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PASSIVE AIRCRAFT STATUS SYSTEM (PASS) Preliminary Plan for Technology Development

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This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

ALBERT S. TORIGIAN, Lt Col, USAF
Deputy Chief
Deployment and Sustainment Division
Air Force Research Laboratory

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13. ABSTRACT *(Maximum 200 words)* The purpose of the Passive Aircraft Status System (PASS) demonstration is to exhibit the potential use of PASS in the aircraft maintenance arena. The PASS demonstration design and development is based upon data collected in the field from various field visits, platforms, and all levels of maintainers. This is the third phase of a three-phase effort and addresses the conceptual design and technologies used in the development of the PASS demonstration. This report represents the preliminary plan for technology development, which encapsulates and demonstrates the benefits of PASS in current and future maintenance processes.			
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1. INTRODUCTION

The purpose of the Passive Aircraft Status System (PASS) demonstration is to exhibit the potential use of PASS in the aircraft maintenance arena. The PASS demonstration design and development is based upon data collected in the field from various field visits, platforms, and all levels of maintainers.

This paper addresses the conceptual design and technologies used in the development of the PASS demonstration. This paper represents the third part of a three-part PASS effort. Part 3 encapsulates and demonstrates the benefits of PASS in current and future maintenance process. Part 2 documented the data collection efforts and determined benefits of PASS for the current maintenance processes. Part 1 determined the technical feasibility of PASS downlink data and the feasibility of putting the PASS system on the aircraft.

2. BACKGROUND

In aircraft legacy systems, significant amounts of sensor data are available for capture on-board. The aircraft data capture in some legacy aircraft are consolidated into a data transfer cartridge or module that is eventually downloaded at the operations or maintenance debrief system. In most cases, the only airborne relay of critical aircraft information is pilot initiated as voice squawk. Within the current general concept of operations, there is no air-to-ground linkage of this aircraft maintenance and logistics data. The PASS concept attempts to break this barrier by sending the maintenance data down early to benefit the maintenance personnel and serve as a force multiplier for generating subsequent sorties.

3. PASS CONCEPT

The PASS concept calls for detailed aircraft data to be collected, transferred, and translated before landing. Figure 1 – Passive Aircraft Status System Concept - illustrates the collection of data from the aircraft, transferring data to the ground via radio frequency (RF) connection, and the use of an interface that converts the data into a format (i.e., fault codes) recognizable by maintenance personnel.

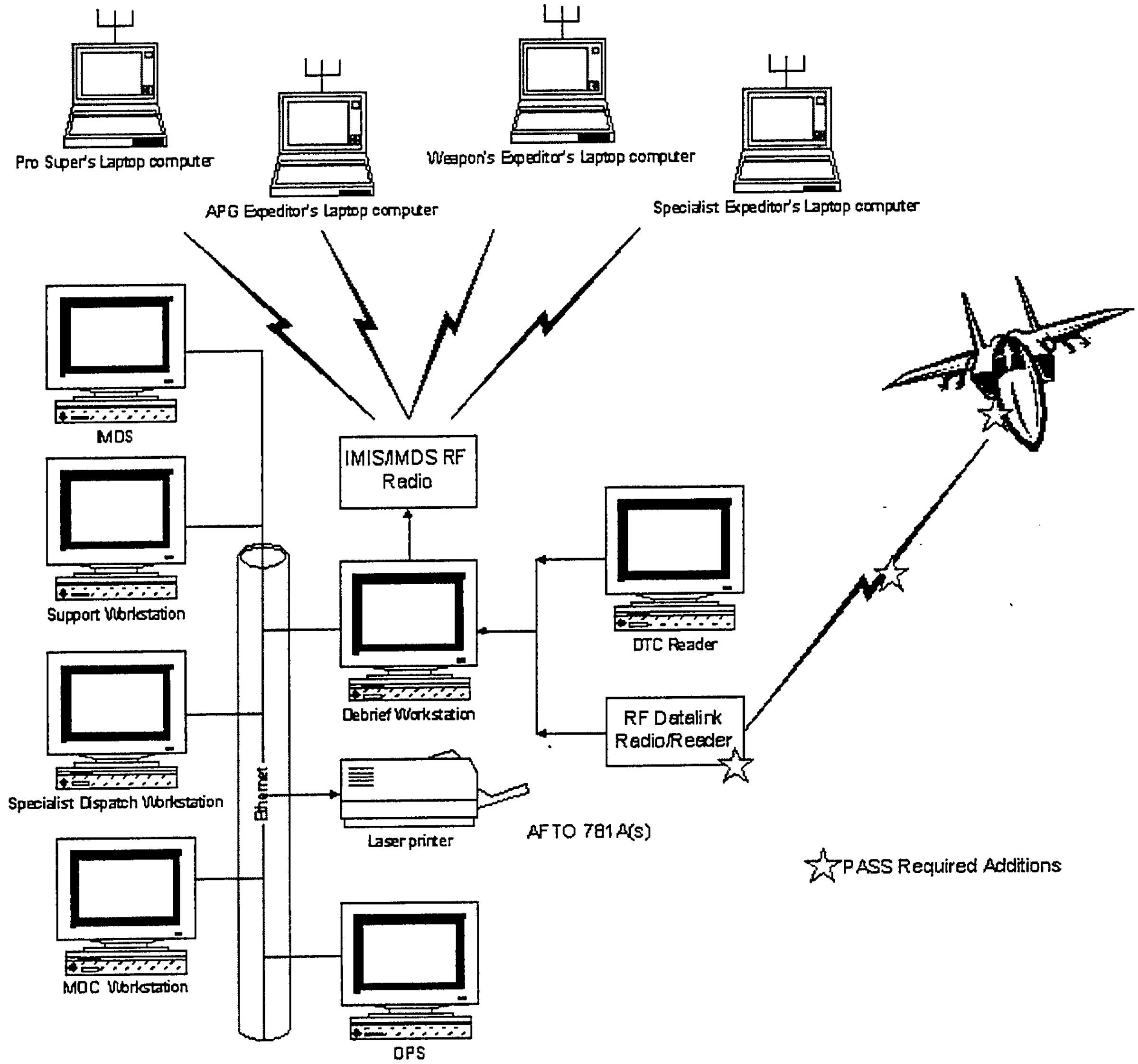

Figure 1 – Passive Aircraft Status System Concept

While the aircraft is still airborne, the converted data are accessible to all maintainers, via an RF or LAN connection allowing access to real-time status and fault data. Having this information before the aircraft lands allows maintainers to make informed maintenance decisions. The goal of the PASS concept is to provide accurate and detailed information to maintenance personnel in a consistent and timely manner before the aircraft lands. There is currently no such capability in the today's legacy aircraft.

In today's environment, pilots typically radio a code squawk when returning from a mission. A code squawk is a high-level status providing the general condition of the aircraft, as assessed by the pilot during the mission. Several key maintenance supervisors use this code squawk along with other information to determine the type of maintenance to be performed on the aircraft. Unfortunately, a code squawk can be too supervisors unable to make key decisions until debrief has occurred, which often leads to valuable time lost.

One benefit of the PASS concept is making detailed information (such as aircraft system and subsystem failures, fuels, munitions expenditures, etc.) available to maintenance personnel while an aircraft is still airborne. Another benefit is the potential to alleviate critical maintenance issues, such as determining the complete health status of the aircraft and all its major systems/subsystems needed for the next sortie.

3.1 Scope of Pass Demonstration

3.1.1 Approach

The selected approach for the PASS demonstration is to use existing laptop equipment with RF modem communication to demonstrate the PASS concept on current and future platforms. The demonstration uses data collected from Mountain Home, Shaw, and Charleston AFB data collection trips. Its purpose is to create and show realistic scenarios that provide a business case for PASS implementation. The demonstration shall also provide conceptual user screens including but not limited to, the Production Superintendent, Airplane General (APG) Expediter, and the Specialist Expediter. Through prior fact-finding and data collection trips, the platforms identified as likely to receive the most benefit from PASS are the fighter aircraft, due to the quick-turns required for their missions. Although F-15C, F-15E, and F-16CJ user data was collected, the focus of the demonstration was to collect detailed data and base the demonstration on the F-16CJ platform. The demonstration generalizes the PASS concept, but any details required for realism in the demonstration targets the F-16CJ platform.

3.1.2 RF Transmission

The RF air-to-ground data link feasibility was discussed and proven feasible in the first technical paper. Therefore, the demonstration's focus is not on the implementation of a specific RF technology, but rather to simulate the airborne data link using an RF modem Commercial-Off-The-Shelf (COTS) product.

3.1.3 Focus

The demonstration's purpose is to display the PASS concept and conceptual screens.

- <u>Demonstrate the PASS Concept:</u> The demonstration shows the flow of PASS fault information in the F-16 maintenance world. A scenario concept has been identified to allow generation and execution of detailed business cases on a PASS simulation application. The scenario simulates airplane and pilot squawks for Inflight, Pilot, Ground, and Debrief stages of the maintenance process. When the scenario executes, squawks are generated real time via RF to a receiving RF modem and stored into a database where it can be viewed real time by various maintenance users.

- Conceptual Screens: Screens were developed for the Pro Super, APG Expediters, and Specialist Expediters. The conceptual screens show how and what PASS data is available to these users.

4. DEMONSTRATION ARCHITECTURE

As shown in Figure 2 – PASS Architecture Concept breaks down into three main areas.

