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Sensor Technology and Futuristic Of Fighter Aircraft

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ABSTRACT
The Next Generation fighter Aircraft seeks a fighter with higher abilities in areas such as reach, persistence, survivability, net-centricity, situation awareness, human system integration and weapons effects. The future system will have to counter foe armed with next generation advanced electronic attack,sophisticated integrated air defense systems, directed energy weapons,passive detection, integrated self-protection and cyber-attack capabilities. It must be capable to operate in the anti-access area-denial (A2/AD) environment that will exist in the next coming years.

I. INTRODUCTION

Current and future military missions require modern aircraft equipped with high-performance avionics from tip to tail. Militaries worldwide are growing increasingly reliant on manned and unmanned military aircraft for the performance of a large number of functions-from intelligence, surveillance, and reconnaissance (ISR) to precision weapons delivery on a specific target. Multi-mode radars and electro-optic sensors in a federated conventional 1553 B architecture integrates various functions of the general system, Flight control system, Engine Control system and weapon systems in addition to conventional avionics functions like communication, Navigation and Identification. Avionics and electronics technology firms are answering the call for compact, airborne systems capable of delivering robust processing power, mission-critical communications, high-resolution targeting imagery, and situational awareness.[1][2]

Sensor technology is advancing rapidly and driving aerospace and defense electronics design, and the ever-increasing use of airborne sensors is driving the need for more capable and compact military electronics with which to process, share, and exploit the data acquired. Just as militaries are employing more sensors than ever before, military aircraft are donning more advanced sensors as a result, warfighters and avionics are often inundated with information and in need of more robust processing and data handling systems.[3]

The ever increasing user requirements, the ever changing threat environment, the increased volume data available on the aircraft from on board systems, on external threat environment through data link on board sensors and the ever growing of new technologies constitute a set of challenges by which Avionics systems designers are facing in current and next generation.[3]

I.1. Problem Statement

When we say futuristic fighter aircraft, the first things comes in our mind is 6th generation of fighter jets. The 6th generation jet will likely be able to take on multiple roles away from air superiority missions, just like the superiority jets of today (4th and 5th generation). In this paper we will discuss on the Challenges in avionics and the role that sensor technologies will play in future fighter aircraft. I read different journals, books and different recent papers. During the writing of this paper the big issue I met is the lack of sufficient materials as these still in debate projects.

I.2. Scope of Study

This paper discuss about the Challenges in avionics and sensor technologies in futuristic fighter aircraft. We will therefore not look at other important types of military aircraft, such as long range bombers or ground attack aircraft. Likewise, the paper will not answer the question whether a future combat aircraft will be manned or optionally unmanned or even fully unmanned.

II. LITERATURE REVIEW

Currently, the Alliance as a whole dominates an edge in terms of air superiority with its 4.5th- and 5th-generation jets. The F-35, F-22, Rafale and the Eurofighter Typhoon will embody the most capable Allied fighter jets for the next three decades at least. However, in recent years, other states have been working to equal, overcome, or counter this dominance. [3][4]

The most intuitive way to achieve these goals is to develop combat aircraft that can take part with Allied fighter jets, and, indeed, different states are developing jets (aircrafts) to compete with them. First and foremost, Russian and Chinese defense companies have made significant strides in developing stealth fighters.

Russia possesses the utmost sophisticated military aviation industry after the United States. It has a number of aircraft in its fleet that vie to be competitive with Allied fighter jets of the 4.5th and 5th generation. The derivatives of the Sukhoi Su-27 Flanker are the most advanced fighters in this generation. The Su-30 Flanker C, for example, structures advanced technology such as long-range phase-array radar and thrust vectoring. Variants have been sold to China, India, and Venezuela among others. The Su-35 Flanker E has even more advanced sensors which some experts believe are powerful in detecting low-observable aircraft. Most importantly, however, Russia is working on the Sukhoi PAK FA. Its prototype, called the T50, first flew in January 2010. The PAK FA is a stealth fighter developed in co-operation with India and aims to compete with the F-22 and F-35 in terms of capabilities. Indeed, some analysts believe that the PAK FA could outperform the F-35. Russia believes that it can be introduced in 2015/2016. [5][6]

