Project PISCES: Developing an in-flight entertainment system for smart devices

Gokhan Erdemir[1], Osman Selvi[2], Veysi Ertekin[2] and Gökhan Eşgi[2]

[1]Electrical and Electronics Eng. Dept., Istanbul Sabahattin Zaim University, Turkey
e-mail: gokhan.erdemir@izu.edu.tr)

[2] Department of Computer Engineering, Istanbul Aydin University, Istanbul, Turkey
Email: {osmanselvi, veysiertekin, gokhanesgi}@stu.aydin.edu.tr

***Abstract*—In-Flight-Entertainment (IFE) systems are the most important services which are provided by airline companies to improve the quality of travel experiences especially in intercontinental and long distance flights. Besides, IFE systems are one of the most important marketing tools for airline companies. However, airline companies don't prefer to use IFE systems for all flights due to increasing cost of aircraft, cost of flight, total weight of aircraft, fault based delay time, maintenance duration and decreasing payload capacity of aircraft, etc. In general, IFE systems are preferred for long distance flights because of all mentioned reasons. This situation is a cause of revenue loss for airline companies when total number of short distance flights and number of passengers are considered. In this study, mobile application which is called PISCES has been developed to present features of the IFE system. By using PISCES, passengers can use their smart devices during flight without any additional equipment to access IFE which is provided by airline companies during not only intercontinental and long distance flights but also short distance flights. Thus, current IFE system which is approximately 4 kg per seat with cabling, will be removed. Because of this reason, total weight of aircraft, flight cost, operational cost, maintenance duration and carbon emission will be reduced per flight. On the other hand, one of the most effective marketing tools of airline companies will be available for all flights. It means that developed application can provide direct and indirect advantages for not only airline companies but also passengers.**

I. Introduction

Flight experience has side effects on passengers; fear, stress, claustrophobia etc. In-Flight Entertainment Systems (IFE) are main tools to decrease these effects during flight. It improves the quality of travel experiences and makes it more enjoyable [1, 2]. IFE provides on demand services like pre-recorded music and film streaming, playing games, communicating with the other passengers, reading e-books, flight information, shopping, watching TV channels, etc. Passengers can adjust the volume of music or videos, and select music, video, e-book, shopping etc. via handset. The volume of music or videos can be adjusted via Passenger Control Unit (PCU) and so on. Voices can be heard by Remote Jack Unit (RJU). Handset also can contains adjust the reading lights and call cabin crew. Current IFE systems, mostly use cabling technology for data transmission between client and media server [3]. Additionally, cabling system has surcharge on installation and maintenance.

Cabling and/or wired IFE increase the cost of entire IFE system. Aims of airline companies can be summarized as serving quality services, reducing flight costs and increasing revenue. If wired systems can be converted to wireless systems, these aims can be achieved. That's why; there is a necessity of using wireless technologies [4].

In this paper, we proposed an IFE system based on wireless access to a remote multimedia server by using passenger's own smart devices. Physically, this work might be able to decrease a big amount of weight. And only requires wireless access points and an internet connection to access remote server. Periodically, server side of software can be upgraded remotely without additional cost and effort. The other advantage of proposed application is that can have access from all platforms includes Aircraft IFE devices. On the other hand, passengers can access the IFE via their personal devices. This situation provides a lot of advantages as hygiene, comfort, etc.

II. Overview of The Current IFE Systems

Currently used IFE systems present pre-recorded music, films, games, chat tools, e-books, flight information, shopping, TV channels [5]. IFE system can be activated by cabin crew for a long time (approximately 14 minutes) before aircraft taking off. Activated IFE system receives some information via Aircraft Interface from other aircraft systems. Each passenger has a monitor which is embedded the rear of seats, headset and handset which are on seat armrest.