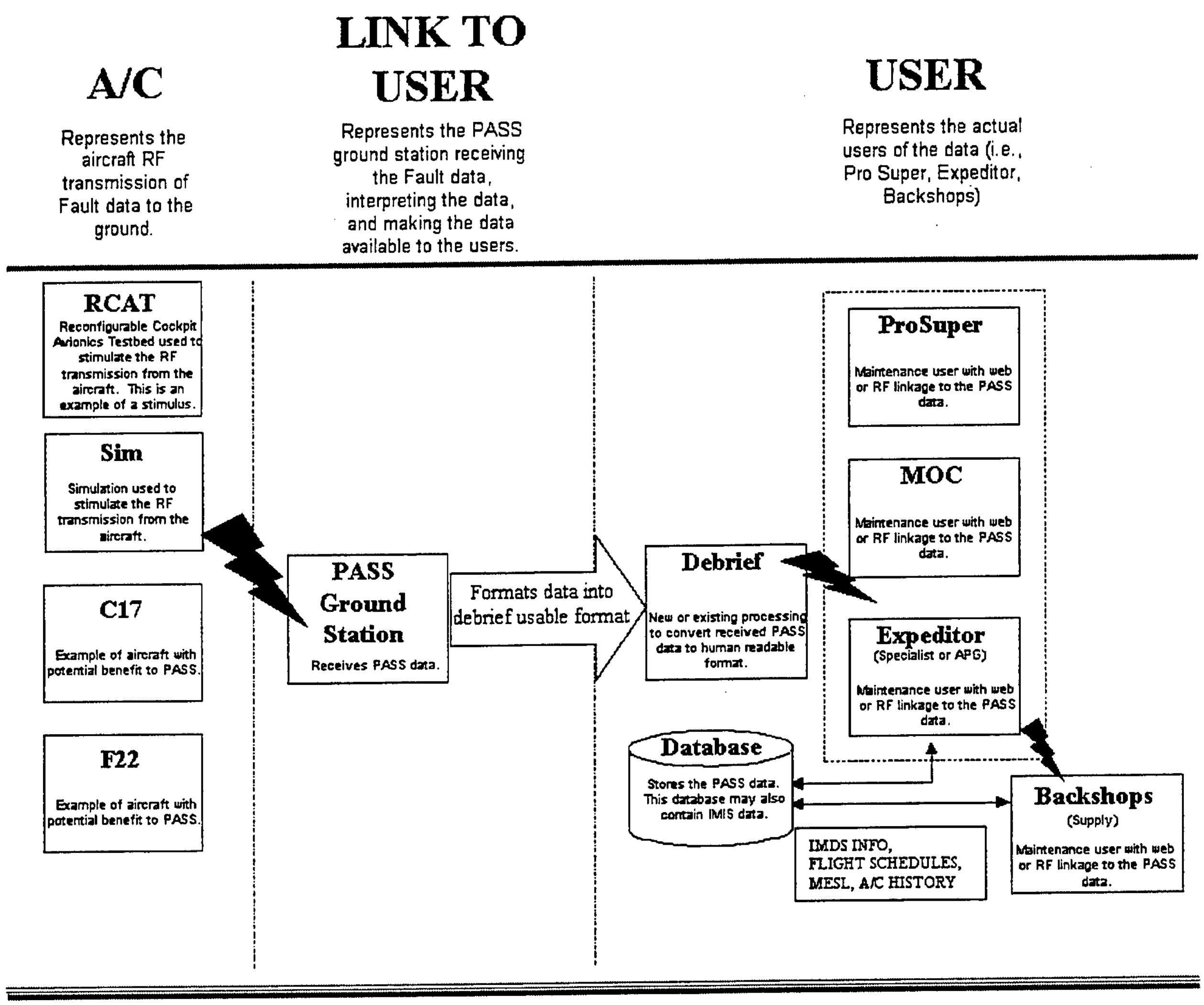

Figure 2 – PASS Architecture Concept

Figure 3 – PASS Demonstration Concept, divides the PASS Demonstration into two main areas. Essentially, the demonstration was broken down in this manner to demonstrate the RF transmission of data from the plane to the ground.

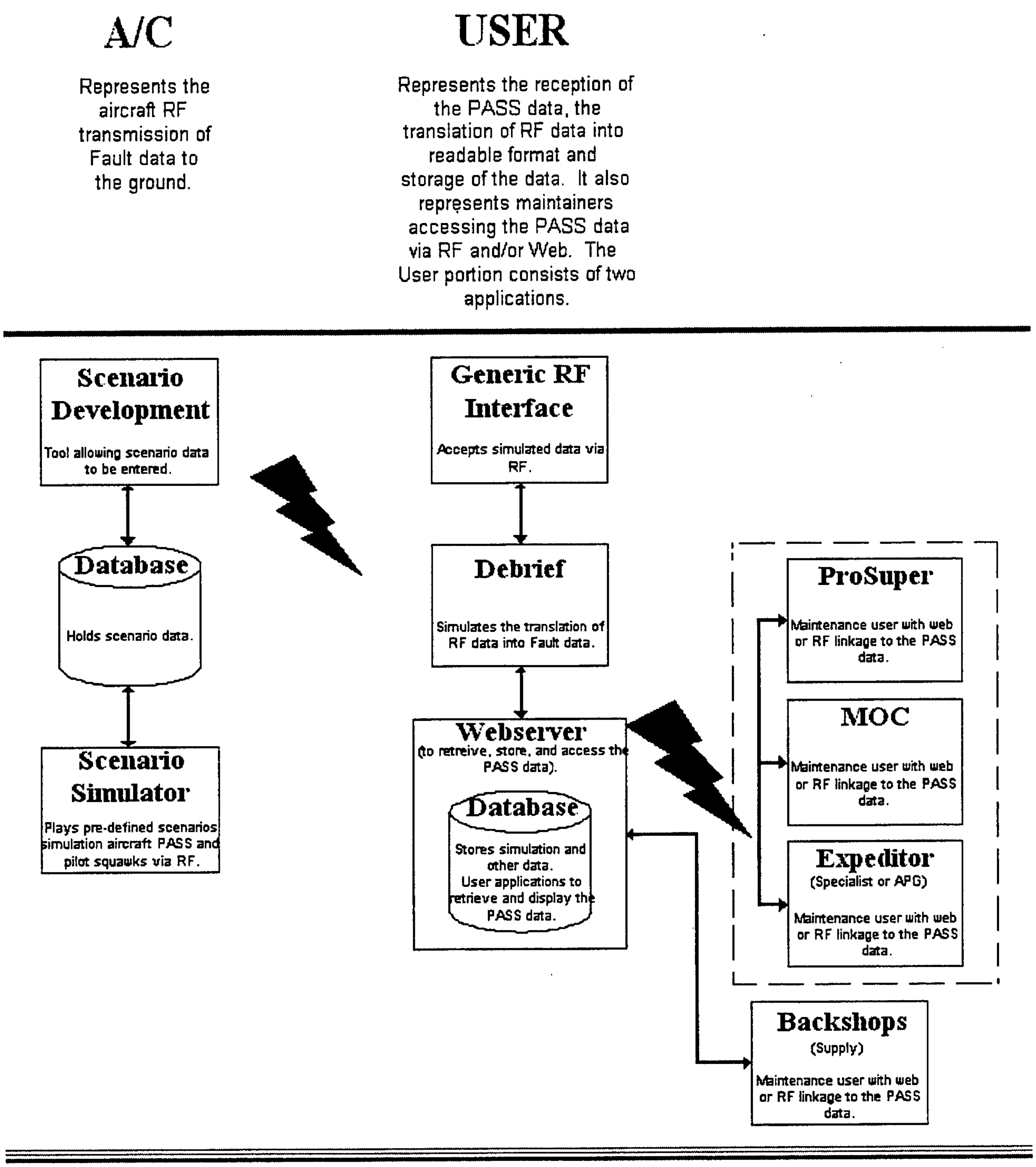

Figure 3 – PASS Demonstration Concept

4.1 Hardware Architecture

The hardware selected for the two main areas of the PASS demonstration is described in the following sections.

4.1.1 Laptops with RF Transmission

Hardware selected to perform the demonstration used available equipment with the goal of emphasizing the transmission of PASS information via RF. Referring to the two areas discussed in Figure 3 – PASS Demonstration Concept, the hardware selected for each area is as follows:

- Aircraft (A/C) – Laptop equipped with RF modem. This laptop serves as the aircraft simulation. Laptop minimum requirements are 128 K memory, 2-gig hard drive, and RF modem link to network.

  (Note: Throughout this paper, this laptop is referred to as the Simulation laptop.)

- User – Laptop equipped with RF modem compatible with the Simulation laptops RF modem. Laptop's minimum requirements are 256 K memory, 2-gig hard drive, and RF modem linked to network. This laptop serves as both a WebServer to receive and store the incoming PASS simulation data, as well as housing the User applications used to view the PASS data through client screens.

  (Note: Throughout this paper, this laptop is referred to as the WebServer/User laptop.)

4.2 Software Architecture

The software applications required for the PASS demonstration are defined in Table 1 – Software Application Requirements.

Table 1 – Software Application Requirements

4.2.1 SIMULATION (RF TRANSMISSION) AND SOFTWARE PACKAGES Software packages and configurations required to design, implement and use the PASS Simulation application.	4.2.2 WEB SERVER AND SOFTWARE PACKAGES USED Software packages and configurations required to design, implement and use the WebServer application.	4.2.3 MAINTENANCE USERS AND SOFTWARE PACKAGES USED Software packages and configurations required to design, implement and use the User Screen applications.
Operating System – Windows NT 4.0 Option Pack 6	Operating System – Windows NT 4.0 Option Pack 6	Operating System – Windows NT 4.0 Option Pack 6
Development System – Borlands JBuilder 3 Professional (uses Java SDK 1.2)	Development System – Borlands JBuilder 3 Professional (uses Java SDK 1.2)	Development System – Borlands JBuilder 3 Professional (uses Java SDK 1.2)
Database – Microsoft Access '97	Database – InterBase Version 5.0	Database – Retrieves database information from the InterBase database on the WebServer
Drivers – ODBC Manager, ODBC driver for Microsoft Access '97	Drivers – ODBC Manager, ODBC driver for Microsoft Access '97 and InterBase JDBC	Drivers – No special drivers
Network - Connection with the WebServer/User laptop	Network - Connection with the Simulation laptop	Network – Connection with WebServer ClientAccess processing required
	WebServer – Internet Information Server (IIS) Version 2.0 for Windows NT Workstation 4.0	

5. SOFTWARE DEMONSTRATION DESIGN APPROACH / TECHNOLOGIES USED

5.1 SIMULATION

The simulation laptop allows the generation and execution of scenarios to demonstrate the aircraft portion of the PASS concept.

5.1.1 Scenarios

A PASS scenario is defined as a collection of squawk events that are pre-programmed into a database. A scenario relates to a squadron of aircraft returning from a sortie and the PASS data each aircraft squawks during scenario execution.

Note: The scenario may also be applied to a sortie launch.

Figure 4 – Scenario Generation Sheet shows a sample entry sheet developed to aid in the planning and generation of a PASS scenario. The Scenario Generation Sheet allows the scenario developer to identify the scenario number, Integrated Maintenance Information System (IMIS)-like data, and squawk events for each tail number in the squadron.

- Scenario Number – Ties the tail number and its squawk events to a particular scenario. Many tail numbers belonging to the same squadron make up a scenario.

- IMIS-like data – Data such as the flying schedule and Estimated Time In Commission (ETIC) are simulated to allow the ProSuper screen to display realistic decision data that are made available through seamless IMIS integration.

- Squawk Events – The squawks this aircraft performs for the identified PASS scenario. The sheet identifies:

  1) Squawk Types

     a. Inflight – Fault codes collected on the aircraft and transmitted via RF link before landing.

     b. Pilot – Normal RF pilot squawk (Code 1,2, or 3 with a subsystem).

     c. Passive Ground – Verification of collected fault data transmitted via RF link at the End Of Runway (EOR).

     d. Active Ground – Human activated squawk transmitting fault codes via RF link while on the ground. (Used for Ground Abort, Redballs).

     e. Debrief – Detailed fault data and write-ups from debrief processing.