China’s military has introduced a number of modern aircraft into its arsenal over last decade, including the Chengdu FC-1/PAC JF-17, which was developed jointly with Pakistan, and the Chengdu J-10, both 4.5th-generation aircraft. In addition, Chinese defense companies are also working on two stealth aircraft simultaneously: the Chengdu J-20 and the Shenyang J-31. The Chinese military is very secretive about these aircraft, and thus not much is known about them publicly. The J-20 will be the more advanced fighter jet of the two. It had its maiden flight in January 2011. Most experts believe that it is less capable than US or Russian 5th-generation fighters, but in the absence of more hard data this is difficult to judge. The J-31 is shrouded in even more mystery since it only made its first flight in October 2012. It is unclear at this stage who the user in the Chinese military will be, but it seems convinced that it will be exported as well. Estimates of when these aircraft will be operational are still uncertain, but the time frames 2017 - 2019 for the J-20 and 2020-2027 for the J-31 have been put forward.

Both the Russian and Chinese 5th-generation programs underline that the Allied advantage in stealth technology could erode or indeed be equaled in the future. Other states might follow in the longer term. However, developing new combat aircraft is very expensive and complex. Therefore, a number of states are seeking to nullify the advantages of Allied air power (and their military power in general) through so-called anti-access and area denial (A2/AD) concepts and capabilities. In the air domain, anti-access and area denial aims to prevent air forces from entering and transiting specific air spaces and thereby to deter opponents. A2/AD is an asymmetric and thus much cheaper approach than the symmetric balancing of military capabilities. [5][6]

Highly sophisticated Integrated Air Defense Systems (IADS) are the cornerstone of air A2/AD strategies. In recent decades, NATO Allies have relied on four principle ways to defeat such air defenses: airborne systems to locate them; anti-radiation missiles, guided bombs and cruise missiles to destroy them; electronic counter-measures to jam them; and stealth technology to evade them. However, recent advances in IADS are posing serious risks to Allied aircraft. This applies in particular to the 4th and 5th generation, but even stealthy aircraft might soon become vulnerable. For example, some experts suggest that, already today, the F-35 cannot reliably as evade the most sophisticated IADS.

The Key technologies in this regard are being developed by the Russian defense industry, which has excelled in building air defense for a long time. Still, the Chinese industry is trying to catch up, and other countries are making progress on this front as well. In the future, Integrated Air Defense Systems (IADS) will likely presents some or all of the following traits:

- higher mobility
- better jamming resistance
- phased array antenna technology, with AESA radars on the horizon
- increased missile range and radar power
- capability to operate in lower radar bands to defeat stealth technology
- better exploitation of hardware and software advances
- enhanced defensive counter-measures
- increased capability to intercept smart weapons
- alternative missile seekers
- techniques to make sure that they will be hard to detect by incoming aircraft
- hybridization of systems, combining anti-aircraft artillery and surface-to-air missiles

Due to emerging technologies in the areas of faster processors, higher packaging densities, passive electro-optic sensors, active phased array radars with covert waveforms as well as faster and efficient signal processing and data fusion algorithms; more functions and higher capabilities can be incorporated in futuristic combat aircraft (Next generation). This section has shown that developments exist that, if they meet or exceed expectations as shown in above characteristics and could undermine this current superiority.[6]

III. TECHNOLOGICAL TRENDS AND THE FUTURE OF FIGHTER AIRCRAFT

Naturally, at such an early stage of thinking about a 6th-generation combat aircraft, the precise capabilities and requirements of such an aircraft are still very much subject to debate. Indeed, the next few years' work on a future fighter jet will be devoted to exploring possibilities and clarifying what such a jet should be able to accomplish. Still, most experts converge around a few general features:

- extreme stealth, e.g. the jets should be stealthy across a greater range of spectrums
- engine efficiency at all flight speeds, from subsonic to multi-Mach speeds
- advanced exterior skin constructed with nano-technology and meta-material, i.e. material engineered to exhibit properties not found in nature
- exceptionally powerful computer networking and communication capabilities
- extremely sensitive sensors
- the option of unmanned flight
- advanced weapon systems, possibly lasers and other directed energy weapons

