SREE NARAYANA GURUKULAM COLLEGE OF ENGINEERING
KOLENCHERY

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Seminar Report
On

AIRBORNE INTERNET

Submitted by:

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DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

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CERTIFICATE

Certified that the seminar project entitled ***Airborne Internet*** *has been successfully completed by* ***Aravind. S.*** *of eighth semester, in partial fulfillment of the requirements for the award of the Degree of Bachelor of Technology in Computer Science and Engineering by M G University, during the academic year 2006.*

Head of Computer Science &Engineering Department	**Staff In Charge Computer Science & Engineering Department**

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ARAVIND.S.

AIRBORNE INTERNET

Abstract

Airborne Internet (A.I.) is an approach to provide a general purpose, multi-application data channel to aviation. It is a concept that adopts modern network theory and principles into the transportation realm, creating a system in which aircraft and people in transit will be connected with a scalable, general purpose, and multi-application aviation data channel. A.I. began as a supporting technology for NASA's Small Aircraft Transportation System (SATS

The ***principle*** behind the A.I. is to establish a robust, reliable, and available digital data channel to aircraft. Establishing the general purpose, multi-application digital data channel connection to the aircraft is analogous to the connection of a desktop computer to its local area network, or to Internet. A primary application for A.I. is to track aircraft for the air traffic control system. Many other applications can utilize the same A.I. data channel. Secondly, it helps in accurately determining an aircraft's position

Airborne Internet Consortium (AIC) is a nonprofit research organization composed of aviation sector participants that collaboratively research, develop, and promote open standards and Internet protocols for aviation digital communications. With the availability of Internet technologies to all sectors of aviation from commercial to general aviation, from the flight deck to the cabin, and from flight-related tasks to entertainment, dramatic increases in communication and transportation mobility will be achieved. Internet protocols and services will make aircraft easier to fly with more situational awareness, safety, and security.

Airborne Internet has the potential to change the way aircraft receive and send data, or more appropriately, information. A.I. will provide an interconnected digital data network between aircraft and to/from the ground. A.I. has the potential to change how aircraft are monitored and tracked by the air traffic control system, how they exchange information with and about other aircraft.

INDEX

Airborne Internet

Airborne Internet (A.I.) is an approach to provide a general purpose, multi-application data channel to aviation. In doing so, A.I. has the potential to provide significant cost savings for aircraft operators and the FAA, as it allows the consolidation of many functions into a common data channel.

A primary application for A.I. is to track aircraft for the air traffic control system. Many other applications can utilize the same A.I. data channel. The applications available are only limited by the bandwidth available. A.I. began as a supporting technology for NASA's Small Aircraft Transportation System (SATS). But there is no reason that A.I. should be limited to SATS-class aircraft. All of aviation, and even transportation, has the potential to benefit from A.I.

The principle behind the A.I. is to establish a robust, reliable, and available digital data channel to aircraft. Establishing the general purpose, multi-application digital data channel connection to the aircraft is analogous to the connection of a desktop computer to its local area network, or even the wide area network we call the Internet. But aircraft are mobile objects. Therefore, mobile routing is required to maintain the data channel connectivity while the aircraft moves from region to region.

The desktop computer, whether used in the office or the home, runs many different applications that can all use the same data channel. The applications are designed around the Internet Protocol (IP) standard to take advantage of the existence of the network connection to the computer. Airborne Internet is built upon the same model. A.I. will provide a general purpose, multi-application data channel that numerous applications can use. By combining application and data functionality over a common data channel, aviation has the potential to significantly reduce costs for equipage on the ground and in the aircraft.

If aircraft utilized IP as network computers do, functions in the cockpit could be enabled not currently being provided. It could open up a whole new set of operating capabilities, cost savings, safety and efficiency for tomorrow's aviation industry. The functions provided today that require the use of multiple on-board systems could be reduced to two simple systems. First, a rigorous and dependable method to maintain the airplane's connection to the ground-based IP network is needed. This function is feasible using a combination of VHF radio (as is used for today's aircraft communications) and an alternate, backup communication method. A satellite communication system could be employed for aircraft that fly in sparsely populated areas that are beyond VHF coverage of the existing NAS infrastructure, or for any aircraft that might lose VHF coverage (even temporarily). Satellite communication is currently being used for trans-oceanic flight today in which aircraft are clearly beyond range of the VHF radio system in the NAS.

