

# System Analysis and Design of Armament Integrated Management System

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## ABSTRACT

Proof and trial activity in a dynamic test range is a complex, sensitive, and herculean activity. It is a system comprising critical functions that accept various armament inputs and produces proof results as output, processing various critical data and sensitive activities in between. Automation of the existing system is a step for reliable, secure, smooth operation and easy maintainability of the system that makes it synchronized with the latest development of range technology. Understanding the flow of data through these functions requires extensive study to realize different inter-linked activities involved with the functions of this system. This paper presents the flow of activities in the automation of dynamic test range of Proof & Experimental Establishment through context level diagram, process flow diagram, data flow diagram, and entity-relationship diagram. Realization of armament integrated management system will be through resilient and high bandwidth network backbone which is a part of this paper. Cloud computing is the latest development in the information technology. This paper also analyses the appropriate model of cloud computing for porting the system in the cloud.

**Keywords:** Context level diagram, process flow diagram, data flow diagram, distributed architecture, cloud computing, armament integrated management system

## 1. INTRODUCTION

Proof & Experimental Establishment (PXE) is involved in dynamic test and evaluation of armament stores where numerous entities are involved. The activity starts with the receipt of armament stores from the external agency, followed by preparation of store receipt intimation, proof detail, floating the proof detail to various entities involved in the firing activity, coordinating various tasks involved in the firing, storage, retrieval, and processing of firing data, reports generation, and finally ends with the successful completion of activity, with dispatch of firing results to the relevant external agency. At present, isolated software modules using distributed architecture are used<sup>1</sup>. There is a requirement of an integrated software module which can centralise all the isolated modules with minimal data redundancy and less paper-driven work.

The objective of armament integrated management system (AIMS) is design, development, testing and implementation of a graphical user interface (GUI)-based software that will interlink different entities to automate the overall dynamic test and evaluation process, starting from inception of armament stores to generation of final reports through storage, retrieval and processing the pre- and post-firing data. AIMS optimises the running processes in and between entities, reduce data redundancy and ensure concurrency using centralised database. It is event-driven so that trial processes are implemented in a streamline manner effectively. Access right for data is implemented so that only authorized user of the respective entities can access the data pertaining to their rights only. System administrator has access to all the data

using passphrase. The software deals with proof/trial details of the armament stores, and hence, very sensitive in nature. A strong security mechanism has been incorporated in the system to protect unauthorized access of the data.

The design and development of AIMS follows the iterative waterfall model of software development life cycle (SDLC). The design phase of AIMS consists of software requirement specifications, process flow diagram, context diagram of the overall system and the sub-systems. The sub-systems of the AIMS also comprise data flow diagram and entity-relationship diagram apart from the process flow diagram and context diagram.

## 2. SOFTWARE REQUIREMENT SPECIFICATIONS

Software requirement specifications (SRS) plays an important role in the analysis phase of SDLC. It collects customers requirements and systematically organises them into a specification document<sup>2</sup>. It provides detailed information of the entire software wrt users' requirements. In AIMS, SRS document collects and analyses all the requirements of users and writes these in a systematic and structured way. It is the final outcome of the requirements analysis and specification phase. It presents a general description of the project with the functional, non-functional requirements and goals of implementation with required hardware interfaces, software interfaces, communication interfaces, memory constraints, etc. It also takes care of product functions, logic, user characteristics, constraints, assumptions and dependencies.

Specific requirements contain use-case-documentation, performance requirements, and design constraints with reliability, availability, security, and maintainability. Supporting information section signifies prioritisation, release plan, etc. In a nutshell it is the brief, consistent, unambiguous, and complete document<sup>3</sup>.