  2) Time of squawk – Time the squawk event will occur from the beginning of the scenario.

  3) Fault Code - The fault codes and aircraft data that are transmitted as part of the squawk event.

  4) Rep – Indicates "Y" if the fault is considered a repeat fault.

  5) Recr – Indicates "Y" if the fault is considered a recurring fault.

  6) Altitude – Altitude of the aircraft at the time the fault occurs.

  7) Air Speed – Air Speed of the aircraft at the time the fault occurs.

  8) Time Fault occurred from start of flight – time in flight when the fault happened.

Scenario Name: Test **Scenario Number:** 1 **Configuration for Next Flight:** IC **ETIC:** P+48 **Status:** FM

Tail Number: 91-0303 **A/C Type:** F-16 **Schedule Today:** F4 **Schedule Tomorrow:** CRTA

Squawk	*Time from Start of Simulation*	*Fuel Rem %*	*MESL Code / Pilot Code*	*Fault Code*	*Fault Description/Pilot Subsystem*	*Rep*	*Rocr*	*Altitude*	*Air Speed*	*Time fault occurred from start of flight*
In Flight	10 secs	20	3	INS999	INS Drifts 10 degrees per hr	Y	N	30000	500	10 min
			2	SMS001	SMS will not communicate on #1 Bus	N	Y	32000	500	20 min
			2	RDR001	RDR will not communicate on #1 Bus	N	N	30050	505	90 min
Expenditures:	*Bombs: 2*	*Bullets: 1*			*Missiles: 2*	*Flares: 1*		*Chaff: 5*		
Pilot	10 min		2		RDR – Mode 2 not working					
Passive Ground	17 min	15	3	INS999	INS Drifts 10 degrees per hr	Y	N	30000	500	10 min
			2	SMS001	SMS will not communicate on #1 Bus	N	Y	32000	500	20 min
			2	RDR001	RDR will not communicate on #1 Bus	N	N	30050	505	90 min
Expenditures:	*Bombs: 2*	*Bullets: 1*			*Missiles: 2*	*Flares: 1*		*Chaff: 5*		
Initiated Ground	N/A									
Expenditures:	*Bombs: 2*	*Bullets: 1*			*Missiles: 2*	*Flares: 1*		*Chaff: 5*		
Debrief	47 min		3	INS999 0203	INS Drifts 10 degrees per hr – malfunction oscillator	Y	N	30000	500	10 min
			2	SMS001 0104	SMS will not communicate on #1 Bus – bus io failure	N	Y	32000	500	20 min
			2	RDR001 0405	RDR will not communicate on #1 Bus – bad synch exciter	N	N	30050	505	90 min

Figure 4 – Scenario Generation Sheet

Once generated, the data from the sheets are transferred into a Microsoft Access database. Due to the complexity of the database, a Java based tool (Scenario Builder) has been identified for development to aid in the scenario generations. This tool replicates the Scenario Generation sheet and allows entries/modifications made in the Scenario Builder to be stored or modified in the underlying scenario database.

5.1.2 Simulation

The PASS simulation is a Java application used to select and execute a pre-defined PASS scenario (see section 5.1.1). When started, the scenario runs at a defined interval (default 1 second) and searches the database for a list of squawk events. The simulation emulates the squawk events by displaying an event at the time indicated by the scenario timer and transmits the data via Remote Method Invocation (RMI) over the RF modem to the WebServer/User RF modem. Figure 5 – Design for PASS Simulation displays a block diagram of the general design concept for the simulation portion of the PASS demonstration.

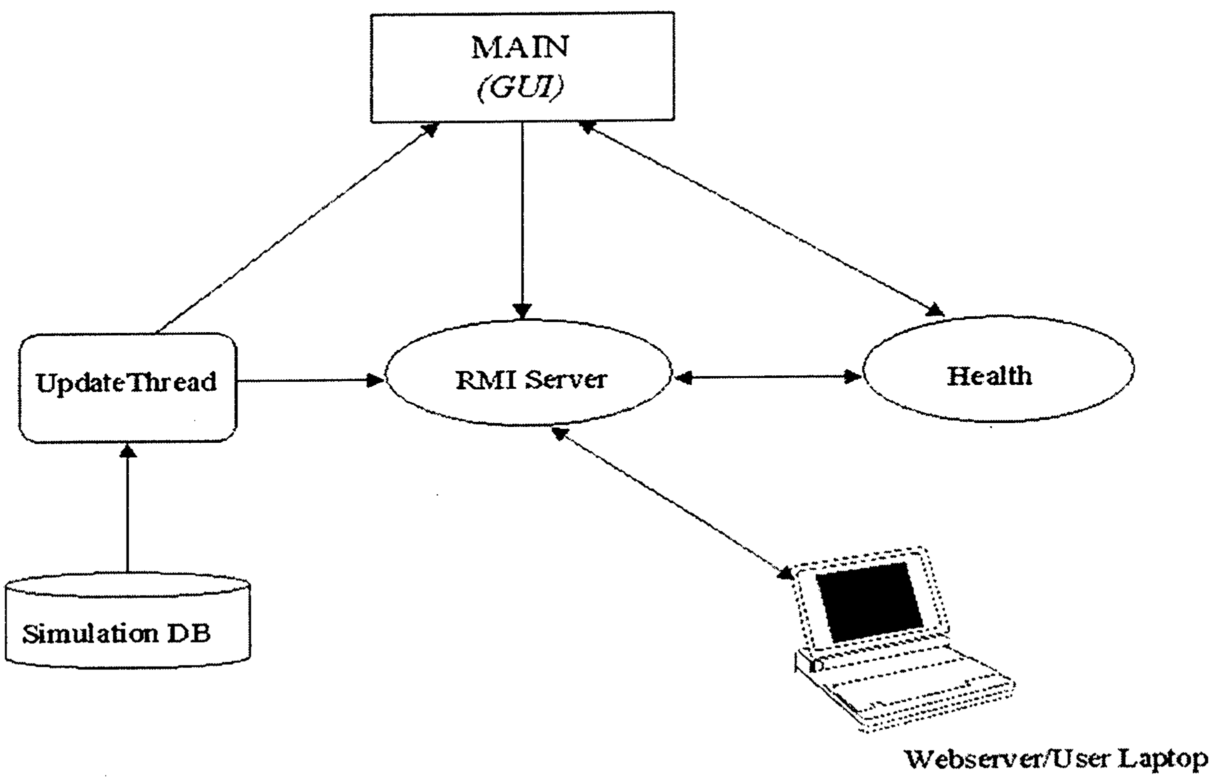

Figure 5 – Design for PASS Simulation

The simulation has a main thread and a daemon (or child) thread. The main thread, Simulate_Pass, sets up and displays the Scenario Control Screen (Refer to section 5.1.4). It also generates and starts the daemon thread, UpdateThread. The main thread receives squawk events and time information from UpdateThread and displays them on the simulation screen.

UpdateThread queries the database for all Squawk events and sends the events to the main thread in real-time. UpdateThread also sends time information to the Main Thread showing the health of UpdateThread and the current interval for the current scenario. UpdateThread also sends the events as object classes to the RMI server using remote object methods via the RF modem.

A background health process also reports the health of the RMI Server/Client communication between the Simulation and the WebServer/User laptops.

5.1.3 Data Transmission (RMI CLIENT)

Remote Method Invocation (RMI) transmission is the chosen transfer method for passing squawk event and health data from the simulation processing to the WebServer/User processing. RMI is used to pass data between the Simulation laptop and the WebServer laptop. RMI allows a server to register classes with remote methods and bind them to the RMI registry. A remote computer may locate and gain access to this object by accessing and invoking remote methods available for the object. Remote methods may contain input and return parameters that allow the transfer of entire objects from one application or machine to another.

A class encapsulating the squawk event implements a remote interface with remote methods to transfer data from the simulation laptop to the WebServer/User laptop. The WebServer processing contains the server portion of the squawk event transfer and the simulation contains the client portion of the squawk event transfer. The WebServer registers the squawk event class with the RMI registry to make a transfer method available to a remote computer for client invocation. The UpdateThread daemon thread packages the squawk event data into the squawk event class and uses RMI technology to transfer the entire object to the WebServer. The WebServer retrieves the data and stores the data into the PASSReceiver database.

A similar class with few or no parameters exists for the health check. The RMI server or client may reside on either the WebServer or the simulation laptop. Remote calls for health checks are invoked by the client and the data are reflected on the Simulation Screen in the form of text or animation.

5.1.4 Conceptual Screens

Figure 6 – PASS Simulation Screen depicts an executing PASS scenario. This screen is an example of the conceptual simulation data to be included on the simulation screen. The simulation screen is a continuous real-time display of the events occurring in the scenario and at what times.