The US Department of Defense has released a 30-year aircraft procurement plan for the Air Force and Navy which includes the possibility of a 6th-generation aircraft. Indeed, both the US

Air Force and Navy are working on projects dubbed respectively Next Generation Tactical Aircraft and Next Generation Air Dominance, with concept jets named F-X and F/A-XX. Both have reached out to industry to gather information on where they see the future to be headed, but the outlines of such next-generation efforts are still very abstract. For the US Air Force, requirements include enhanced capabilities in terms of distance, persistence (fuel efficiency), survivability, net-centricity (capable of networking in a joint and/or combined force), sustained awareness through advanced sensors and radars, better interconnection between a pilot and the computer systems, and advanced weapon systems. Both initiatives outline preliminary research, but nothing that resembles a production or even merely a prototype platform. Some experts suggest that neither service currently has the appetite for an expensive combat aircraft development program, given the current budgetary environment and past experiences with cost overruns. In fact, under both program, it is possible that sufficiently upgraded F-35 could fill the position of such next-generation capabilities.

The possibility of a 6th-generation aircraft program is also highly dependent on developments within the US aerospace and defense industry. The mission requirements of jet fighters will be increasingly shaped by technologies that are currently undergoing exponential advances. Rapidly evolving computer hardware and software, sensors, stealth, materials, and weapons are making current technologies outdated in a matter of years. At the same time, advances in structural and engine designs for aircraft remain relatively static. In other words, a future program risks becoming out of date before an air frame is developed. [5][6]

III.1. Sensors

Today, integrated sensors on 5th-generation aircraft give pilots 360-degree vision, electro-optical scanning, and targeting abilities to locate and track enemy forces. Pilots use this system to identify fixed and moving targets simultaneously, covering large areas around the aircraft. The F-35, for example, has one nose radar and five electro-optical sensors placed around the plane. 5th-generation aircraft also work as information gatherers that instantly send all their sensor feeds back to the command centre.

Next-generation aircraft will combine all of these features into a more detailed and comprehensive system. The range of the sensors will dramatically increase as well as their ability to recognize relevant battle developments and process complex mission planning. Instead of separate sensors and radar, the entire skin of a 6th generation fighter could function as a large integrated sensor. Through improvements in nano-technology and composite skins, sensor capabilities could be embedded in areas of a jet previously off-limits due to heat and surface reasons. This would present a much more comprehensive view of the battlefield.

Sensors dominate not only the digital battlefield, but also manned and unmanned military airframes. Engineers are installing "more and more sensors around the airframe," The sensor skin would give the plane increased processing capabilities and possibly automatic target recognition capabilities. In short, the aircraft would be able to automatically identify objects, buildings, and even people.[2][8]

III.2. The Network

Fighter jets of the 6th generation will likely advance network centric warfare substantially. A fighter jet will serve as an individual network command centre, continuously determining mission prerogatives and transmitting them to own or allied unmanned aerial, ground, and naval vehicles. Such jets will have the capacity to operate numerous unmanned aerial vehicles (UAVs) conceived for more specific tasks, which will accompany the plane in group formations. These UAV wingmen could take verbal instructions and be able to complete complex tasks. [2]

III.3. Data Fusion Demand

One of the biggest enhancements happening now and going forward is that avionics are doing a better job of providing an integrated situational awareness picture for the pilot, Instead of the pilot having to look at data from the radar and infrared or EW sensors and then put all the data together, the processing capability now going on military aircraft enables that whole process to be done automatically so that the pilot is seeing the complete situational awareness picture without having to fuse the data himself."

Platforms are much more highly integrated and have much higher levels of data fusion-all for the purpose of reducing pilot workload so they can better focus on the mission at hand and reduce the need to do the data analysis by checking three or four different sensors or instruments. Older avionics architectures had independent systems, each with its own displays; now, we are seeing integrated and network centric systems fusing data and presenting the combined data on a single display for the pilot to access more quickly and efficiently.