Passengers can do shopping, playing games, listening recorded music or music channels, reading e-books or newspapers, calling cabin crew, etc. via handset or touched screen. Cabin crew or pilots can broadcast announcements and recorded messages via internal cabin speakers. Passengers listen via Remote Jack Unit (RJU). Seat Electronic Box (SEB) provides communication between handset and monitor and gets data (video/movie/announcement) through HDD Onboard Media Loader (OML). System continues to work in this circle [6]. Current IFE systems used following protocols:

- Ethernet: Ethernet protocols used for communication between system controllers and aircraft/cabin equipment.
- RS-232/RS-485: RS-232/RS-485 is used for data transmission and control.
- ARINC 429: ARINC-429 is used for aircraft data interface protocol.

The first example of IFE system can be observed at 1969 by PAN AM (Pan American World Airways) so that announce to passengers via voice. In the historical process was integrated telephone, fax, satellite communication features. At 1989, first in-seat video broadcast feature added [7]. Today, IFE Systems can be inspected under two part: hardware & software architecture. Today hardware architectures formed with copper or fiber wires, control units, seat electronic boxes, floor disconnect boxes, terminating plugs, LCD monitors, LAN hubs, Fiber Channel Hubs, HDD Onboard Media Loaders (OMLs), multiplexers etc. For example, all these parts cost about 5 tons in the Airbus A340 type Aircrafts [8]. Also in the all flying systems require the permission of the all manufactures. These IFE systems need maintenance and repairing periodically. Software generally is designed for specific hardware. Passengers cannot access to IFE via their personal devices.

Although, putting new equipment on aircrafts for data transmission is more complicated. Instead of adding new equipment there are some other existed applications like using seat rails for data communication [9]. Besides, client-server architecture uses too much traffic and requires expensive equipment. In some workings suggest P2P (Peer to Peer) architecture which eliminates the centralization of system on a single server to distribute load to peers [10].

Visible light communication is another way for data communication [2], [11]. In this technology, basically, passenger plugs PDA (Passenger data adapter) to passengers' personal device. This device communicates with light source takes place at the top of passenger seat.

Software capabilities of them generally have those features; live TV, map which shows current position of aircraft, games, music/radio, shopping, cabin-crew announcement, internet, phone etc. Those major system producer companies can be listed such as Lufthansa, Panasonic, Virgin America, Avant, Lumexis, Matsushita, and Thales (Fig.1.).

Figure 1. Screen views of some IFE Systems, (a) Virgin Atlantic, (b) Avant and (c) Panasonic.

III. System Architecture

A. Technical Specifications

IFE systems can be activated by cabin crew. Activated IFE system receives some basic information via Aircraft Interface (AI) from other aircraft systems. Passenger can navigate in the menu via handset or touch screens, and music/sounds can be listened via Unit Remote Jack (URJ) input. Seat Electronic Box (SEB) helps digital communication between handset and main board, it basically reaches to HDD via Onboard Media Loader (OML) and retrieves source files (videos, films, announcements etc.) [6]. Generally, IFE systems are too heavy for aircrafts. For instance; Airbus 340's IFE system has 11097.43 pound (4993.84kg) of weight [8]. Current IFE systems use two types of cables: copper and fiber optical. Copper cable systems, cheaper but heavier than others, and need lots of multiplexers. Fiber optical systems, are lighter and simple than others but more expensive. Copper cabled system and fiber optic cable system connects media server with end points are shown in the Fig. 2.

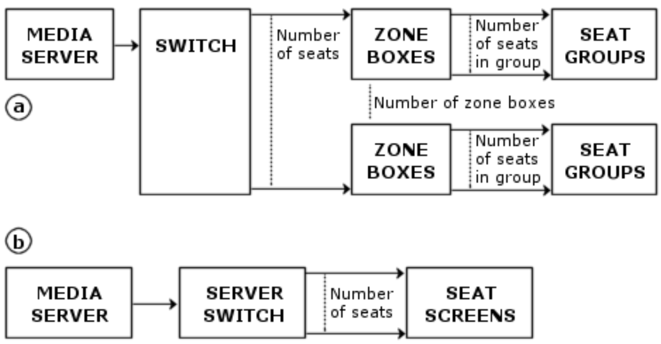

Figure 2. Structure of current IFE system with (a) copper cabled system and (b) fiber optic system

B. Software Properties

General features of IFE systems can be listed as followings:

Voice; according to passenger's preferences, it can be podcast, radio or music. Passengers can turn sound down or up at any time and switch between broadcasts.