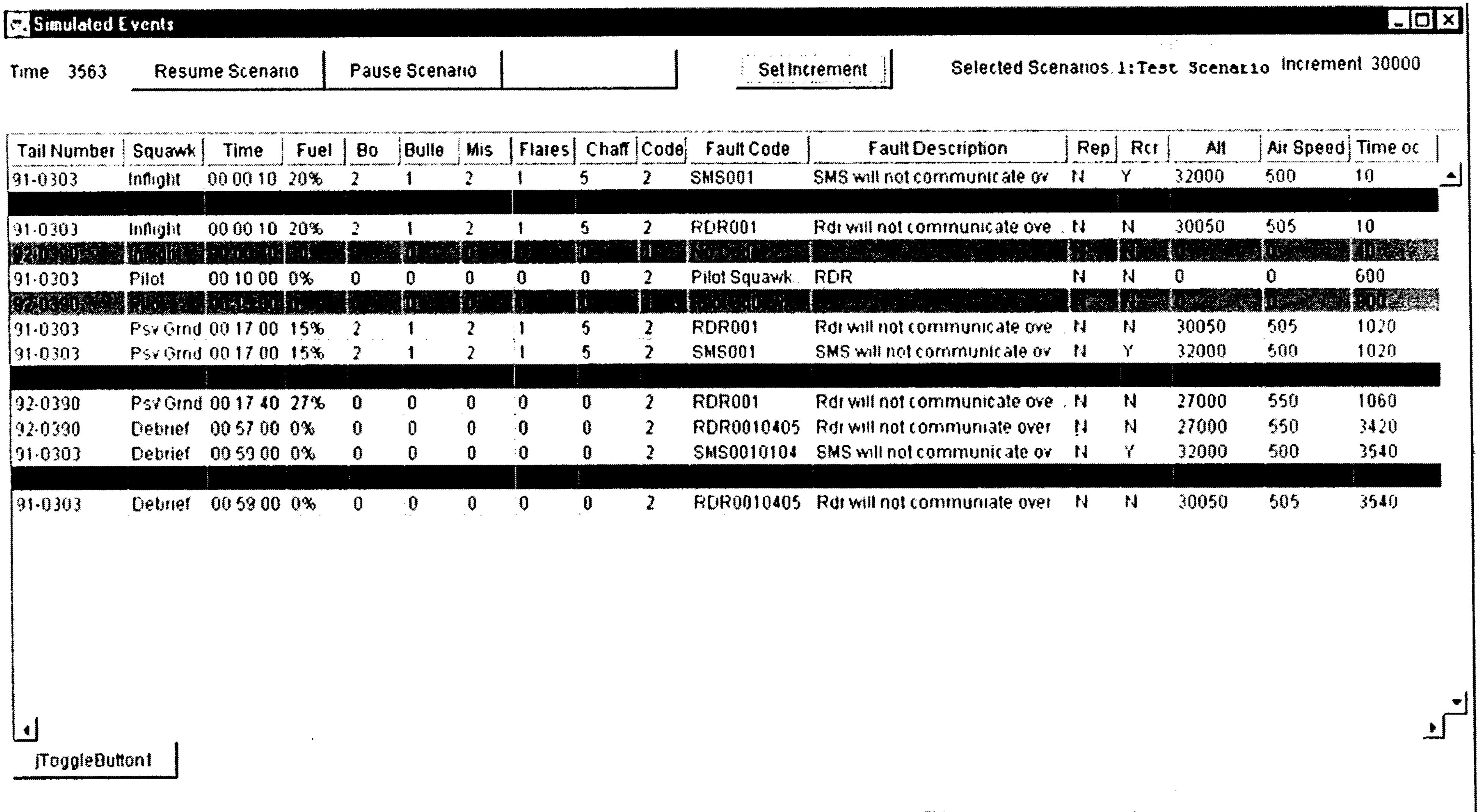

Figure 6 – PASS Simulation Screen

Table 2 – Simulation Screen Conceptual Areas provides three conceptual areas (scenario control, scenario status, and scenario data) of the simulation screen.

Table 2 – Simulation Screen Conceptual Areas

Scenario Control	Scenario Status	Scenario Data
Select Scenario – User may select which scenario to run from a list of pre-defined scenarios located in the Simulation database.	Time – Shows the current scenario time. The scenario time jumps by the interval defined in the Select Interval button. A running time indicates the UpdateThread is healthy.	A time ordered list of Squawk events and all data reported for that squawk event. This data is generated and displayed when the scenario clock matches or is greater than the time attached to an event in the currently running scenario.
Start Scenario – User may start the scenario. This button also used to resume the scenario.	Health – Show the health status of the RMI connection at a pre-defined interval. Health status may be textual or in the form of animation (not shown in picture).	
Pause – User may Pause the Scenario while the scenario is running.		
Stop – User may stop the scenario while the scenario is running.		
Select Interval – Interval at which the scenario clock runs. The default value is 1 second. The user may increase the interval in whole seconds. This is used to make the scenario run faster and is available while the scenario is running.		

5.1.5 Scenario Database

The scenario database holds the pre-generated PASS scenario data for use with the PASS Simulation software. The database contains many lookup tables to ensure that only specific items may be added to various tables. Figure 7 – PASS Simulation Database Relationships with Lookup Tables shows the database design for the scenario database with lookup tables. Figure 8 – PASS Simulation Database Relationships without Lookup Tables shows the database design with the lookup tables removed to give a better view of the main tables used in the PASS simulation.

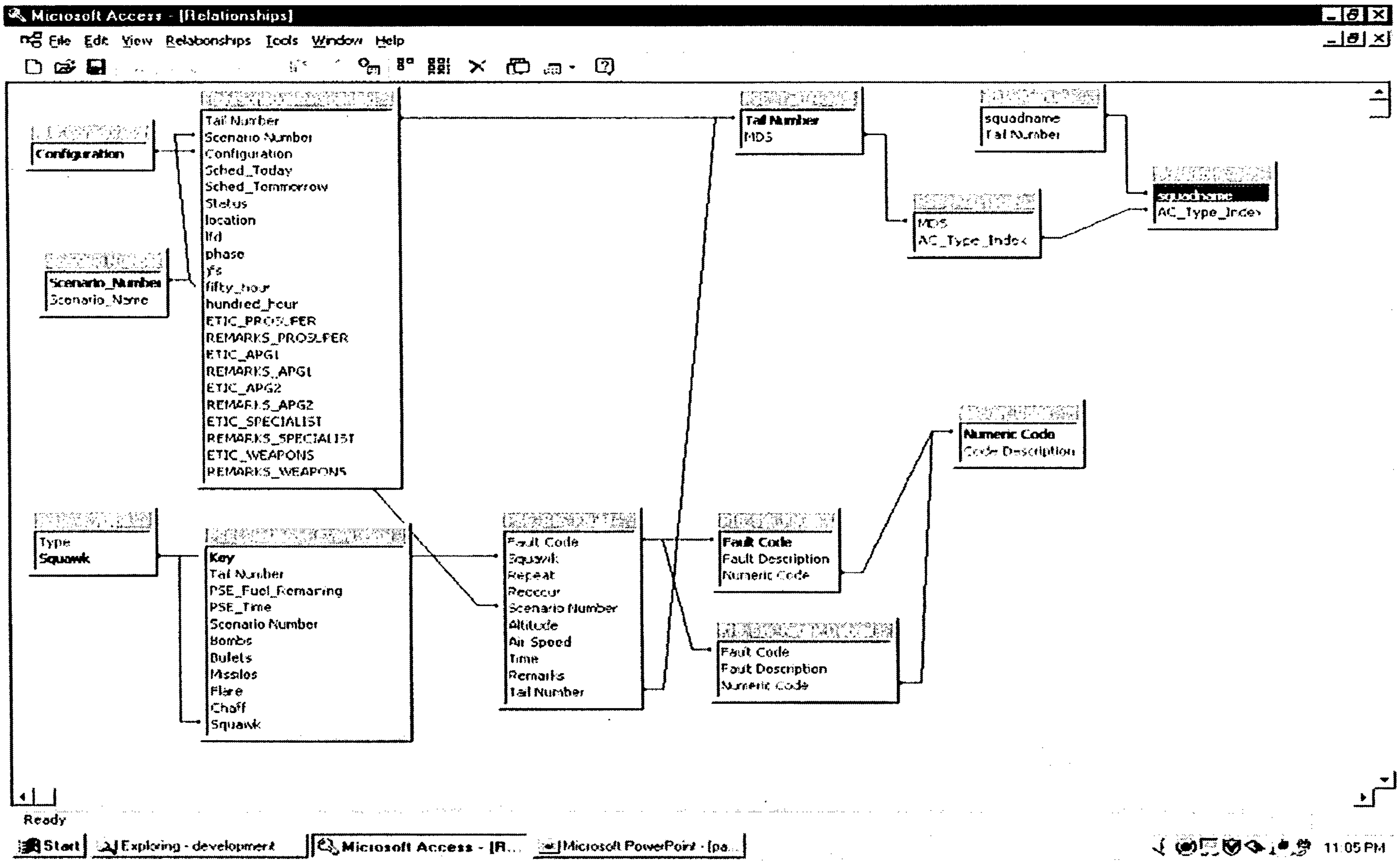

Figure 7 – PASS Simulation Database Relationships with Lookup Tables

The main tables in the scenario database are F-16_Sim_Faults, F16_Sim_Faults_Debrief, PSE_Simulation_Event_Final, PSE_Sim_Faults, and FlightSchedulePerScenario. A brief explanation of each table is provided in Figure 8.

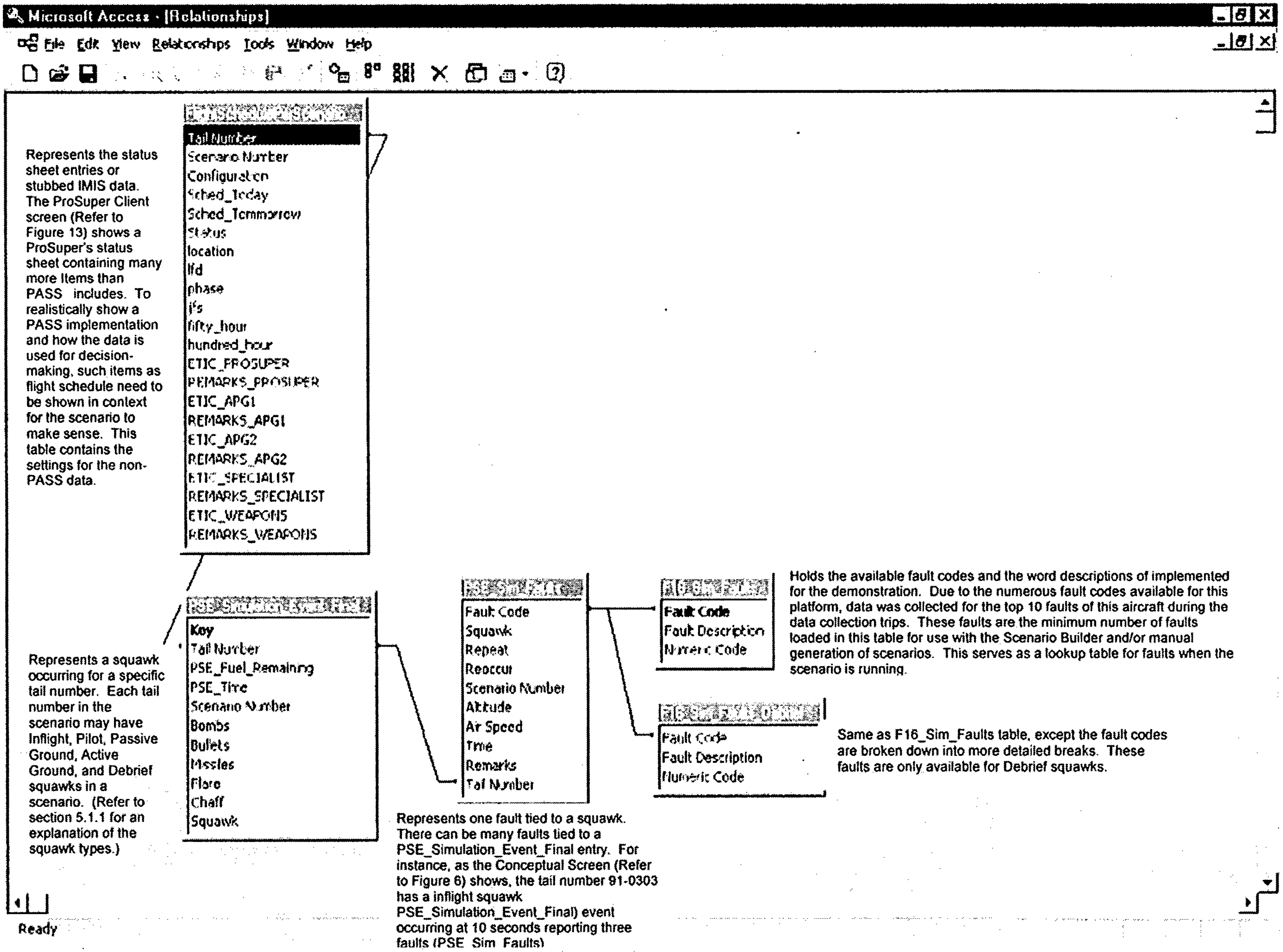

Figure 8 – PASS Simulation Database Relationships without Lookup Tables

Microsoft Access '97 was selected for the scenario database. Access was selected for ease of use and quick programmability and usability. The simulation is merely a stimulation tool to populate the PASSReceiver database located on the WebServer laptop. Any relational database such as Oracle, SQL Server, and InterBase etc. may be used in place of Access.