### 3. CONTEXT ANALYSIS

A context diagram is a high-level logical approach for efficient and systematic design and development of a software product to clearly define system and its environment by interacting between its entities. Context diagram is further grouped into sub-systems to represent the complete system in an organised way<sup>4</sup>. Figure 1 shows the highest level of abstraction of AIMS to clearly depict the scenario where the other sub-systems are interacting with it. AIMS comprises of 17 dynamic entities which directly participate in the system. The interaction starts with the ammunition (AMMN) entity, which participates in the events like receipt of ammunition, receipt of Firing Program (FP), receipt of Proof Details (PD), preparation of Store Receipt Intimation (SRI) and Internal Issue Voucher (IIV), generation of monthly expiry report, sending burning certificate and disposal instructions to the concerned authority, respectively. Ammunition Preparation (APW) entity receives FP and PD and executes the events like sending Internal Issue Voucher Return (IIVR), forwarding After Firing (AF) and Before Firing (BF) measurement of the fired projectiles. It forwards trial result to Firing Planning and Coordination Cell (FPCC), which is directly involved in generation of FP after receiving PD and

SRI. Trial and Evaluation (TE)/Proof and Ballistic (PB) entity generates PD and sends compiled result as well as backloading instructions after receiving and executing FP. Weapon entity too forwards SRI and receives FP and PD. Range entity receives FP and PD and is responsible for sending After Firing Recovery Report. Instrument entity provides instrument/environmental conditioning chamber status, firing result after getting FP and PD. General Store (GS) directly communicates armour-plate issued info and SRI to the system. The workculture of Naval Armament Depot (NAD) is just like AMMN and Weapon Entity. Naval Proof and Trial (NPT) acts like TE/PB Entity. Both NAD and NPT focus in the field of Naval Trials. Computer and networking systems group (CNSG) plays a vital role in the system by executing the role of a system administrator as well as database administrator. The role of external agency is to release proof report and proof sample details and to receive Nominal Issue Voucher (NIV), compiled result and Issue Voucher (IV). This overall context diagram represents the system as a whole whereas the individual 17 other sub-systems are also elaborated in their subsequent context diagrams.

### 4. PROCESS FLOW

Process Flow Diagram is a technique referred in the software requirement analysis phase of SDLC<sup>5</sup>. It decomposes a system with all its processes, input data, output data, and their systematic flow in the system<sup>6</sup>. It does not incorporate the inconsequential details of the processes. In AIMS, the overall Process Flow Diagram is graphically represented in Fig. 2. Diagram shows a clear understanding of all the processes that finally facilitate with required output from the system. The different entities are grouped together as per their similar job roles are presented in the diagram accordingly. Diagram illustrates that external entity is involved in sending annual production program and annual requirement for proof and trial purpose. It receives quarterly requirement for the same purpose. TE/PB/NPT analyses the feasibility of the firing requirement spelt out by the external agency and finally prepares Proof Details and sends related trial result to the external agency. Instrument (INST)/High speed image photonic (HIP)/Meteorology (MET)/Survey (SURV) provides logistic support for the dynamic proof and trial work. It ends up with forwarding the processed trial result to TE/PB/NPT. AMMN and Naval Armament Depot (NAD) are responsible for optimized receipt and issue of ammunitions. AMMN provides service to Army whereas NAD gives services to Navy. FPCC generates Firing Program after receiving proof details from concerned entities. It also receives Store Receipt Intimation (SRI) report from AMMN/NAD entities. WEAPON/APW/Communication (COMMN)/ Range Survey (RSD)/RANGE/GS receives Proof Details and acts accordingly to conduct dynamic proof and trial successfully. CNSG being a system and database administrator, performs recovery of data, backup of data, record of logs, fine-tuning of database and also forwarding request for reprint of PD/FP to the concerned entity. The corresponding individual process flow diagrams of the entities are drilled down for better understanding of the sub-systems. The total number of process flow diagrams in AIMS is 17.