Video; passengers can have access to recorded visual elements such as movies or series. Passengers can change visual quality of the video or voice, additionally subtitles can be added.

Game; games which are designed for adults or children, can be played free or paid (by credit card). Also, games can be played online or offline, depending on the software's features.

Chat; passengers can have internal conversation with the other passengers. Social media platforms and other chat software can be used external communication.

Reading; adult or children passengers can benefit from free or paid services such as newspaper, books, magazines etc.

Order; passengers can use application panels located within the IFE software for drinks, foods and other orders.

Flight track; if passengers want to see where is the current location and/or speed of aircraft, they can have access immediately with 2D or 3D visualization interface.

Advertisement; upon the request of various advertising content by aircraft company can be displayed in different moments to passenger via IFE application or built in seat panels.

Shopping; passenger can find a chance to shop during their flight from shopping service of airline companies.

C. *Maintenance and Repair of Present IFE Systems*

Software Side; software upgrading and maintenance schedule usually are performed monthly.

Hardware Side; maintenance or repair events are performed such as at the maintenance time or the expiration of its life of the used components or for any reason damaged components.

IV. FEATURES OF DEVELOPED IFE SYSTEM

Proposed approach consists of three main parts which are media server, remote web server and client software, respectively. Developed IFE system's software and the physical properties are described below.

A. *Media Server*

In presented system, we integrate media server to generic inflight Wi-Fi system which is illustrated in Fig.3. Passengers can access easily via their personal devices (PED) which are already connected to Wi-Fi system.

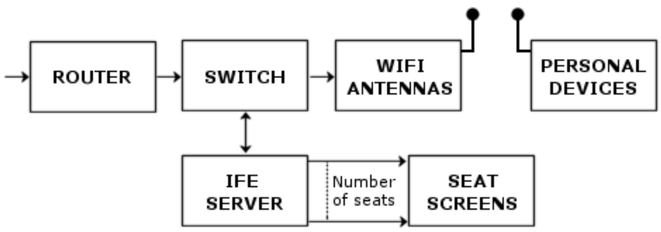

Figure 3. Integration schema of developed mobile IFE system to current structure.

B. *Remote Web Server*

In this study, we recommend a remote server which works on cloud environment (Fig.4.). This design technique allows IFE Systems to manage remotely.

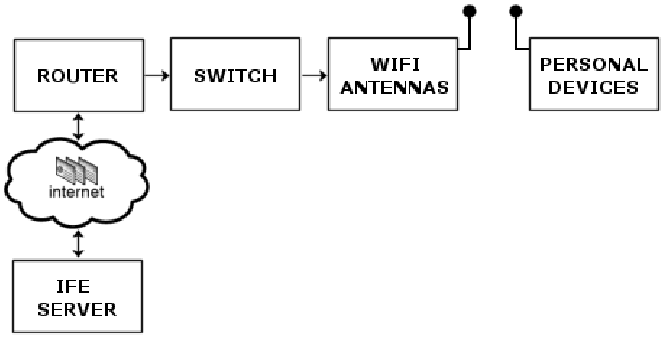

Figure 4. Structure of proposed mobile IFE system

Passengers can connect IFE System with their personal devices or in-flight rental devices alternatively. Each device can access to IFE System via company issued mobile application. Present wireless technologies provide sufficient bandwidths [3], [6], [12-13].

C. *Software*

Developed IFE system has login, Music, Radio, Movie, TV, Game, Shopping features which are shown in Fig.5.- Fig.10. PHP, Composer, ORM, Twig Template Engine, MySQL, Apache Web Server are used in the development of software (Fig.5.- Fig.10.). Official trailers of movies and trial versions of games are used for demonstration from Fig.5 to Fig.10.