This capability is a game changer for military pilots, lending to faster, better informed decisions.[2][8]

III.4. Factors To Be Considered During The Development Of Fighter Aircraft

Many factors are needed with each other and the fine balance has to be achieved to obtain optimum design. The figure below describes the various factors to be considered during the development of fighter aircraft and the factors to be considered in Avionics System design are described in subsequent paragraphs.[4]

III.4.1. Electromagnetic environment

Military operations are executed in an information environment increasingly complicated by the electromagnetic (EM) spectrum. The portion of the information environment is referred to as the electromagnetic environment (EME). The recognized need for military forces to have unimpeded access to and use of the electromagnetic environment creates vulnerabilities and opportunities for electronic warfare (EW) in support of military operations.

To prevent against EM threat such as lighting strikes, High power microwave and EMI from high power emitters, these have to be considered in early design stage at the Life raft Unit(LRU) level and at the aircraft level.

Among their many other advantages, Fiber Optics are completely immune to EMI. Which means the evolution of fly-by-wire systems to fly-by-light systems not only expands data carrying capacity and reduces the weight of interconnect cabling, but it also eliminates the many risks and problems of electromagnetic interference. The Electromagnetic compatibility (EMC) and the Electromagnetic Pulse (EMP) design should be optimised with the use of analytical tools for PCB design to minimize emission /susceptibility at the printed circuit board (PCB) component level. [4][8]

III.4.2. Electronic warfare (EW) environment

[4]Electronic warfare is any military action involving the use of the EM spectrum to include directed energy (DE) to control the EM spectrum or to attack an enemy. This is not limited to radio or radar frequencies but includes IR, visible, ultraviolet, and other less used portions of the EM spectrum. This includes self-protection, standoff, and escort jamming, and antiradiation attacks. EW is a specialized tool that enhances many air and space functions at multiple levels of conflict

The purpose of EW is to deny the opponent an advantage in theEM spectrumand ensure friendly unimpeded access to the EM spectrum portion of the information environment. EW can be applied from air, sea, land, and space by manned and unmanned systems. EW is employed to support military operations involving various levels of detection, denial, deception, disruption, degradation, protection, and destruction.

EW contributes to the success of information operations (IO) by using offensive and defensive tactics and techniques in a variety of combinations to shape, disrupt, and exploit adversarial use of the EM spectrum while protecting friendly freedom of action in that spectrum. Expanding reliance on the EM spectrum increases both the potential and the challenges of EW in information operations. All of the core, supporting, and related information operations capabilities either directly use EW or indirectly benefit from EW.

The principal EW activities have been developed over time to exploit the opportunities and vulnerabilities that are inherent in the physics of EM energy. Activities used in EW include: electro-optical, infrared and radio frequency countermeasures; EM compatibility and deception; EM hardening, interference, intrusion, and jamming; electronic masking, probing, reconnaissance, and intelligence; electronics security; EW reprogramming; emission control;