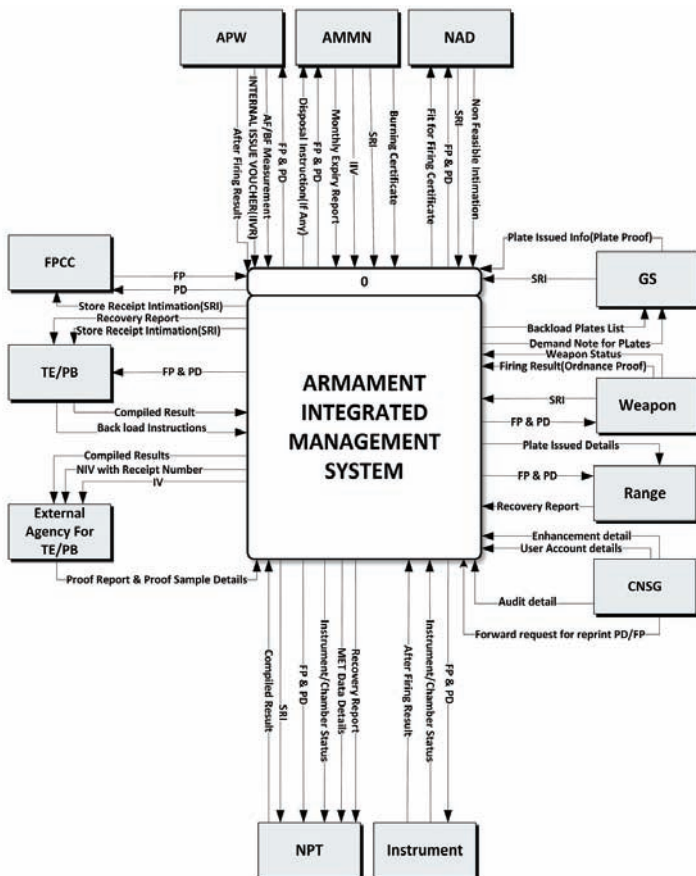


Figure 1. Context diagram.