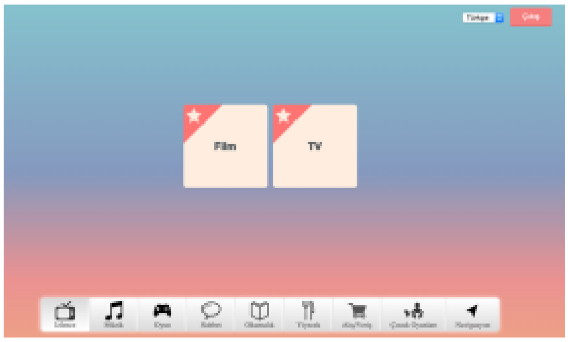

Figure 5. Movie / TV selection screen

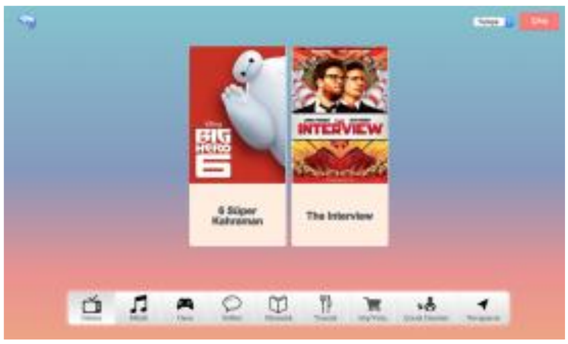

Figure 5. Movie list

Figure 7. Sample movie

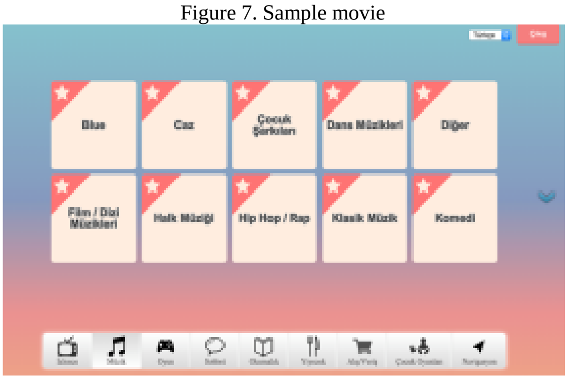

Figure 8. Music categories

Figure 9. Music samples

Figure 10. Games

V. Comparison with the Current IFE Systems

The advantages of developed IFE System are mainly listed in Table 1. and disadvantages of current IFE system in Table 2.

TABLE I. ADVANTAGES OF DEVELOPED IFE SYSTEM.

Properties	Developed IFE System
Saving flight cost	Fuel consumption is decreased because of total weight loss.
Cabling	Extra cabling is not necessary.
Weight	Aircraft's weight is decreased due to no cabling.
Saving equipment costs	Passengers can use their own devices and equipment.
Productivity	Cabin crew's workload is decreased.
Hygiene	Passengers can use their own equipment.
Flexibility and maintenance	New tools can be installed easily without docking.

TABLE II. DISADVANTAGES OF CURRENT IFE SYSTEM.

Properties	Current IFE System
Saving flight cost	There is no change in fuel consumption of aircraft.
Cabling	Cabling is necessary.
Weight	Aircraft's weight is additionally increased 4 kg per seat.
Saving equipment costs	Passengers use head phone equipment which is supported by the airline company.
Productivity	Cabin crew is responsible for delivering and collecting head phones and other equipment.
Hygiene	Passengers use commonly used equipment.
Flexibility and maintenance	New tools' installation needs docking and take more time.

All features that we mentioned in Table 1. save lots of effort and money. Disadvantages of developed IFE system are in Table 3.

TABLE III. DISADVANTAGES OF DEVELOPED IFE SYSTEM.

Properties	Developed IFE System
Passenger Demands	Can only be done through the control panel at the top of the head.
Passenger Flight Information System's	Is not available.
Device	PEDs or rental devices
Audio	Is not available.
Boarding Music	Is not available.