5.1.6 Simulation Limitations

RMI only allows data transfer between Java Virtual Machines. The PASS demonstration only contains Java Virtual Machines; therefore, the use of RMI meets the requirements. However, for PASS implementation involving legacy systems, CORBA methodology must be investigated due to its flexibility of allowing many different languages (i.e. Java, C++, Visual Basic) to communicate with each other. Jini, a more flexible Java interconnection language, may also be considered.

Real-time additions to the scenario will be available scenario is running, but these additions will not be stored to the scenario in the simulation database.

5.2 WebServer

The WebServer acts as the central data processor to receive, decode, store, and distribute PASS information. WebServer processing receives the data from the simulation via RF and stores the data into the PassReceive database. The WebServer also distributes the stored data to any clients requesting PASS information.

Figure 9 – Design for PASS WebServer shows the WebServer design. The WebServer application shares its residence with the Maintenance User applications on the second laptop. The design for the communication between the WebServer and Maintenance Users processing implements RMI and/or Web technology.

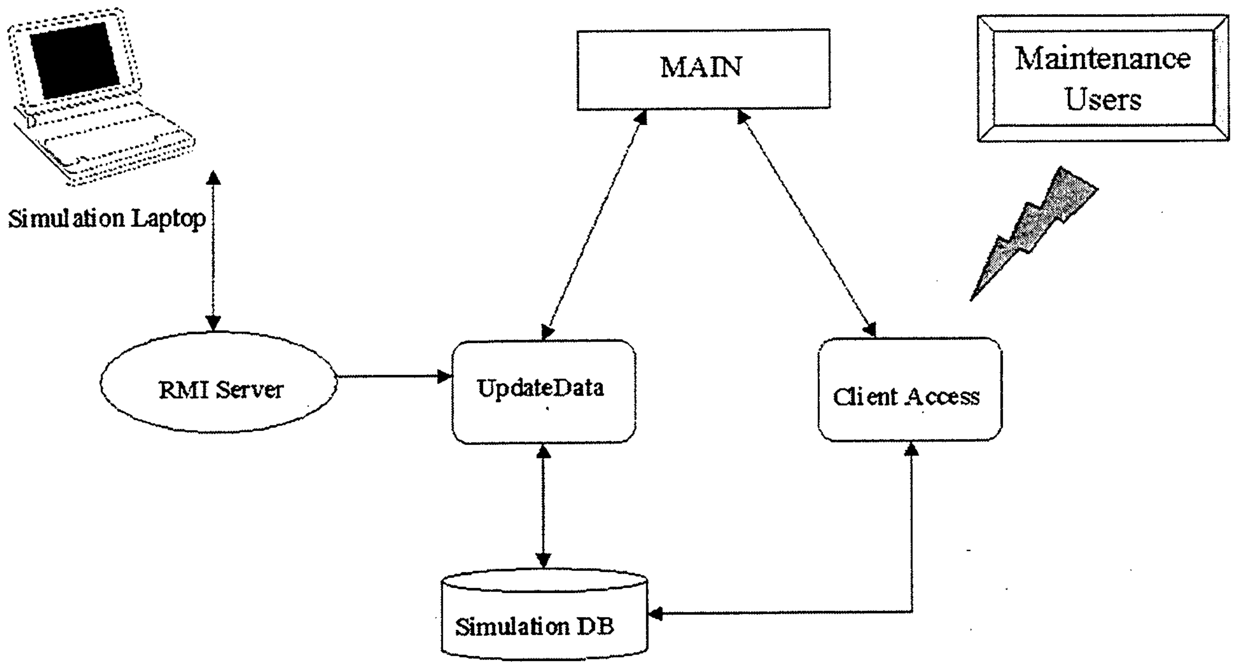

Figure 9 – Design for PASS WebServer

The WebServer has a main thread and two daemon threads. The main thread generates and starts two daemon threads 1) the UpdateDatabase thread and 2) the ClientAccess thread.

The UpdateDatabase thread retrieves the squawk events from the PASS simulation and stores the data in the appropriate tables in the PASSReceiver database. The RMI Server is part of this thread, which creates and registers the server implementing remote methods for receiving squawk events. This thread also receives Static Plane Data before scenario execution and updates the StaticPlaneData table in the PASSReceiver database. RMI responses to health checks are also handled via this thread.

The ClientAccess Thread processes all retrieval and update requests for the Maintenance User screens. This includes PASS Login verification and changes made by the users. See client screens section 5.3 for more details on user updateable data in the maintenance screens.

> *Note: All updates/retrieval classes in the database must be synchronized to ensure database integrity throughout the system.*

The WebServer processing keeps a copy of its classes in the root directory of the Internet Information Server (IIS). These classes provide client computers access to remote stubs and classes needed for RMI technology implementation.

5.2.1 Data Reception (RMI SERVER)

RMI transmission is the chosen transfer method for passing squawk event and health data from the simulation processing to the WebServer/User processing. RMI allows classes with remote methods to be registered and bound to the RMI registry. A remote computer may gain access to these methods by creating an object containing remote interfaces and invoking the methods. Remote methods may contain input and return parameters that may be used to transfer entire objects.

A class encapsulating the squawk event implements a remote interface with remote methods to transfer data from the simulation laptop to the WebServer/User laptop. The WebServer processing contains the server portion of the squawk event transfer and the simulation contains the client portion of the squawk event transfer. WebServer processing registers the squawk event class with the RMI registry to make a transfer method available to a remote computer for client invocation. The daemon thread packages the squawk event data into the squawk event class and utilizes RMI methods to transfer the entire object to the WebServer. The Webserver also retrieves and stores the data into the PASSReceiver database.

A similar class with few or no parameters exists for the health check. The RMI server or client may reside on either the WebServer or the simulation laptop. Remote calls for health checks are invoked by the client and the data are reflected on the Simulation Screen in the form of text or animation.

5.2.2 Data Storage

The PASSReceiver database stores the simulation data for request and retrieval from the Maintenance User Screens. Figure 10 – PASSReceiver Database Relationships with Lookup Tables shows the relationship diagram for the PASSReceiver database with all lookup tables displayed. The layout of the database tables (seven main tables), to include a brief explanation of each is shown in Figure 11 – PASSReceiver Database Relationships without Lookup Tables.

The database tool used for the PASS demonstration is an open source database, InterBase, packaged with the JBuilder tool. Due to the nature of the WebServer processing, the database tool must be compatible with SQL programming/commands. InterBase 5 was chosen due to the availability and compatibility with SQL. The version used for the PASS demonstration only provides a local server; therefore, the database is not accessible remotely.

> *Note: For PASS implementation, especially for the integration of PASS with IMIS-type legacy systems, conclusive studies should be performed on commercially available databases such as Oracle, SQL Server and the full version of InterBase to ensure a complete enterprise PASS implementation can be obtained. The PASSReceiver database ultimately should reside on a separate machine from the WebServer.*