Second, a means of accurately determining an aircraft's position is required. Current technology in GPS receivers provides position information reliably and accurately. WAAS and LAAS are aviation systems that utilize GPS and provide error correction to allow aircraft the accuracy needed for navigation and landing.

By combining the GPS provided position information of any moving aircraft (or other vehicle) with reliable mobile network connectivity, the aircraft's position could be constantly reported to the ground network for processing. Further, this data could be intelligently parsed to provide position and tracking information back to aircraft so its flight crew could be aware of other aircraft movement in its proximity. Air-to-air position reporting is possible (such as Automatic Dependent Surveillance-Broadcast or ADS-B) if the proper radio method is used. In the end state, it is possible that enough aircraft could utilize the A.I. architecture to create a virtual network in the sky.

At any given moment, there are between 4500 and 6000 aircraft in flight over the United States. Air transport aircraft could not only use A.I. for their own purposes, but they could provide a network router function that could sell excess bandwidth to other less bandwidth-demanding aircraft. This network in the sky not only reduces equipage and saves system costs, it could create a revenue stream for air carriers that does not currently exist. It becomes a win-win situation for aviation.

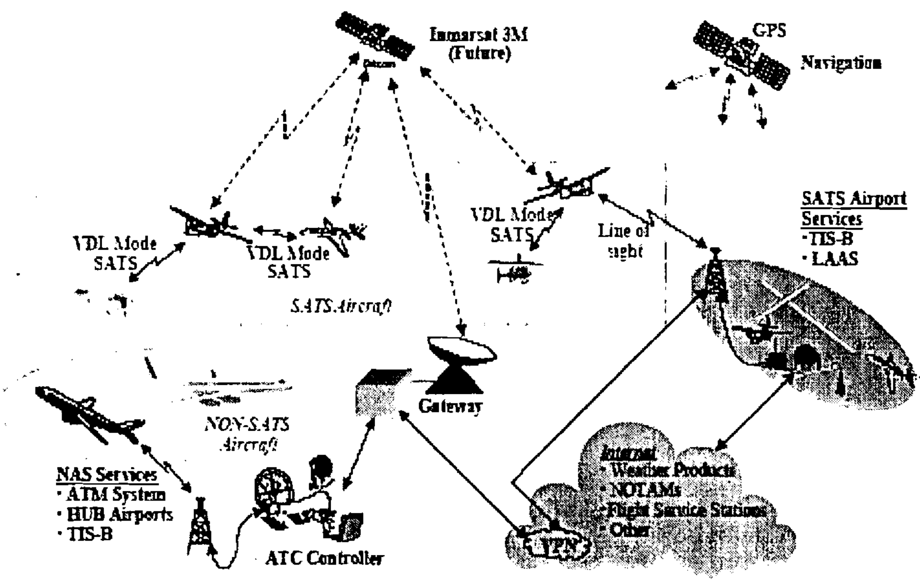

Figure 1 SATS Airborne Internet Conceptual Operation

ADVANTAGE

Increase productivity and economic growth

- The use of commercial Internet protocols and services will improve situational awareness, which will make aircraft easier to fly and reduce pilot workload
- The growth in connectivity will enable higher-volume aircraft operations and allow people in transit (i.e., passengers) to use otherwise unproductive time
- Communication and transportation mobility will increase, creating new markets and causing established markets to expand at accelerated rates which will increase investments in economic development and create jobs

Lower cost

- Flight deck functions in the aircraft will be consolidated and the number of required radios will be reduced, which will save aircraft owners money in addition to weight and space
- Most communication will occur in a peer-to-peer fashion between aircraft, which will reduce the amount of expensive ground infrastructure (such as antennas) the FAA needs to build and maintain
- Many people are already familiar with commercial off-the-shelf (COTS) Internet technologies, which will reduce the amount of time and money required to create and manage the Airborne Internet

Increase security, reliability, and scalability

- The use of XML Web Service protocols will make the Collaborative Information Environment (CIE) secure and reliable, unlike many current aviation communication methods
- The Airborne Internet will retain the resilience of the commercial Internet, which will allow it to scale to events such as extraordinary traffic volume, disruptive weather, or exponent ional increases in user volume