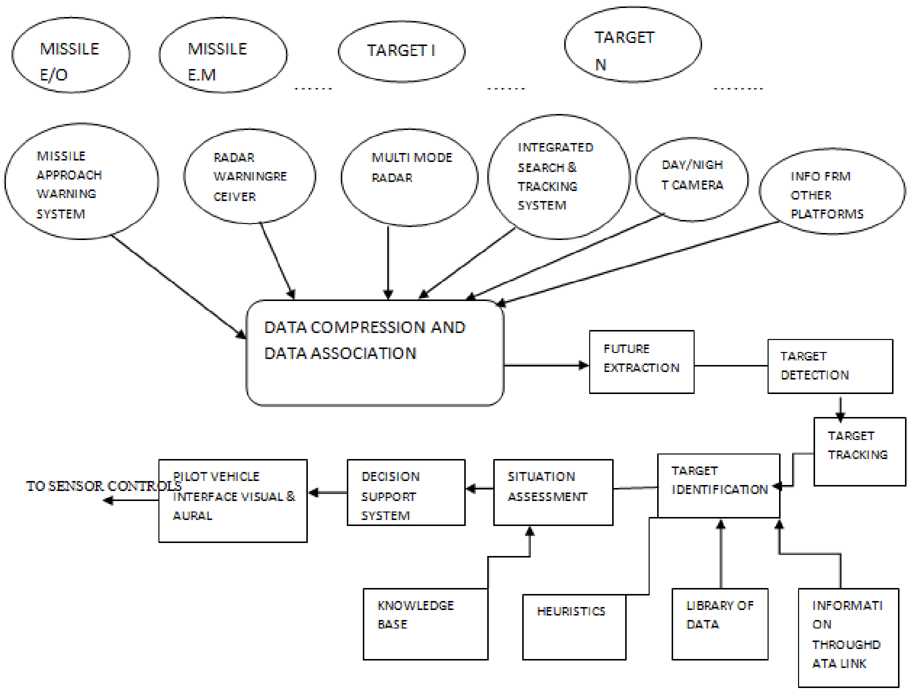
spectrum management; and wartime reserve modes Electronic warfare includes three major subdivisions: electronic attack (EA), electronic protection (EP), and electronic warfare support (ES).[1]

Electronic attack involves the use of EM energy, directed energy, or antiradiation weapons to attack personnel, facilities, or equipment with the intent of degrading, neutralizing, or destroying enemy combat capability.

Electronic protection involves actions taken to protect personnel, facilities, and equipment from any effects of friendly or enemy use of the electromagnetic spectrum that degrade, neutralize, or destroy friendly combat capability.

Electronic warfare support is the subdivision of EW involving actions tasked by, or under direct control of, an operational commander to search for, intercept, identify, and locate or localize sources of intentional and unintentional radiated EM energy for the purpose of immediate threat recognition, targeting, planning, and conduct of future operations

Briefly, the most profound effects of the EW threat is the necessity to go in for passive sensors like IR Search and Tracking (IRST) system. With powerful radar warning receivers capable of detecting and identifying radar in real time (escort jamming): the radars can be detected, located, identified and jammed. However IRST cannot give accurate range and position information, which can be provided only by a modern Multi Mode Radar. Hence fighter aircraft pilots will have to evolve suitable tactics to use IRST as basic surveillance device with Radar used to illuminate only targets of interest for brief period to obtain more accurate information. Towed Radar and IR decoys are being used in modern fighter aircraft as an Electronic CounterCountermeasure (ECCM). The following figure shows the typical multi sensor data fusion system for fighter aircraft.



III.4.3. Electro optic Environment and Missile Threat

A recent and future advancement in missile guidance is the introduction of **electrooptical** sensors. This scans designated area for targets via optical imaging. Once a target is acquired, the missile will lock-on to it for the kill. Electro-optical seekers can be programmed to target vital area of an aircraft, such as the cockpit. Air-to-air missiles are typically long, thin cylinders in order to reduce their cross section and thus minimize drag at the high speeds at which they travel.[4][8]

Missiles are divided into five primary systems: seeker, guidance, warhead, rocket motor, and control actuation.At the front is the seeker, either a radar system, radar homer, or infra-red detector. Behind that lies the avionics which control the missile. Typically after that, in the centre of the missile, is the warhead, usually several kilograms of high explosive surrounded by metal that fragments on detonation (or in some cases, pre-fragmented metal).

Depending on the launch phase, both IR and UV band Missile Approach Warning (MAW) receiver may have to be used; this last measures

accurately the angle of arrival of missile, so that the pilot can take control of the action or use DMIR (Directional Modulated Infra Red) beam jammer.
All the EW resources such as RWR, MAWS, LWR and IR jammer have to be integrated into a coherent EW suite. And, this EW suite has to be integrated with other sensors such as radar and IRST as well as threat information obtained from ground based and airborne platforms through data link, to present threat scenario to pilot through data fusion.

III.4.4. Stealth Environment

As the technology keep growing in fighter aircraft, stealth aircrafts are designed to avoid detection using a variety of advanced technologies that reduce reflection/emission of radar, IR, visible light, radio frequency spectrum, and audio, collectively known as stealth technology.