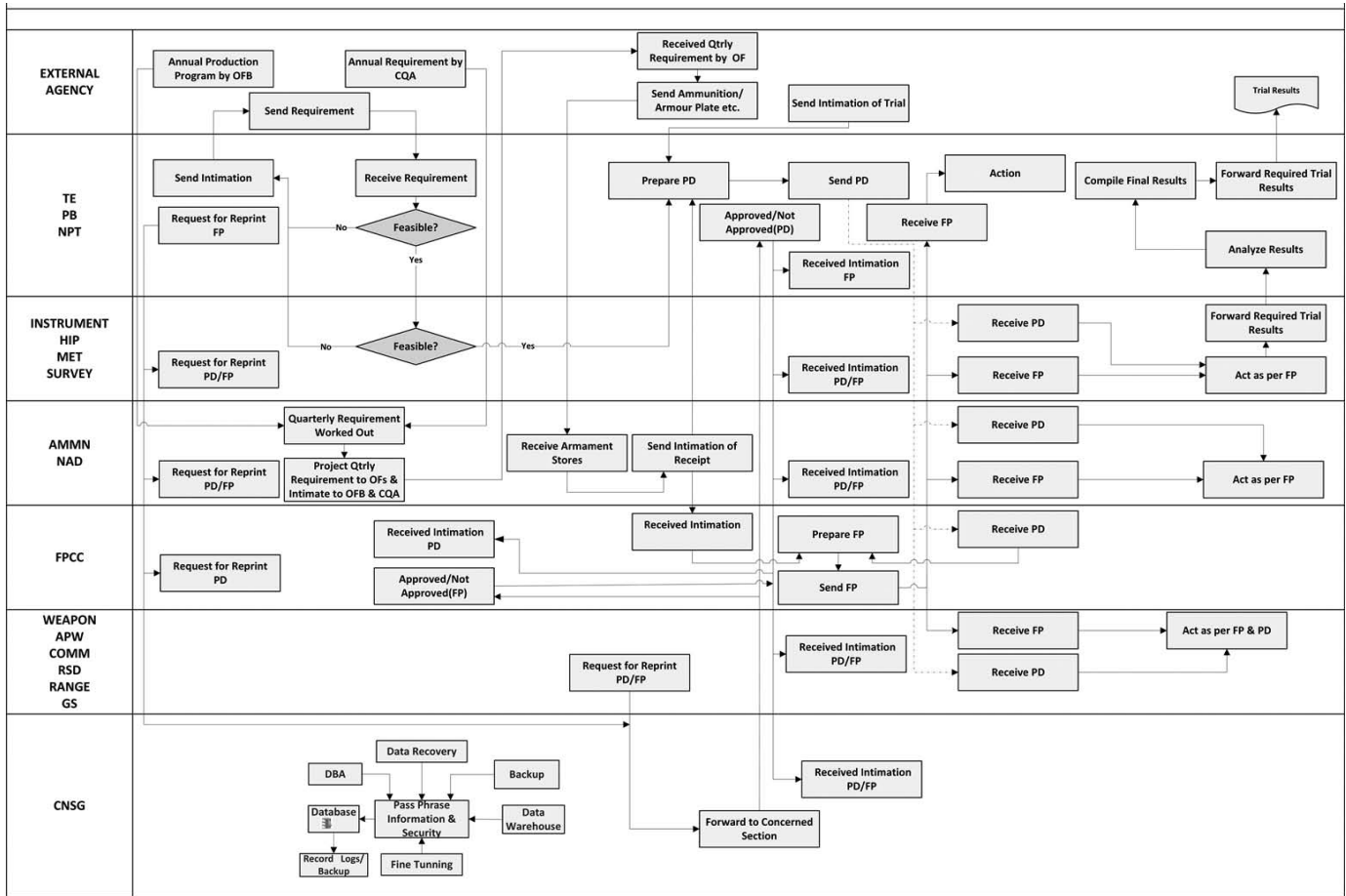


Figure 2. Process flow diagram.

**5. DATA FLOW AND ENTITY RELATIONSHIP IN AIMS**

Data Flow Diagram (DFD) is a graphical representation of the system used in the analysis and design phase of SDLC<sup>7</sup>. It clearly represents a system with systematic flow of input and output data and their storage. AIMS consists of DFDs of different entities to understand the system in a systematic and methodical way. It simply provides the detailed representation of the processes. This system has 17 entities where each of the entities has different level of detailed Data Flow Diagram. Again, all the 17 DFDs have their own set of Level 0, Level 1, Level 2 diagrams to clearly illustrate the inner process, input data, output data, and their storage. In this paper, only the DFDs related to TE/PB entity are being discussed. TE/PB entity is responsible for different activities like generation of PD, receipt of FP and SRI. It actively involves itself in the process of forwarding burning/demolition/disposal/backloading instructions to the concerned authority. It receives report on recovered shells after firing. This entity also executes, analyses and forwards trial related results to the designated external entity. The details related to the data flow of TE/PB are shown in Fig. 3. Total numbers of data flow diagrams in AIMS is 49.

Entity-relationship Diagram (ERD) is a graphical representation of entities and their relationship to each other. It is a data model using a set of construct and rules. It formally specifies the definition, convention, and use of the role construct<sup>8</sup>. AIMS comprises 17 number of ERDs to represent the system

in a systematic way. It conceptualises AIMS database design in a methodical way. It delivers an exact representation of the data content, structure, and constraints required by AIMS.

**6. DISTRIBUTED ARCHITECTURE AND CLOUD COMPUTING**

The distributed architecture comprises client/server and three-tiered interface<sup>9</sup>. In client/server architecture, client and server modules communicate through standardised, abstract interfaces, and behave like an integrated application system<sup>10</sup>. Each module is therefore shareable and reusable and can be included in other application systems. In three-tiered architecture, application components lie between the user and the back-end, and communicate with them as shown in Fig. 4. It is easy to deploy because the client is simple and logic is centralised. In three-tiered systems, programmers who have excellent user interface skills can concentrate on developing powerful presentation components, and they do not need to know about the inner workings of the applications. Meanwhile database analysts, who know the best ways to access data from a database do not need to be concerned with how the data is presented to an end user. System analysts and programmers can concentrate on developing algorithms and coding. In AIMS, both client/server and three-tiered architecture is used. Data Manipulation Language (DML) intrinsic modules are developed using client/server architecture whereas view related modules are developed using three-tiered architecture. Storage