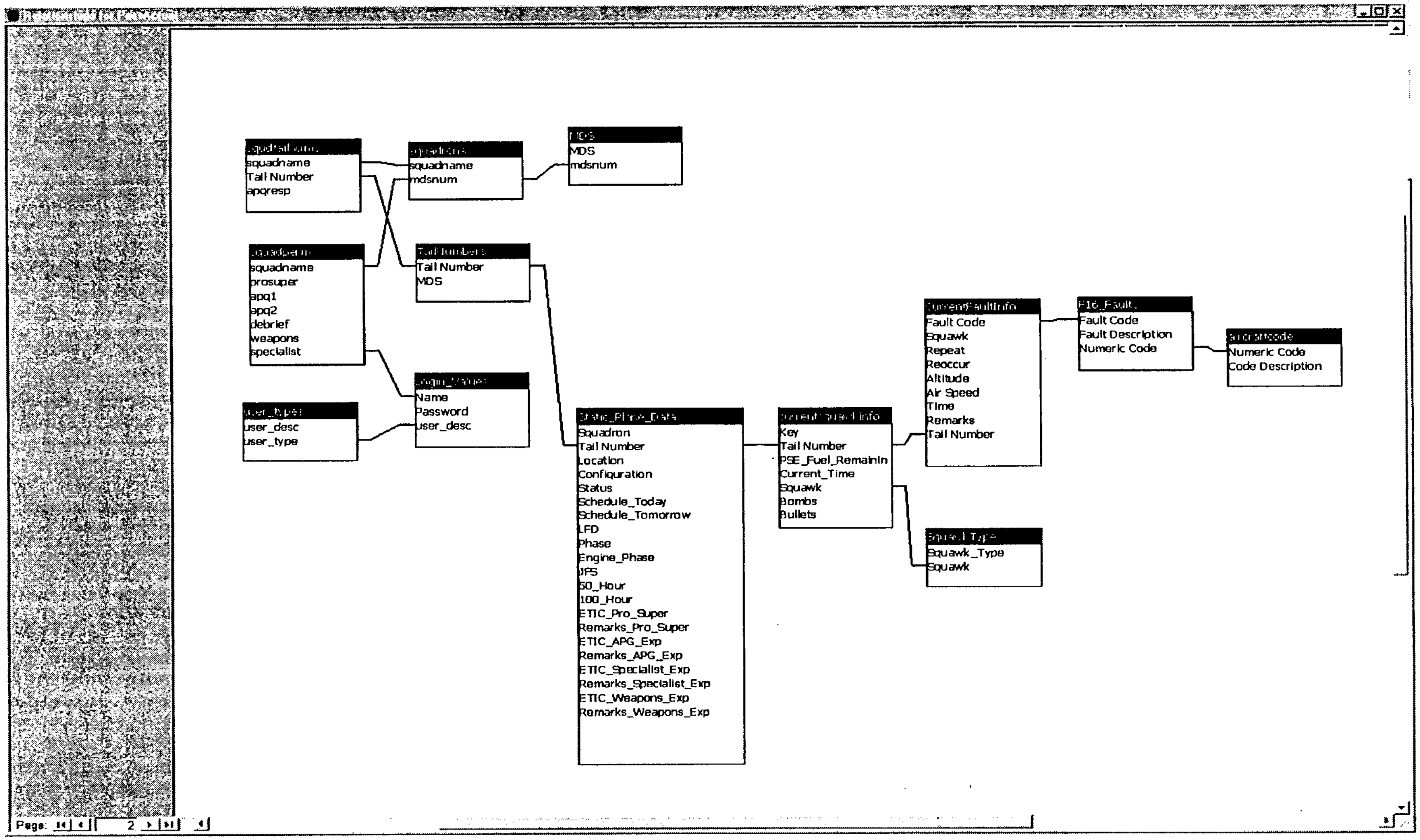

Figure 10 – PASSReceiver Database Relationships with Lookup Tables

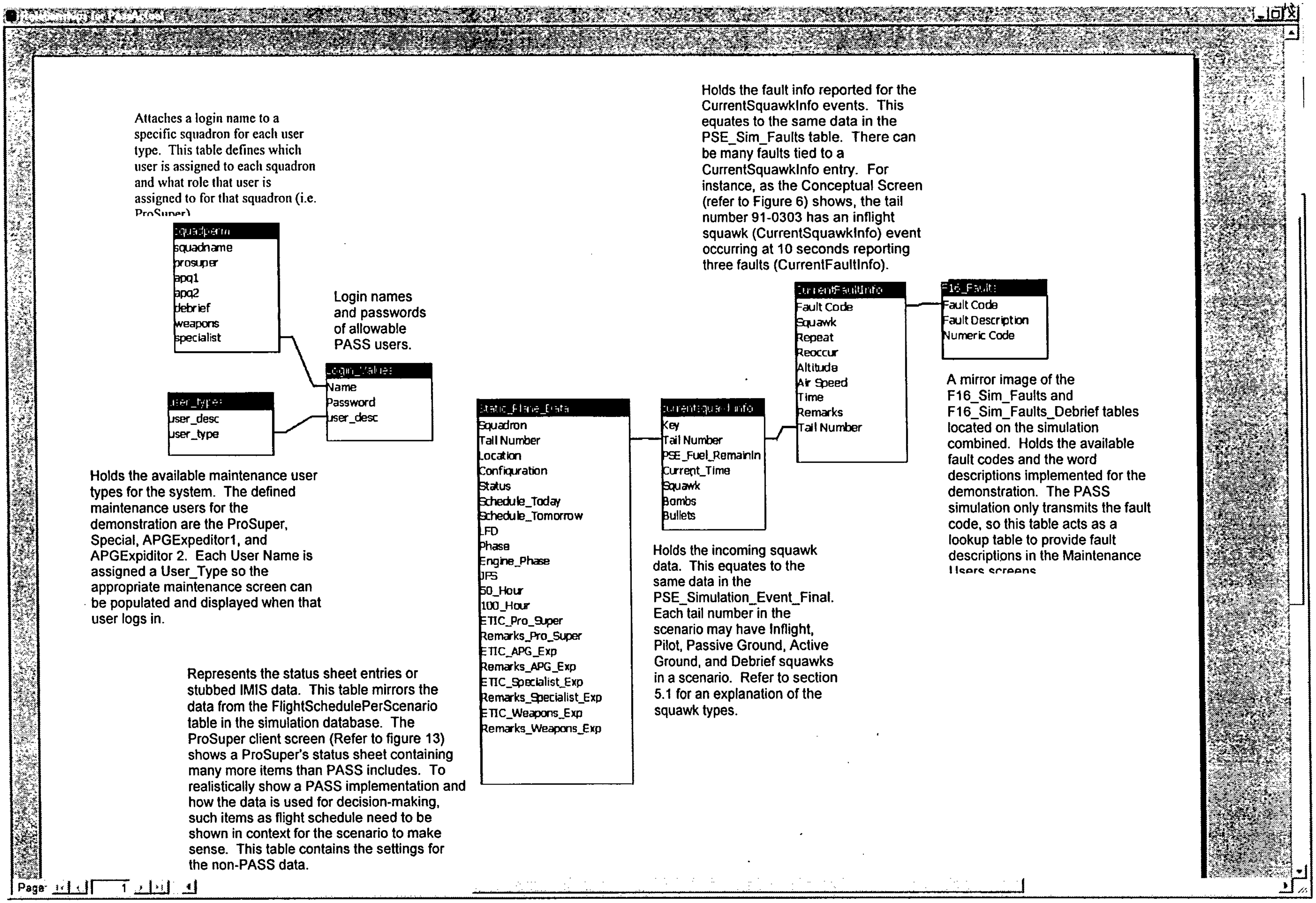

Figure 11 – PASSReceiver Database Relationships without Lookup Tables

The PASS simulation transfers the StaticPlaneData via RMI when the Start Scenario button is selected. Upon Receipt, the WebServer processing stores the data in the PASSReceiver database. When a user logs in, the maintenance users screen is populated using the data from this table to show valid flying schedules, ETICs, etc. There is also default data in the databases in case the Scenario is generated without specific data.

5.2.3 Web Server Limitations

The use of InterBase for a local database server is constrained in that the PASSReceiver database cannot be updated remotely. The PASS demonstration design forces all updates to the database to be handled through either the UpdateDatabase thread or the ClientAccess thread. Therefore, the database cannot be move to a separate machine unless the full version of InterBase or another remote accessible database is used.

5.3 Maintenance Users

The maintenance users may access the PASS maintenance data through the Maintenance User applications. These applications consist of Web pages and or Java applications using many technologies such as Java applets, VBScript, JavaScript, and Hypertext Markup Language (HTML) as appropriate. The following sections provide prototype screens for each of the Maintenance Users screens required for the PASS demonstration. These screens are conceptual and represent the general concepts of the PASS demonstration and the information it provides. Due to the nature of this paper, and the ongoing implementation of the demonstration, final screens will be defined on the completion of the PASS demonstration system.

5.3.1 Entering System

Figure 12 – PASS Login Screen is provided to allow entry into the PASS application upon verification of a User Name and Password. The login screen performs two functions. The first function allows the user to enter the system for security access and privilege levels. The second function identifies the type of user to the PASS application. Based on the user login and password, the PASS application determines the users assigned type and shows the appropriate PASS user screen.

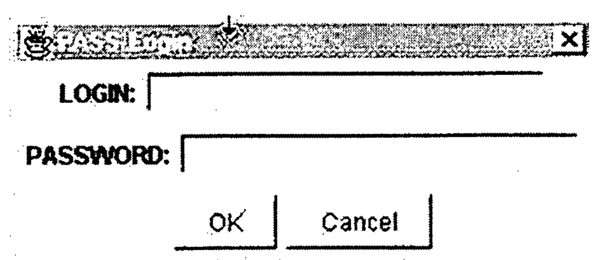

Figure 12 – PASS Login Screen

5.3.2 Pro Super Screens and Privileges

If the user logs in as a Pro Super, a screen similar to Figure 13 – Pro Super PASS Concept Screen is displayed.

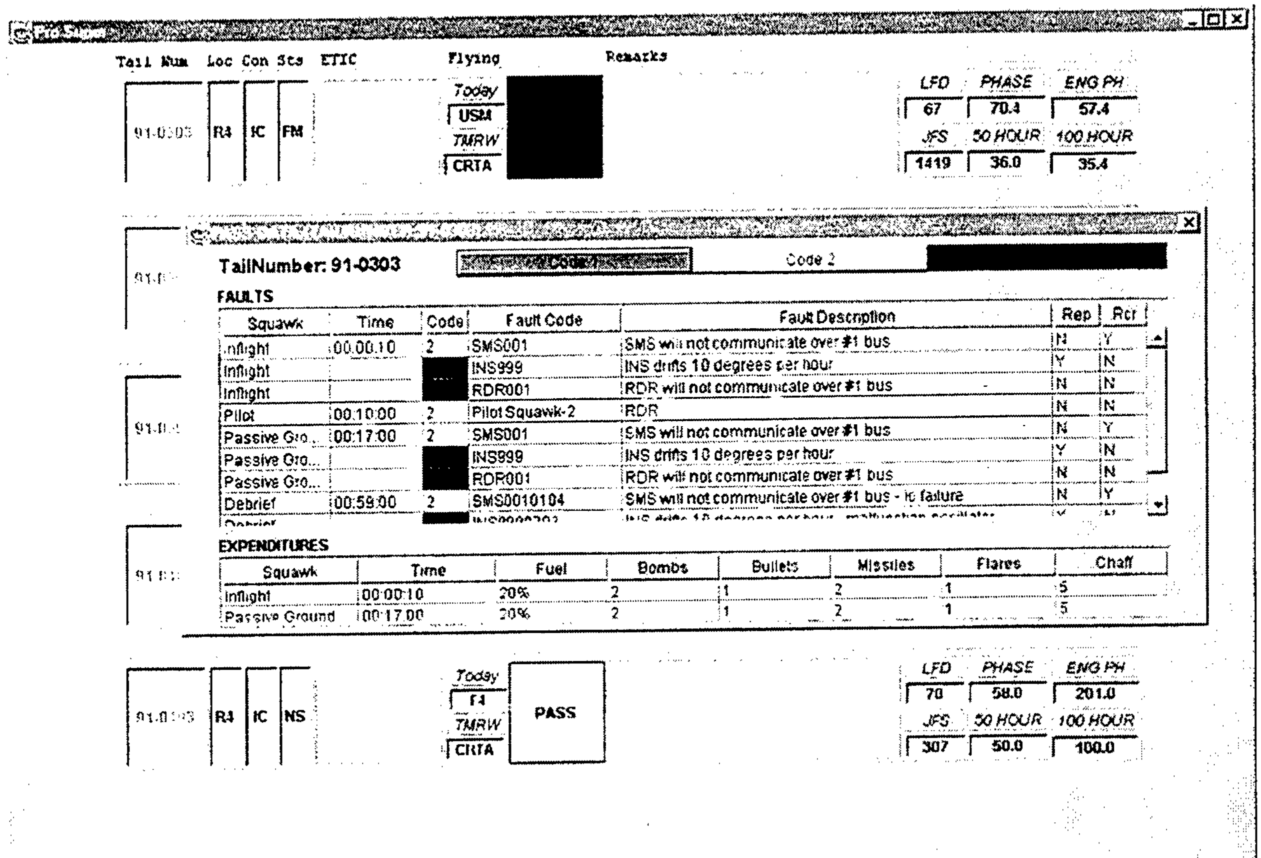

Figure 13 – Pro Super PASS Concept Screen

The larger screen labeled Pro Super mimics an electronic version of the current clipboard status sheet used in today's maintenance environment. A row for each tail number assigned to the Pro Super is displayed along with any pre-set scenario data for each plane. The button labeled PASS has been added to the electronic Pro Super status sheet. The Pro Super may select the PASS button to display the smaller PASS DATA window. The PASS DATA window displays data for a specific tail number. The PASS data available to the Pro Super and the privileges (defined in Italics) are as follows:

- <u>TailNumber</u> – identifies the tail number of the aircraft the data is detailed for *(Read Only)*
- <u>Code 1, 2, and 3 buttons</u> – Allows the Pro Super to select the current status code of the plane based on the squawk entries and the data available on the status sheet. The code defaults to the lowest code in the code column based on the latest squawk information. The Pro Super may either exit, accepting the default selection, or make a code selection. Upon exit or selection of the code, the status

sheet updates the PASS button with the proper color and code and updates all other displays real-time. *(Pro Super selection)*

- Faults *(Read Only)*: The faults block is used to display the PASS or Pilot fault data transmitted.