III.4.5. Methods of avoiding detection

One of the main efforts taken by designers of the stealth aircraft is to carry the weapons payload of the aircraft internally. This has shown that carrying weapons internally can considerably decrease the radar cross-section of the aircraft. Bombs and Missiles have a tendency to reflect the incoming radar waves to a higher extent. Thus the missiles are carried in internal bombs which are opened only when the weapons are released. On the other hand passive sensors like IRST will increase the stealth capabilities of aircraft and to decrease the radar cross section of aircraft, antenna and electro optic sensors will have to be conformal with aircraft structure.

Fighter aircraft use another method of avoiding detection for a very long time. Ground Radars can use the radar waves or electro-magnetic energy of planes radar and locate it. An aircraft can remain undetected just by turning off his radar. In case of some of the modern stealth aircraft, it uses its wingman in tandem to track its target and destroy it. It is done in the following way: The fighter, which is going to attack moves forward, the wingman (the second aircraft) on the other hand remains at a safe distance from the target which the other fighter is approaching. The wingman provides the other fighter with the radar location of the enemy aircraft by a secured IFDL (In Flight Data Link). Thus the enemy radar is only able to detect the wingman while the attacking fighter approaches the enemy without making any sharp turns. This is done not to make any sudden variations in a stealth aircraft's radar signature. Thus the fighter, who moves forward, is able to attack the enemy without being detected.

For the next generation, many projects remain over the horizon that will use stealth technology as its primary capability. They come from some of the most unlikely contenders. These projects include the Euro JSF, which will be designed by the team that developed the EF-2000. Russia is stepping forward with its LFS project with the S-54 and other designs. Two new entries into this field will be India and China. India will be introducing its Advanced Medium Combat Aircraft (AMCA), which is a twin engine fighter without vertical stabilizers. This fighter will use thrust vectoring instead of rudders. China will be introducing the J-12 (F-12/XXJ) which is equivalent to US fighter F-22.

Stealth technology is clearly the future of air combat. In the future, as air defense systems grow more accurate and deadly, stealth technology can be a factor for a decisive by a country over the other. In the future, stealth technology will not only be incorporated in fighters and bombers but also in ships, helicopters and transport planes.[4][8]

III.4.6. Pilot Vehicle Interface (PVI)

The 5th and 6th generation for fighter aircraft present an optimal Pilot Vehicle Interface (PVI) which can decrease pilot workload and increase situation awareness (internal and external), this is a critical factor in future combat aircrafts.

Modern and future PVI is made by digital glass cockpit systems use liquid crystal display (LCD) screens to display critical flight information, although in early examples bulky cathode ray tube (CRT) monitors were used. Also known by a variety of similar acronyms such as electronic flight information systems (EFIS) and cockpit display system (CDS), glass cockpit displays are usually based around primary flight displays (PFDs) engine indications and crew alerting system (EICAS) and multifunction displays (MFDs), which allow clusters of mechanical flight instrument gauges to be replaced with graphical representations of information from onboard and external sensors and navigation systems.

Another revolution in PVI is the use of the voice Interactive System which will result in decreased pilot workload. These voice command systems are present speaker dependent with limited vocabulary of 100-200 words. Recognition performance in the noise cockpit environment is 95% to 98%. As the result of this limitation the voice command system can be used only for non critical system. Critical commands such as missile fire will still be by a switch in the cockpit or control stick. In the future with improvements in speech signal processing techniques, the vocabulary could increase with 100% recognition performance achieved.[4][8]

III.4.7. Survivability

Aircraft combat survivability (ACS) is defined as the capability of an aircraft to avoid or withstand a man-made hostile environment. It can be measured by the probability the aircraft survives an encounter (combat) with the environment. The more general term **aircraft survivability** refers to the capability of an aircraft to avoid or withstand hostile environments, including both man-made and naturally occuring environments, such as lightning strikes, mid-air collisions, and crashes. The more traditional discipline known as **system safety** attempts to minimize those conditions known as hazards that can lead to a mishap in environments that are not made hostile by man. Thus, together, the system safety and survivability disciplines attempt to maintain safe operation and maximize the survival of aircraft in all environments in both peacetime and wartime. For the hardware and software points of view, redundancy, fault tolerant computing and reconfigurable architecture have to be considered to increase aircraft survivability [4][8]

III.4.8. Availability / maintainability

As availability is defined as the mission capable rate and the maintainability as ease with which a product can be maintained in order to isolate and correct defects or their cause or other different characteristics these factors have to be taken into consideration in avionics systems design and in fighter aircrafts design.