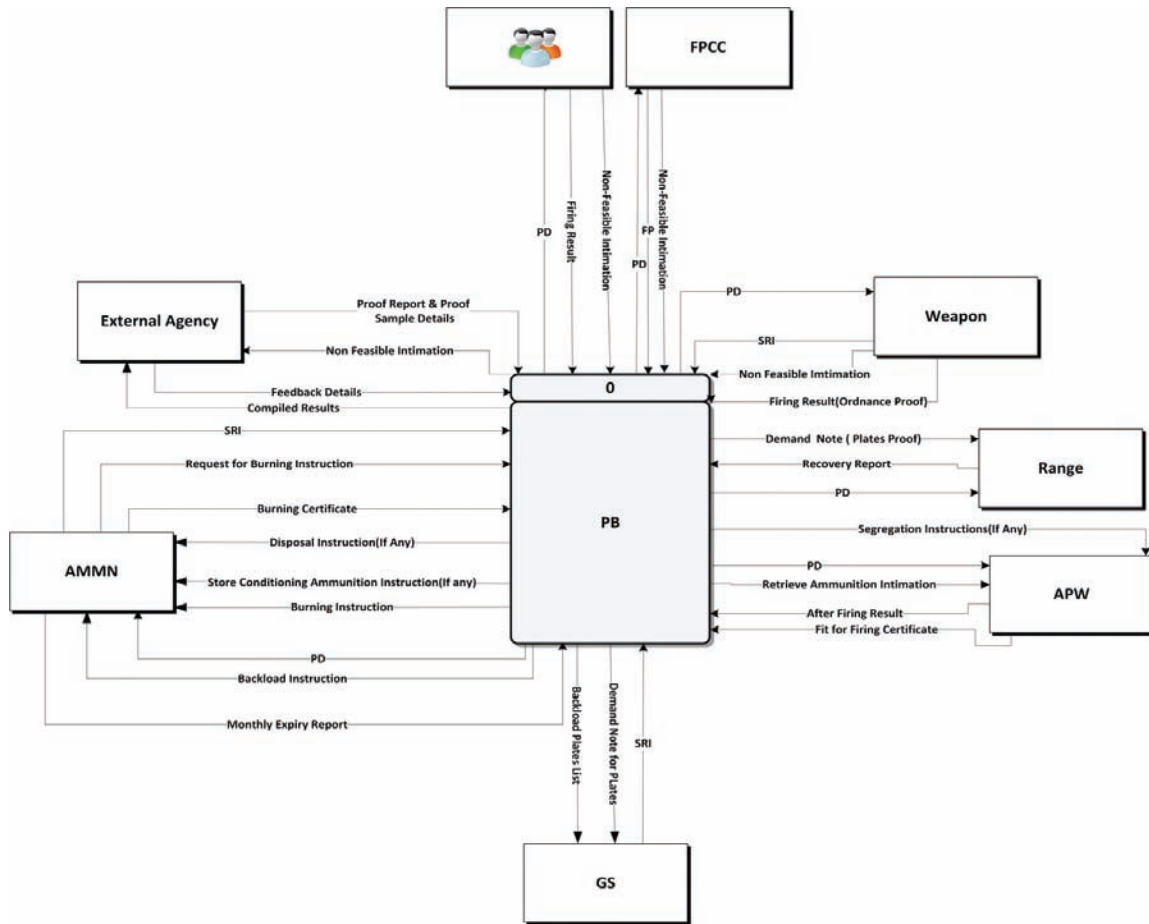


Figure 3. Data flow diagram.