  1) Squawk – Indicating type of squawk.

     a. Inflight –Fault codes collected on the aircraft and transmitted via RF link before landing.

     b. Pilot – Normal UHF pilot squawk (Code 1,2, or 3 with a subsystem).

     c. Passive Ground – Verification of collected fault data transmitted via RF link at EOR.

     d. Active Ground – Human activated squawk transmitting fault codes via RF link while on the ground. (Used for Ground Abort, Redballs).

     e. Debrief – Detailed fault data and write-ups from debrief processing.

  2) Time of squawk – Time the squawk occurred.

  3) Code – Minimum Essential Systems List (MESL) Code pertaining to this fault code.

  4) Fault Code – Alphanumeric code indicating the failure.

  5) Fault Description – Word description of the fault.

  6) Repeats –Yes, if fault occurred in last flight. No, otherwise.

  7) Recur - Yes, if same fault occurred within last five flights. No, otherwise.

- Expenditures *(Read Only)*: The expenditure block is used to display the PASS or Pilot expenditure data transmitted.

  1) Squawk – Indicating type of squawk.

     a. Inflight – Expenditure data transmitted via RF link before landing.

     b. Passive Ground – Verification of collected expenditure data transmitted via RF link at EOR.

  2) Fuel – Percentage of fuel remaining are displayed in percentage remaining.

  3) Bombs– Number of bombs expended.

  4) Bullets– Number of bullets expended.

5) Missiles – Number of missiles expended.

6) Flares - Number of flares expended.

7) Chaff - Number of chaff expended.

Note: For full PASS design and implementation, weapons data needs to be based on configuration of aircraft to show x of y expenditures (i.e. 2 of 5 missiles) instead of just the amount expended.

5.3.3 APG Expeditors Screens and Privileges

If the user logs in as an APG Expeditor, a screen similar to Figure 14 – Expeditor PASS Concept Screen is displayed.

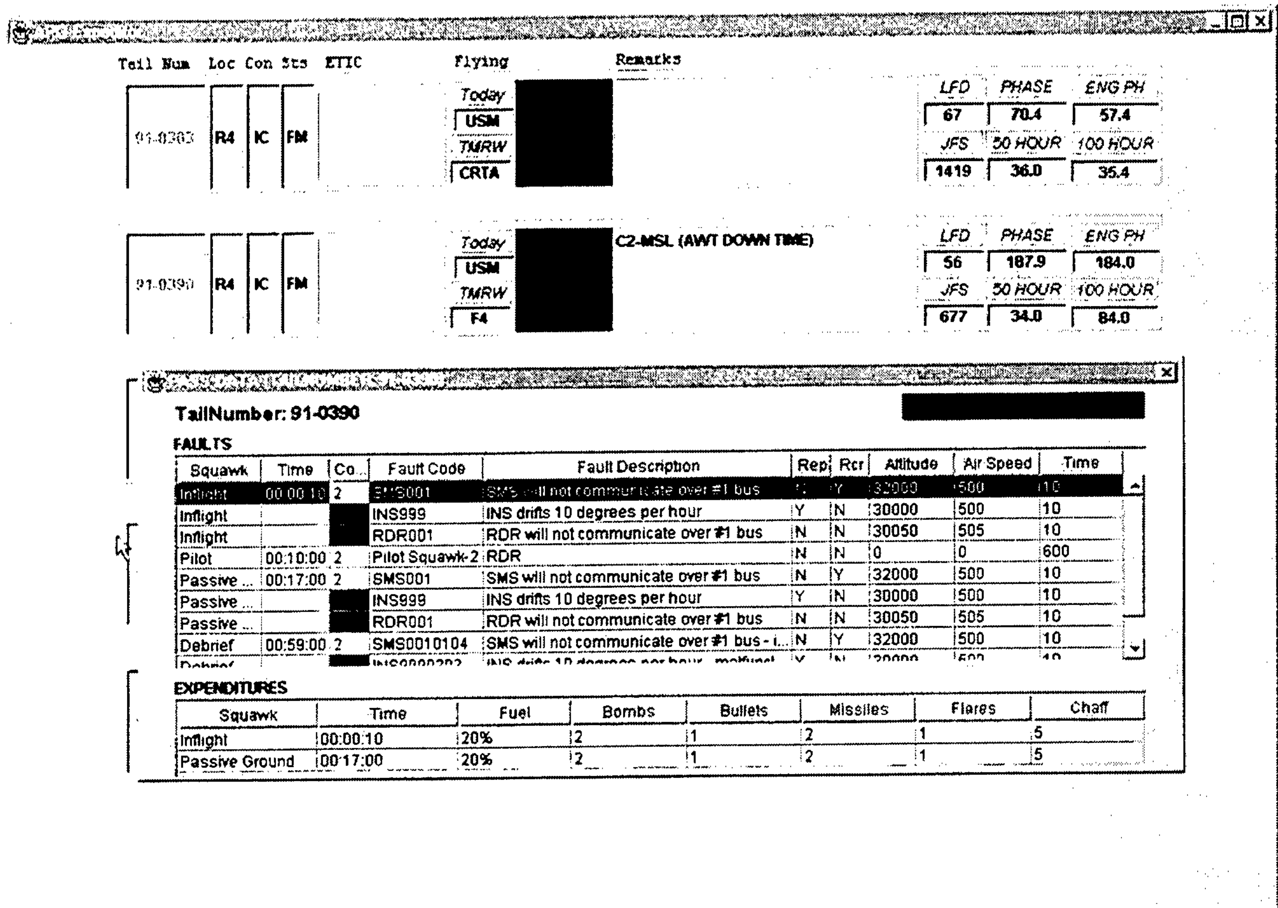

Figure 14 – Expeditor PASS Concept Screen

The larger screen labeled APG Expeditor mimics an electronic version of the current clipboard status sheet used in today's maintenance environment. A row for each tail number assigned to the APG Expeditor appears in this area along with any pre-set scenario data for each plane. The button labeled PASS has been added to the electronic APG Expeditor status sheet. When new PASS data is available, the APG Expeditor may select the PASS button to display the smaller PASS DATA window. The PASS DATA window displays data for a specific tail number. The PASS data available to the APG Expeditor and the privileges (defined in italics) are as follows:

> *(Note the similarity in the APG Expeditor and ProSuper screens. In essence, the APG Expeditor has the same data available to the ProSuper for fewer tail numbers. However, the APG Expeditor does not make the final determination of the code, the ProSuper does. The code displayed to the APG expeditor is the same as what is shown on the ProSuper screen in real-time.)*

- Tail Number – identifies the tail number the data is detailed for *(Read Only).*
- Code – The current status of the aircraft as determined by the ProSuper *(Read Only).*
- Faults *(Read Only)*: The faults indicate the PASS or Pilot data transmitted.

1) Squawk – Indicating type of squawk.

   a. Inflight –Fault codes collected on the aircraft and transmitted via RF link before landing.

   b. Pilot – Normal UHF pilot squawk (Code 1,2, or 3 with a subsystem).

   c. Passive Ground – Verification of collected fault data transmitted via RF link at EOR.

   d. Active Ground – Human activated squawk transmitting fault codes via RF link while on the ground. (Used for Ground Abort, Redballs).

   e. Debrief – Detailed fault data and write-ups from debrief processing.

2) Time of squawk – Time the squawk occurred.

3) Code – MESL Code pertaining to this fault code.

4) Fault Code – Alphanumeric code indicating the failure.

5) Fault Description – Word description of the fault.

6) Repeats –Yes, if fault occurred in last flight. No, otherwise

7) Recur - Yes, if fault occurred within last five flights. No, otherwise.

- Expenditures *(Read Only)*:

  1) Squawk – Indicating type of squawk.

     a. Inflight –Fault codes collected on the aircraft and transmitted via RF link before landing.

     b. Passive Ground – Verification of collected fault data transmitted via RF link at EOR.

  2) Time of squawk – Time the squawk occurred.

  3) Fuel – Percentage of fuel remaining.

  4) Bombs– Number of bombs expended.

  5) Bullets– Number of bullets expended.

  6) Missiles – Number of missiles expended.

  7) Flares - Number of flares expended.

  8) Chaff - Number of chaff expended.

     Note: For full PASS design and implementation, weapons data needs to be based on configuration of aircraft to show x of y expenditures (i.e. 2 of 5 missiles) instead of just the amount expended.

5.3.4 Specialist Expeditor Screens and Privileges

If the user logs in as a Specialist, a screen similar to Figure 15 – Specialist PASS Concept Screen is displayed.

