services
- A check mark indicates all points of interoperability in the system have been examined and no issues exist at present time.

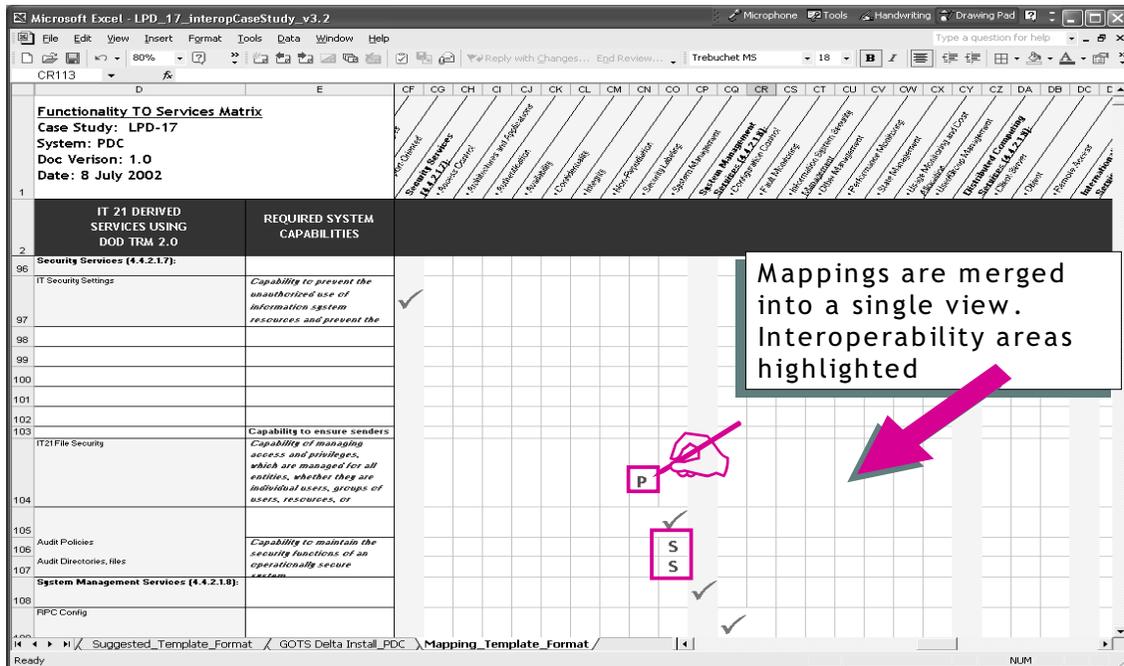


Figure 9-19. Level 4 Mapping

Preliminary Findings

- ITSG to JTA standards mapping identified both differences in existing standards and evolution of standards over time (JTA 1.0 –JTA 4.0).
- Future projects may result in utilization of interoperability management matrix to monitor systems development through project lifecycle.
- Existing documentation uses incongruent nomenclature to indicate the identical or equivalent functions, services, and standards. (e.g., lack of a common technical reference model)
- Different hardware and software can support the same services, however the implementation can differ: services view (i.e., Operating System Services) vs. implementation is different (i.e., NT vs. UNIX).
- Track and capture “point-in-time” views of the system can be made for comparison.

Summary

- LPD 17 C4ISR interoperability is ongoing.
- The potential for using the TRM to address LPD 17 C4ISR interoperability is promising.
- “As-Is” state during the project lifecycle can be compared to “To-Be” or “end state.”
- The TRM offers a good baseline process for accurate mapping of requirements, services, interfaces, and standards.
- TRM methodology provides insight for point-in-time technology insertion and transition
- TRM may facilitate compliance with a technical architecture (e.g., DoD JTA) between government, contractors, and developers.

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