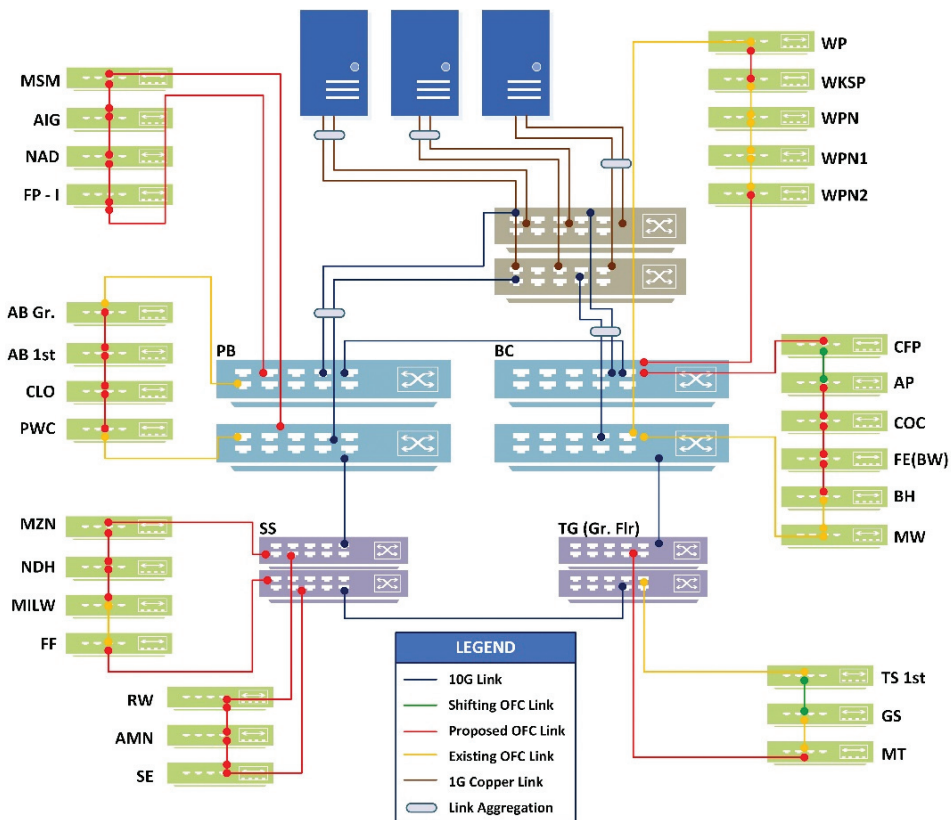


Figure 4. Schematic diagram of network.

of data is common to client /server as well to the three-tiered architecture-based modules. This strategy is used to ensure consistency and minimal redundancy in data.

Cloud computing is a distributed architecture-based computing service where different services such as servers, storage and applications are delivered<sup>11</sup>. It has the ability to provide on-demand service provisioning, scalability and flexibility. It focuses on maximising the effectiveness of the shared resources and dynamically reallocates these as per the demand. Tehnologies extensively used in cloud computing are virtualisation, distributed architecture, high-speed computing and information security. In AIMS software-as-a-service (SaaS) the model of private cloud would be used. This will help Resource Pooling where resources are pooled to serve multiple entities using multitenant model, with different physical and virtual resources dynamically assigned and reassigned according to demand. It will also provide rapid elasticity, the resources can be elastically provisioned and released automatically and scale rapidly where outward and inward consumer rates with demand.

## 7. FUTURE WORK

As discussed in previous sections that the basic objective of AIMS is to transmit various firing related data from different firing locations to the centralised server for storage, retrieval, and processing of firing results and generation of reports. For faster transmission of data to the centralised server realisation of “Resilient Network backbone” is undertaken. The resilient network will have 10 Gbps backbone connection with ring topology with zero point failure. It will be robust, having low latency, fast convergence, high scalability, single point management, i.e., Software-defined networking (SDN), highly secured with authentication-authorization-accounting (AAA) server and IPV6 compliance. It will be equipped with Software-defined networking features that will provide single point management and also will have facility to build up cloud application on this network backbone. The schematic diagram of the network is shown Fig. 5.

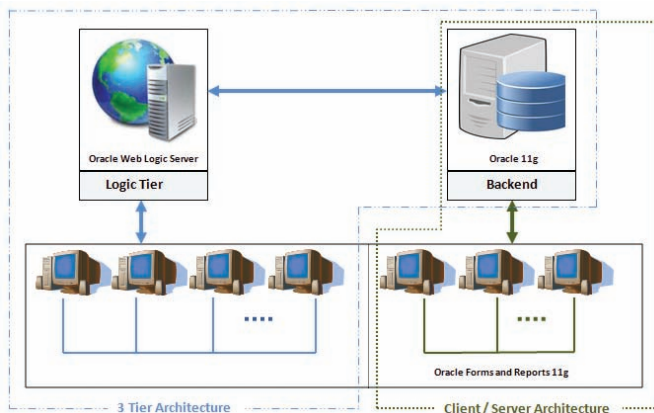


Figure 5. Distributed architecture interface.

## 8. CONCLUSION

The main idea of designing AIMS is to create a well-defined and structured process for all entities to function in a

coherent manner with the overall objective of lowering data redundancy, optimizing data storage, enhancing workflow management, increase data mining capabilities and achieve complete process automation. Systematic and methodological SDLC approach has been taken care for smooth design, development and execution of this software. Realization of resilient network backbone is included for faster transmission of data. The concept of distributed architecture and cloud computing is appreciated by keeping pace with recent and upcoming technologies.

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