Reduce risk

- Many stakeholders will share the costs of creating and maintaining the Airborne Internet, which will reduce the possibility of one organization dominating or abruptly terminating the data channel

Increase innovation

- The use of open standards will allow companies to focus on building better radios, applications, and services instead of competing on basic communication protocols

Increase flexibility

- The Airborne Internet will be data link and device-independent, which will allow aircraft operators to select equipment based on their available resources and needs
- The use of commercial Internet technology will allow the Airborne Internet and the Collaborative Information Environment to be interoperable with entire transportation system and the rest of the world

APPLICATION

US Radar Using AI

A standoff radar plane used by the U.S. Air Force for deep-strike assaults since the 1991 Gulf War has been tested for providing airborne Internet access. Under a program called "Interim Capability for Airborne Networking," the Joint Stars, or Joint Surveillance Target Attack Radar System, aircraft used its dedicated radios to link to the Pentagon's Secret IP Router Network, or Siprnet. The Air Force and Northrop Grumman Corp. tested the packet data technique at Nellis Air Force Base, Nev. The scheme accelerates data rates considerably from the earlier Dial-Up Rate IP over Existing Radios, or Drier, program, tested on Joint Stars planes in 2003. The new ICAN system can link to ground stations via HF, UHF, VHF and satellite links. The tests at Nellis represented the initial proof-of- concept phase. The next phase of the program includes additional testing and prototype deployment. The military's need for bandwidth is growing as forces deployed in Iraq seek speedier access to battlefield data. Meanwhile, the Pentagon is trying to implement its bandwidth-hungry network-centric warfare doctrine

Airborne Internet Consortium

The Airborne Internet Consortium (AIC) is a nonprofit research organization composed of aviation sector participants that collaboratively research, develop, and promote open standards and Internet protocols for aviation digital communications

Need

The need for an Airborne Internet Consortium (AIC) is based on the lack of a common organization for the aviation industry to leverage commercial Internet technologies. The advent of new digital communication and processing technologies is radically changing the way commercial businesses and social communications are being conducted. It would appear that aviation is the last industrial segment to embrace the latest digital and Internet technologies.

Purpose

The purpose of the AIC is to accelerate the rate of adoption and absorption of digital and Internet technologies into aviation. The AIC will provide the necessary research, certification and guidance methodologies, advocacy, and influence in order to create the necessary technologies, policies, and regulations required for the use of commercial Internet protocols in aviation.

Benefits

With the availability of Internet technologies to all sectors of aviation from commercial to general aviation, from the flight deck to the cabin, and from flight-related tasks to entertainment, dramatic increases in communication and transportation mobility will be achieved. Internet protocols and services will make aircraft easier to fly with more situational awareness, safety, and security. Also, the productivity of passengers will be increased because the growth in connectivity will allow people in transit to use otherwise unproductive time.

Once this increased communication and transportation mobility is implemented, new markets will be created and established markets will expand at accelerated rates which will increase investments in economic development and create jobs.

Scalability

To encourage the creation and growth of markets, the Airborne Internet Consortium must identify and develop technologies that will scale. The commercial success of Internet is not only been due to its ability to increase communication mobility, it has also occurred because of its ability to scale exponentially. The Internet has been able to meet the demands placed on it by not having a fixed network topology or architecture. For this reason, part of the AIC effort will include modern network theory and principles so that the Airborne Internet will retain the resilience of the commercial Internet and not fail to scale to events such as extraordinary traffic volume, disruptive weather, or exponentional increases in user volume.

JPDO Partnership

The power of future networked system architectures to transform aviation will enable scalable airspace and aircraft architectures, flexible ground infrastructures, and new approaches to safety and security in the system of systems known as Aviation. To insure that the Airborne Internet Consortium is aware of network theory developments in aviation, the AIC will maintain a close working relationship with the Joint Planning and Development.

Objectives:

- Create Airborne Internet (AI) guiding principles
- Create an Airborne Internet Operational Concept
- Create and evaluate Airborne Internet "system of systems" architectures
- Influence, tailor, or create standards for the Airborne Internet
- Demonstrate the capability of an Airborne Internet

Mission

The mission of the Airborne Internet Consortium (AIC) is to define, develop, and promote the common system elements necessary to deploy comprehensive aviation-based digital data link capabilities throughout the nation using evolving Internet technologies.