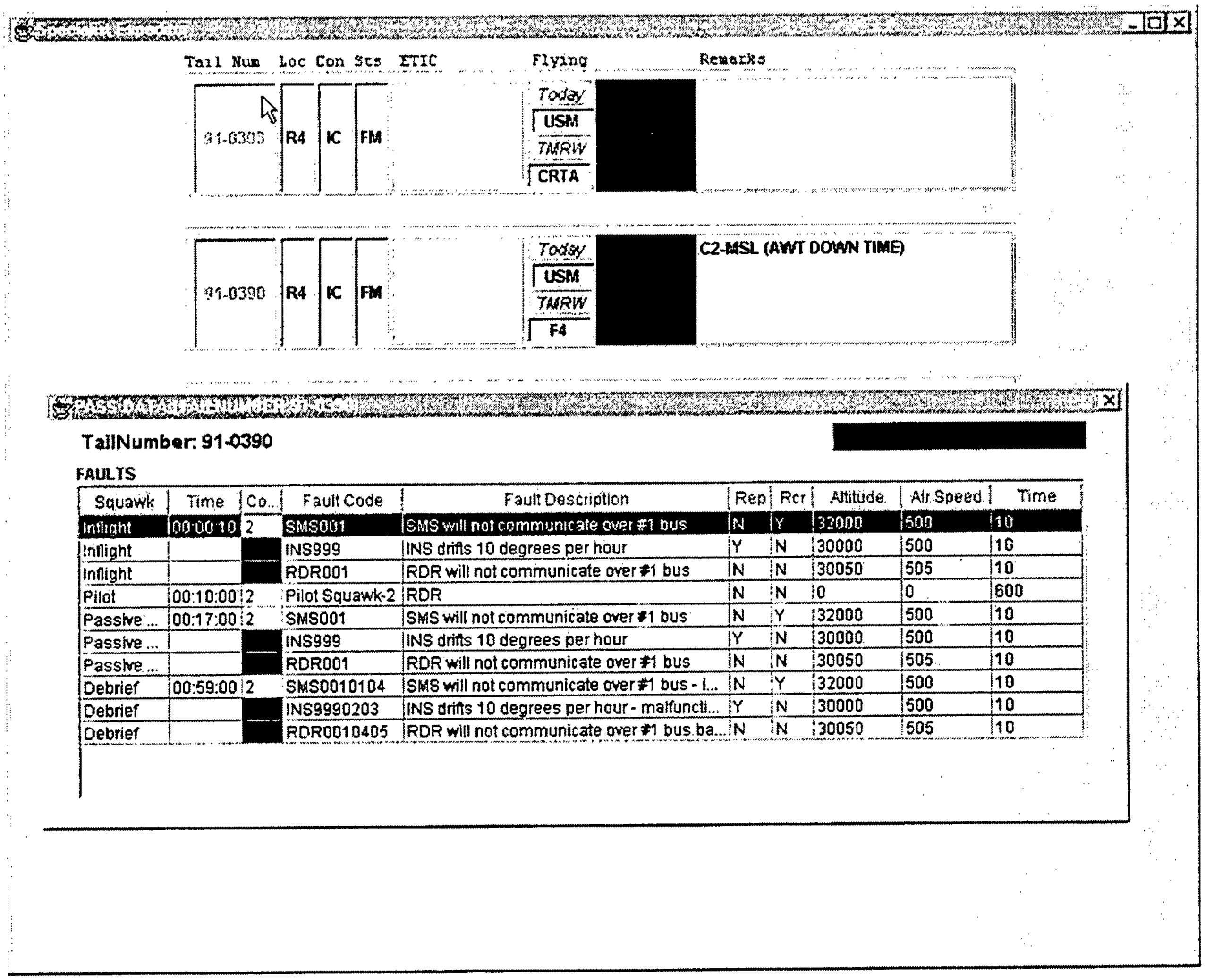

Figure 15 – Specialist PASS Concept Screen

The larger screen labeled Specialist mimics an electronic version of the current grease board or clipboard status sheet used in specialist expediter trucks in today's maintenance environment. A row for all tail numbers assigned to the Specialist appears in this area along with any pre-set scenario data for each plane. The button labeled PASS has been added to the electronic Specialist status sheet. When new PASS data is available, the Specialist may select the PASS button to display the smaller PASS DATA window. The PASS DATA window displays data for a specific tail number. The PASS data available to the Specialist and the privileges (defined in italics) are as follows:

- TailNumber – identifies the tail number the data is detailed for *(Read Only)*.
- Code – The current status of the aircraft as determined by the Pro Super *(Read Only)*.
- Faults *(Read Only)*: The faults indicate the PASS or Pilot data transmitted.

1) Squawk – Indicating type of squawk.

   a. Inflight –Fault codes collected on the aircraft and transmitted via RF link before landing.

   b. Pilot – Normal RF pilot squawk (Code 1,2, or 3 with a subsystem).

   c. Passive Ground – Verification of collected fault data transmitted via RF link at EOR.

   d. Active Ground – Human activated squawk transmitting fault codes via RF link while on the ground. (Used for Ground Abort, Redballs).

   e. Debrief – Detailed fault data and write-ups from debrief processing.

2) Time of squawk – Time the squawk occurred.

3) Code – MESL Code pertaining to this fault code.

4) Fault Code – Alphanumeric code indicating the failure.

5) Fault Description – Word description of the fault.

6) Repeats –Yes, if fault occurred within last flight. No, otherwise.

7) Recur – Yes, if fault occurred within last five flights. No, otherwise.

8) Air Speed – Speed of aircraft when fault occurred.

9) Altitude – Altitude of aircraft when fault occurred.

10) Time – Time when fault occurred.

5.3.5 Weapons Expeditors Screens and Privileges

The Weapons Expeditors Screens are not depicted separately because they are very similar to the specialist expeditor.

5.3.6 Debrief Screens and Privileges

The Debriefer Screens were determined out of scope for this effort.

5.3.7 User Limitations

Users may update or view items based on privileges identified for the user type.

5.4 Databases

5.4.1 Storage and retrieval of data

Data is retrieved through the ClientAccess thread of the WebServer processing. The Java application or applet requests the current situation data for the assigned tailnumbers. The ClientAccess thread identifies a requestor's user type and returns the appropriate information.

Any updates made by a user are stored by the ClientAccess processing and if required, sent to any other user on the system real-time.

5.4.2 Database Limitations

Using InterBase as a local WebServer does not allow the database to be placed on a separate machine from the WebServer logic (i.e. business logic) for remote access. This limitation is discussed in further detail in Section 6.4.

6. CONSIDERATIONS FOR DESIGNING DEPLOYED SYSTEM NOT ADDRESSED IN DEMONSTRATION

Several shortcuts were taken due to the time, schedule, budget, and equipment constraints during the design and implementation of the PASS demonstration. Table 3 – Shortcut and Design Considerations focus on major areas where known shortcuts were taken along with notes on what items should be considered in a full-scale design and implementation of PASS.

Table 3 – Shortcut and Design Considerations

	Shortcut	Design Considerations
6.1 Security	Login accounts for PASS were implemented as a simple database lookup table.	Windows NT accounts or other security measures should be investigated.
	RF transmission was not encrypted.	Due to the nature of the PASS maintenance data, the PASS data should be encrypted via the data-link. Upon selection of PASS equipment, encryption/decryption hardware/software should be investigated.

	Shortcut	Design Considerations
6.2 Users	Screens targeted ProSuper, APG Expeditor, and Specialist.	All levels of Maintenance users can benefit from the PASS concept. Weapons and Debrief were mentioned in the paper in small detail. Backshops, as well as the maintainer all show potential PASS benefit. Other areas such as Operations, MOC and Safety should be considered as benefactors for PASS design, implementation and integration of PASS with IMIS.
	Screens are conceptual.	The screens are conceptual. Actual demonstrations of the PASS demonstration may define other views or ideas. These comments should be tracked and considered for PASS implementation.
	Switchology was not implemented for the Specialist menus.	Switchology needs to be addressed when defining the data collection requirements for PASS implementation.
	Flight duration was not addressed in conceptual screens.	Many maintenance schedules are mandated by flight time. Debriefers expressed the requirement for a Weight Off Wheels time entry and a Weight On Wheels time entry as part of PASS implementation. This would aid in consistent flight duration calculations throughout the maintenance process and alleviate small additions of flight times (i.e. 5 minutes) being added to flight logs decreasing maintenance intervals over time.
	Flight Parameters/Switchology	Switchology was also a desire for the Specialists. Due to time and schedule a limited set of flight parameters were defined. For PASS design and implementation, more in-depth investigation of the available flight parameters and switchology needed is required.

	Shortcut	Design Considerations
6.3 RF Data Link Integrity/Error Checking	The scenario data from the simulation to the WebServer is only sent once without error checking.	The data link selected most probably will have checksum, parity, or other type of error checking. Any software design effort for PASS must take error checking and data integrity into consideration.
6.4 Generality, Customizability and Maintainability of System	Screens target one platform and one configuration.	The screens are configured for one ProSuper working a squadron of F-16CJ aircraft. The ProSuper staff consists of two APG Expeditors, one Specialist Expeditor, one Weapons Expeditor, and one Debriefer. This configuration is not applicable base wide. The Maintenance staff should be fully customizable in a PASS implementation to fit any staff configuration.
	Screen information is standardized across all screens as a set configuration.	The detailed data in the table should allow for sort, selection, and filter capabilities. This would give a more customized and less cluttered view of the data of interest. Drill-down screens may even be explored.
	The InterBase version implemented is packaged with JBuilder and is local version only. This limits the database to no remote database access.	The InterBase local server meets the requirements for the PASS demonstration, but limits the flexibility of the design for full PASS implementation. For full PASS implementation, many other database products are available and should be evaluated for best performance and other PASS requirements.
	InterBase version is local access only.	For PASS implementation, especially for the integration of PASS with IMIS type legacy systems, conclusive studies should be performed on commercially available databases such as Oracle, SQL Server, and the full version of InterBase to ensure a complete enterprise PASS implementation can be obtained. The PASSReceiver database should ultimately reside on a separate machine from the WebServer.

	Shortcut	Design Considerations
6.5 Integration with IMIS and IMDS Systems	Status data such as flight schedule, location etc existing in the top-level menus for the users explored are simulated data.	For full PASS implementation benefits, PASS must integrate seamlessly with the legacy systems. These systems include, but are not limited to, IMIS, IMDS, CAMS, CFRS, and GO81. The integration of the entire information network must be considered for both a home base and deployed system.
6.6 WebServer	The Microsoft IIS application was selected due to the availability and requirement for a WebServer.	For full PASS implementation, many other WebServers are available and should be evaluated for best performance and other PASS requirements.

7. SUMMARY

The PASS demonstration design encapsulates and provides a means to show how PASS could benefit today's maintenance environment. The benefits of PASS may also be applied to the forthcoming paperless maintenance environment, such as the F-22 platform.

The PASS demonstration allows pre-generated scenarios to be executed, demonstrating real time situational displays of how and when PASS data is made available to various levels of maintenance users at different phases of the launch/recovery maintenance process.

With proper scenario generation, the PASS demonstration can realistically show the benefits of a PASS implementation in any maintenance environment. The PASS demonstration lays the groundwork for a full-scale PASS implementation.

8. REFERENCES

- Passive Aircraft Status System (PASS) Technology Review and Data Collection, Report #AFRL-HE-WP-TR-2000-0143, AD-B264777.
- Passive Aircraft Status System (PASS) Design and Analysis (Report to be published at a later date).