Redundancy and fault tolerant computing also result in higher availability of the system. The Mean time between failure (MTBF) can be achieved by decreasing power dissipation with consequent reduction in temperature rise of component. The use of common hardware modules help in improving availability and maintainability.

The advanced modern avionics equipment are based on microprocessor and microcontroller; all system and LRUS have Built-In-Test (BIT). The power-on BIT helps in ascertaining the health of an LRU at power on. The pilot initiated BIT help in find out the health of a LRU on ground or during flight. The continuous built in test during the Operation Flight Profile (OFP) helps in detecting fault during flight and flight failure reports can be generated which help in diagnosing fault after a flight.

Extensive test can be carried out on the aircraft without removing the LRU to pin point faults of LRUs and PCBs using Maintenance BIT activated from the cockpit by the maintenance engineer.[4][8]

III.4.9. Upgradability

An open architecture using VME (Versa Module Europa) bus and the use of standard 1553B and 1760 bus enable easy upgradation. Modular hardware and software elements also help in upgrading hardware and software easily. While designing LRUs spare processing capacity 50% and spare memory capacity 50% is mandatory to ensure upgradability. [4][8]

IV. CHALLENGES IN AVIONICS

Today DOD is being challenged to do more with less. This has focused attention on affordability opportunities and challenges with emphasis on combat and commercial-based avionics and electronics. The life of older (legacy) aircraft is being extended while their avionics systems are becoming obsolete, and more difficult and expensive to maintain and support. New aircraft also need to be more affordable and have functionality and performance equal to or exceeding that of existing systems. Lower upgrade and support costs for existing aircraft and lower acquisition and support costs for next generation avionics systems, are primary challenges [8]

IV.1. CHALLENGES IN HARDWARE

The present challenges is the primitive of various VLSI components. Hence part management becomes a major challenge to LRU designer, The other challenge is the no availability of MILSDT components this is both a problem and blessing that the LRU engineers are facing but the cost comes down by an order of magnitude. The other challenges that avionics facing in hardware is the use of modular Line Replaceable Modules (LRM) in reconfigurable Integrated Modular Avionics architecture. Architecture built around MIL-STD 1553B is driven by cost consideration, commonly used commercial open standards like VME 64 are finding favour.

The only way to overcome the problem of primitives of electronic hardware is to adopt open standard/open architecture, This has the advantages of availability of low cost standard commercial card and if we take an example of VME-64 Bus is open system architecture appears to be the route chosen by European agencies. Other one is like OSMAC which is the open architecture Mission Computer developed in UK, NATO has also taken the lead in Program of standardization called ASAAC (allied standard avionics architecture council).

The following are the common modules which fit into the open architecture:

1. Common Integrated Processor (CIP) built around a powerful processor like 68040/68060, Pentium II or Power PC

2. Common Data processor Module
3. Common Graphic processor modules
4. Common IF modules
5. 1553 Bus controller/Remote terminal Modules
6. Signal processor modules etc

Common IF modules and common LO modules require that the RF design should take care of commonality at initial design stage. Candidates for common RF modules includes Radar, Radio altimeter EW (RWR), data link, V/UHF communication, satellite data link etc.

The use of common Hardware module, contain amount of extra overheads may have to be accepted as penalty. However, open source architecture take care of processor primitives, One area for commonality being considered is JSF multifunction nose array with standard apertures for communication, Navigation , identification equipment and for EW system and radar. [8]

IV.2. CHALLENGES IN SOFTWARE

Software has become the pacing element in the development and modernization of military avionics systems,

Technology trends in weapon systems are driving exponential growth in software complexity Autonomous systems, adaptive systems, fault-tolerant systems etc. Traditional approaches and processes do not scale well, program-specific architectures, languages, tools unaligned with commercial practices; the high turnover in defense software workforce and ad-hoc knowledge management for legacy systems constantly climbing the learning curve.