Outputs:

- **Research Studies** – All research reports are copyrighted and treated as shared data rights among Principal members:
    - National Airborne Internet operations concept
- **Standards and Guidelines Reports** – All standards and guidelines reports prepared for release into the public domain:
    - National Airborne Internet standards
    - Guidelines for Airborne Internet product certification
- **Standards Setting Liaison** – All ongoing standards liaison services provided to members as long as necessary to achieve the targeted goals for influencing and/or creating standards:
    - Standards liaison working groups

Public and Private Benefits

The AIC intends to undertake its research through collaborations with the public sector in a manner that will:

- Enable a safer, more secure, more cost efficient global airspace system by eliminating communications as a constraint on the economic viability of aviation related applications
- Facilitate collaborative research and development in the field of aviation communications
- Develop open systems architecture and standards for aviation digital communications
- Foster and promote general purpose, multi-application, scalable data channel protocols in aviation
- Develop intellectual content to guide public and private investment in aviation digital communications
- Promote international adoption of open systems architecture, standards, information management structures, and protocols for aviation digital communications
- Foster use of advanced aviation digital communications technology for public security

How Airborne Internet Works

The word on just about every Internet user's lips these days is "broadband." We have so much more data to send and download today, including audio files, video files and photos, that it's clogging our wimpy modems. Many Internet users are switching to cable modems and digital subscriber lines (DSL's) to increase their bandwidth. There's also a new type of service being developed that will take broadband into the air.

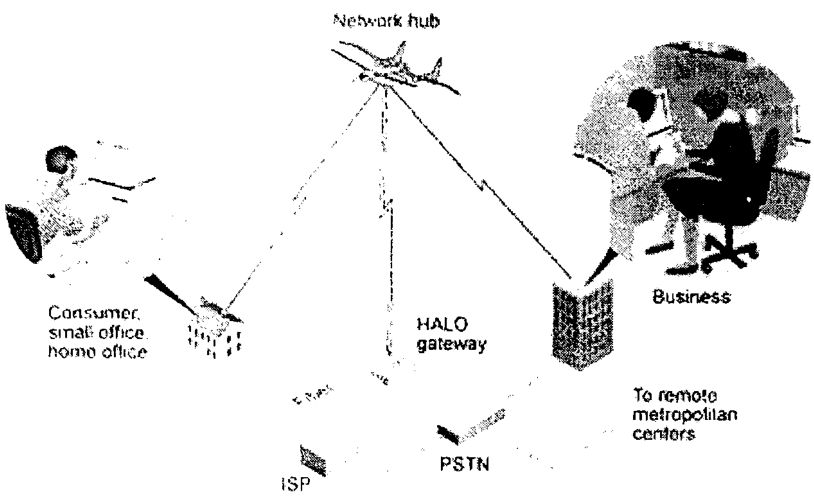

Photo courtesy Angel Technologies

This diagram shows how the HALO Network will enable a high-speed wireless Internet connection

At least three companies are planning to provide high-speed wireless Internet connection by placing aircraft in fixed patterns over hundreds of cities. Angel Technologies is planning an airborne Internet network, called **High Altitude Long Operation** (HALO), which would use lightweight planes to circle overhead and provide data delivery faster than a T1 line for businesses. Consumers would get a connection comparable to DSL. Also, AeroVironment has teamed up with NASA on a solar-powered, unmanned plane that would work like the HALO network, and Sky Station International is planning a similar venture using blimps instead of planes.

Architecture Development Methodology

Architecture defines the structural and collaborative relationships of system components. Often described using views (e.g., functional, component, implementation, temporal, user), the architecture provides information to guide system and software developers during initial development and inevitable system improvement activities. In addition to defining the functional and physical relationships between system components, architecture often provides design guidance in an attempt to achieve other desirable objectives such as efficient resource utilization, incremental development, verifiability, use of COTS products, ease of maintenance, and system extensibility.