VI. Conclusion

In this study, design and development of an IFE system for smart devices which is called PISCES has been studied and discussed its impact from both productivity and applicability points of view. Proposed approach offers some direct advantages as saving flight cost, no extra cabling for IFE per seat, reduction of the total weight of aircraft, saving equipment costs, to decrease cabin crew's workload, hygiene, flexibility, maintenance, etc. Moreover, PISCES is nature friendly project. Carbon emission will be reduced per flight because of reduction of total weight of aircraft and fuel consumption. The developed IFE system can be integrated to current systems. However, current systems should be dropped out to increase productivity. Following features can be added to developed system as future works:

- Instant flight information can be served via PFIS.
- Online product selling (goods and services)
- Interrupt audio output anytime for announcements.
- Online data may allow aircraft companies to offer campaigns to passengers.
- Passenger's specific flight data can be collected for future flight offers.

ACKNOWLEDGMENT

The project was supported by a scientific research grant (KLUBAP-045) of the Kirklareli University.

REFERENCES

[1] Liu, H., "In-Flight Entertainment System: State of the Art and Research Directions," Semantic Media Adaptation and Personalization, Second International Workshop on, pp. 241-244, 2007.

[2] Schuessele, L., Felhauer, T., Christ, A., Klausmann, T., Kaufmann, A., Gerold, A., "A novel broadband communication system for aircraft in-flight entertainment applications," Broadband Multimedia Systems and Broadcasting (BMSB), 2011 IEEE International Symposium on, pp.1-6, 2011.

[3] Luo, J., Keusgen, W., Kortke, A., Peter, M., "A Design Concept for a 60 GHz Wireless In-Flight Entertainment System," Vehicular Technology Conference, 2008. VTC 2008-Fall. IEEE 68th, pp.1-5, 2008.

[4] Goyal, P., "Emerging in-flight end-user needs for entertainment, computing and communications," Fly by Wireless Workshop (FBW), 2011 4th Annual Caneus, pp.1-4, 2011.

[5] Balcombe, K., Fraser, I., Harris, L., "Consumer willingness to pay for in-flight service and comfort levels: A choice experiment," Journal of Air Transport Management, vol. 15(5), pp. 221-226, 2009.

[6] Akl, A., Gayraud, T., Berthou, P., "Investigating Several Wireless Technologies to Build a Heteregeneous Network for the In-Flight Entertainment System inside an Aircraft Cabin," Wireless and Mobile Communications (ICWMC), 2010 6th International Conference on, pp.532-537, 2010.

[7] Lee, D. B., "In-flight entertainment-getting from wishlist to reality," Digital Avionics Systems Conference, 1998. Proceedings., 17th DASC. The AIAA/IEEE/SAE, vol. 2, pp. G16/1-G16/8 vol. 2, 31 Oct-7 Nov 1998.

[8] Panasonic Avionics Corporation, "Ex2 Line Maintenance Training Course Training Guide," 2nd Edition, California: PAC, 2010, ch. 8, p. 8.

[9] Schuessele, L., Felhauer, T., Christ, A., Klausmann, T., Weber, C., "Application of wireless technology for IP-based aircraft in-flight entertainment," Wireless Systems (IDAACS-SWS), 2012 IEEE 1st International Symposium on, pp.39-42, 2012.

[10] Loureiro, R. Z., Anzaloni, A., "Searching content on peer-to-peer networks for in-flight entertainment," Aerospace Conference, 2011 IEEE, pp.1-14, 2011.

[11] Quintana, C., Guerra, V., Rufo, J., Rabadan, J., Perez-Jimenez, R., "Reading lamp-based visible light communication system for in-flight entertainment," Consumer Electronics, IEEE u.Transactions on, vol. 59(1), pp. 31-37, 2013.

[12] Garcia, A. P., Kotterman, W., Thoma, R. S., Trautwein, U., Bruckner, D., Wirnitzer, W., Kunisch, J., "60 GHz in-cabin real-time channel sounding," Communications and Networking in China, 2009. ChinaCOM 2009. Fourth International Conference on, pp.1-5, 2009.

[13] Scott-Hayward, S., Garcia-Palacios, E., "Delivering HD video for wireless in-flight entertainment with IEEE 802.15.3c," Signals and Systems Conference (ISSC 2012), IET Irish, pp.1-6, 2012.