In modern high software intensive Avionics and sensor suite for fighter aircraft, the cost of development, testing and maintenance of software can be substantial. Any savings in cost by using better software engineering methodology and using common re-usable software modules is the desired approach. Then development of large real time software avionics should be done using software component like hardware integrated computer solution (ICS) software, printed circuit board (PCBs) are called frameworks. Such approach leads to shorter development time, lower cost and easy maintainability. Because The use of such reusable library of software modules can leads to some penalties in the form of slower response

Some of common software modules are listed below:

- ❖ 1553B Bus controller/ Remote Terminal S/W
- ❖ Library of basic cursive symbology for MFD
- ❖ Navigation function modules
- ❖ Common Data acquisation

etc

More powerful Case tools will reduce development cycle time. Such as Case tool allow easier generation of documents, easier testing and configuration of software and easier maintenance of software. The real time embedded mission software is considered to be generally not safety critical, it is desirable to build in some amount of fault tolerance in the avionics software. However a method called Data Fusion Integrity Processor (DFIP) has been suggested as simple cost effective technique for mission critical system. [4][8]

IV.3. CHALLENGES IN SENSOR TECHNOLOGY

The avionics and sensors program was established to evaluate emerging avionics and sensors technologies, and to assess the capabilities of current integrated and nonintegrated aircraft avionics, sensor systems, and support equipment.

Stealth and passive sensors technologies are very important in fighter aircraft IR, IRST and MAW are the most considerable sensor, to keep in view requirements of stealth and cost reduction, IR sensors have be conformal and preferably shared between various system, these would allow functions of missile warning, air to air search and track and air to ground navigation these set of passive sensors reduce cost and weight. The good example is Northrop Grummawhic has launched development of distributed architecture IR system DIRS for JSF.

This use six conformal staring array IR sensor, each with 90 degrees to 90 degrees field of view ,distributed around the airframe to provide 360 degree coverage. The 1000*1000 focal plane array can provide high resolution FLIR imagery in the HUD and also angle of arrival information from MAWS and IRST.

In the area of inertial sensors, Ring Laser Gyro (RLG) have displaced old horse spanning mass gyros and the Fiber Optic Gyro (FOG) are the threatening the supremacy of RLG INS. The fighter aircraft with FOG drift of 0.01 deg/hour is likely to be available in few next year, the advantages of FOG is the easier manufacturing and less cost and FOG INS with differential GPS can improve accuracy and aids in landing at air field which do not have ILS facilities. With further improvements predicted for DGPS, it is expected that DGPS will be used for landing without the help of ILS.

In future, Optical Gyros may be challenged by microelectronic gyros which utilizes vibrating mass fabricated on silicon chip and with the accelerometer on silicon ship also a truly monolithic INS sensor system may evolve in future. [4][8]

V. CONCLUSION

The rapid advances in technologies of Microelectronics, fast processor and sensor technologies coupled with the user requirements, to counter the emerging threat scenario which imposes severe demands on the avionics system design. The EW and missile threat scenario of the future will impose restriction on active sensors such as radars paving the way for increased use of passive Electro-optic Sensors such as IRST and MAWS. Advances in stealth technology will improve the requirements for covert waveform in all transmitters and use of conformal antennas. Large LCD displays in the cockpit unifying the sensor imagery from various sensors will be a reality enabling the pilot to have realistic situation awareness. While the technologies listed above are mostly evolutionary in nature, it is difficult to forecast the changes in fighter aircraft avionics and sensors in a long term perspective. Smart sensors and smart antenna arrays with adaptive properties would be embedded in the structures. An era utilizing nano technologies and molecular electronics, circuit themselves could be embedded inside the structure and the laser to Pilot being real, a window cockpit could be visualized.

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