1) Understand the SATS operational concepts

2) Define system level requirements

3) Investigate and evaluate the external environment

4) Identify trends and issues that must be addressed

5) Apply modern system design techniques

6) Document the result and submit for review

1) Understand the SATS operational concepts – Everyone tends to relate to SATS in a unique way. It is more a new way of thinking about air transportation than a technical concept that beckons to be explored. This leads to a variety of definitions of what SATS is – or should be. To bind the AI architecture problem, we developed a set of system operation assumptions. A sampling of these key assumptions is listed below:

- Pilot – Until such time as highly automated systems can be fully tested and certified, SATS aircraft will have at least one qualified, instrument rated pilot on board. Because of the level of automation on board, the SATS system will enable this pilot to be much more proficient and able to fly in nearly all weather conditions into a large number of minimally equipped airports.

- Airspace – SATS aircraft will share airspace with non-SATS aircraft. This implies a minimum level of system compatibility and equipage in both SATS and non-SATS aircraft. SATS aircraft en route will operate in Class A airspace, SATS aircraft landing at small/medium sized airports will operate in Class C, D, or E airspace.

- Avionics – in addition to the minimum set of avionics required of normal IFR1[2] aircraft, SATS aircraft will have on board additional avionics equipment to enable the pilot to operate in near all-weather situations. If SATS is to be prototyped in 2005 and operational in 2025, this equipment will need to be compatible with systems used by commercial and general aviation airports to not require expensive new ground support systems not currently planned by the FAA.

- Flight rules – to meet its objectives, SATS aircraft will need to be able to access small and medium sized airports. These same airports currently support VFR2[3] traffic in addition to IFR traffic. Flight rules will have to be modified to support a mixture of IFR, VFR and SATS traffic.

2) Define system level requirements – Specific, verifiable requirements for a SATS communications system must be developed. The communications system is unique in that it is both an end system and an enabling infrastructure. As an end system it must provide pilot-controller, pilot-pilot, and pilot-flight operations communications. As an enabling infrastructure it must support applications associated with navigation, surveillance, and other functions.

Requirements need to be developed in the traditional areas of communication, navigation, and surveillance, including both avionics and ground infrastructure, consistent with the infrastructure defined in the task below. System level requirements also need to be developed for onboard flight management and sensor/actuator systems capable of providing the level of support necessary to achieve the SATS goal of two crew performance with a single crew member. Other requirements will include support for passenger support systems

3) Investigate and evaluate the external environment – SATS, although a revolutionary transportation concept will have to work within the National Airspace System (NAS). This is true both during SATS prototyping in 2005 and during full-scale development, in 2025. The NAS itself is evolving necessitating developing an understanding of the capabilities of NAS over time. This can be very tricky as the NAS is subject to many forces that are political, not technical, and as such is difficult to predict. For example, there are currently three competing communication technologies to provide aircraft-aircraft position reporting. Clearly, there is agreement that position reporting is desirable, but which technological approach will survive is like trying to choose between VHS and Betamax before the marketplace has spoken.

4) Identify trends and issues that must be addressed – To be successful, SATS must function within the context of technology evolution and systems development. We present a summary of some of the trends and issues in the next section of this paper.

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5) Apply modern system design techniques – SATS presents an ideal opportunity to apply object-oriented design techniques for the collection, analysis and documentation of system architecture. Elements of the resulting design include:

- Design patterns to identify key components of the design
- layers of abstraction to minimize coupling of user level functionality to implementation details
- Exploitation of natural cohesiveness, common software functional patterns
- Communications protocols between major functional objects

Document the result and submit for review – Peer review is a vital step in the development of architecture for a system as complex and safety critical as a new aircraft transportation system.

Conclusion

The ***Airborne Internet*** (AI) is about information connectivity. It is a concept that adopts modern network theory and principles into the transportation realm, creating a system in which aircraft and people in transit will be connected with a scalable, general purpose, and multi-application aviation data channel. It connects aircraft and people in transit.

Airborne Internet provides aircraft to the ground, ground to ground and aircraft to aircraft communications in support of air traffic management, fleet operations, and passenger support services.

Airborne Internet has the potential to change the way aircraft receive and send data, or more appropriately, information. A.I. will provide an interconnected digital data network between aircraft and to/from the ground. A.I. has the potential to change how aircraft are monitored and tracked by the air traffic control system, how they exchange information with and about other aircraft

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