SIXTH FRAMEWORK PROGRAMME
PRIORITY [4]
AERONAUTICS AND SPACE

SPECIFIC TARGETED RESEARCH PROJECT

Deliverable D4.1:

State of Art of In-flight Entertainment Systems and Office Work Infrastructure

Project acronym: **SEAT**
Project full title: **S**mart t**E**chnologies for stress free **A**ir **T**ravel
Proposal/Contract no.: **AST5-CT-2006-030958**

Due date of deliverable: 2006-DEC-20
Actual submission date:

Start date of project: 2006-09-01 Duration: 36 months

Organisation name of lead contractor for this deliverable: Technical University of Eindhoven

Revision:

Project co-funded by the European Commission within the Sixth Framework Programme (2006-2009)		
Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Revision History

Date	Ver.	Author	Comments
7-DEC-06	1.0	Hao Liu	Delivered for WP4 internal discussion
9-DEC-06			Checked by WP4 leader
17-DEC-06	1.1	Hao Liu	Improved version
19-DEC-06			Checked by WP4 leader
20-DEC-06	1. 2	Hao Liu	Improved version
20-DEC-06			Final approved by WP4 leader

List of Abbreviations

CD	Compact Disc
ESRB	Entertainment Software Rating Board
eTES	Enhanced Total Entertainment System
FACE	Friendly Aircraft Cabin Environment
IFE	In-flight Entertainment
JAL	Japan Airlines
KLM	Royal Dutch Airlines
MPAA	Motion Picture Association of America
NATO	National Association of Theatre Owners
PC	Personal Computer
RIAA	Recording Industry Association of America
SEAT	**S**mart t**E**chnologies for stress free **A**ir **T**ravel
TES	Total Entertainment System
TV	Television
TVPG	TV Parental Guidelines
WATS	World Air Transport Statistics
WP	Work package
n.d	no date
NRDs	Needs, Requirements and Desires

Definitions for Terminology

Aircraft: An aircraft is any vehicle or craft capable of atmospheric flight.

Casual Games: Games that generally involve less complicated game controls and overall complexity in terms of game play or investment required to get through game.

Desires: Desires are used to refer to things that people “want” to have.

Ergonomics: Ergonomics is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimize human well-being and overall system performance.

Flight: Flight is the process by which an aircraft achieves sustained movement through the air by aerodynamically generating lift. A flight consists of four phases: take-off, flying, landing, and emergency situations.

Mother language: Mother language is the language that was learned first by the person.

Needs: The concept of Needs is used to refer to things that people "must" have.

Non-volatile memory: Non-volatile memory is computer memory that can retain the stored information even when not powered.

Long haul: A journey over a long distance.

Requirements: Requirements are used to refer to things that people “should” have.

Seat pitch: Seat pitch is the distance between seat rows.

Table of Contents

1. User requirements

Passenger comfort is clearly a main factor in user's acceptance of transportation systems. Dumur, Barnard and Boy (2004) discussed human factors in designing of a more comfortable aircraft cabin for passengers. Comfort is a complex concept, consisting of both objective ergonomics requirements and subjective impressions. Elements of comfort can be described by four different models:

1) The passenger bubble, in which the passenger is isolated from disturbances and can pursue his/her own activities;
2) The health model, where the focus is on absence of discomfort, potential health dangers and annoyance, and on physical well-being;
3) The community model, in which passengers belong to a public-transport group, who communicate and share common experiences;
4) The aesthetic-economical model, in which comfort is perceived as being in an interesting, advanced and beautiful environment, for a reasonable price.

All these models put different requirements on the passengers' environment, sometimes overlapping, but sometimes also conflicting. In order to support designing for comfort, Dumur, Barnard and Boy (2004) present a model in which these requirements can be combined based on cognitive function analysis. Four principles are identified that should guide design: (1) affordance, (2) situational awareness, (3) individualization and customization, and (4) variability and flexibility.

As part of the European SEAT (Aliabadi 2006) project, work page 4 focuses on providing situation-aware, personalized entertainment services and a better office work infrastructure for each passenger. In this chapter, we will analysis passenger's entertainment and office work requirements via literature study, field observations, cognitive function analysis and group task analysis.

1.1 Users' IFE requirements

The enclosed environment of the aircraft and long hours of travelling opts to cause both physiological and psychological discomfort and even stress to the passengers. Many airlines have realised the potential of the on-board entertainment in improvement of customers' comfort level, and realized the IFE systems based on pre-set concept of what customer likes and requires as a homogeneous passenger group that has similar tastes and desires. However, since the passengers come from highly heterogeneous pools (such as age, gender, ethnicity, etc.), have different individual entertainment preferences and experience different flight situations, one will find that contextually selected entertainment services could bring better physical and psychological comfort to the passenger. In this section, we will first discuss the categories of user's entertainment requirements, and then, based on these categories, we will check user entertainment requirements in different situations.

1.1.1 Categories of user's entertainment requirements

Generally, the entertainment might be divided into two categories (Livaditi 2002): **Passive**- the user-system interaction levels are very low and the passenger simply enjoys a chosen form of entertainment that is presented to them in an organized and packaged form. Passive entertainment is also akin to linear viewing or listening. This means that during passive entertainment service consumption the passenger prefers watching or listening programs that have a continuous service content flow. Examples of passive entertainment services are **audio and video on demand, audio and video broadcasting**. **Active** - the user spends time to actively interact with the entertainment system where the following entertainment service content is determined by the interaction between the user and the system. Examples of this type of entertainment are: **gaming, exercise, gambling.**

1.1.2 Users' entertainment requirements in different situations

Airline passengers usually come from different geographic area, social or ethnic group which implies different entertainment inclination, and at the same time each passenger has different individual entertainment preferences. So, except for providing entertainment services at a central level, airlines should also provide entertainment services at group and individual levels in order to cater for contextually entertainment requirements.

An entertainment group is composed by passengers who share the same inclination of entertainment services. Each group reflected to some extent the age, sex, and preferred language, etc. represented in the general passenger. For example, the passenger whose preferred language is French would like the entertainment service to be provided in French. A passenger can belong to several entertainment groups. For example, a female passenger whose preferred language is French also belongs to the female entertainment group. In the following, we will discuss the group entertainment requirements based on user's age, gender, and preferred language information.

Age group entertainment requirements: Video, audio, and games are popular among people of all ages. But the content of them varies widely. Some of them may be hazardous to passenger's emotional health. Luckily, the rating system can help the passenger decide whether a particular program is suitable for him/her or his/her children. The movie rating system is a voluntary system sponsored by the MPAA (n.d.) and the NATO (n.d.) to provide parents with advance information on films, enabling parents to make judgments on movies they want or do not want their children to watch. The rating symbols such as G, PG, and PG13 suggest the movie's age appropriateness and advices to the parents if their children want to see the movie. The ESRB (n.d.), which is set up by the entertainment software industry's trade association, maintains a two-part rating system for video and computer games: the rating symbol, such as E or M, which suggests the game's age appropriateness; and content descriptors, like Blood and Gore, which point out specific elements of the game that have caused the rating and that may be of concern. All music is not always appropriate for all ages, parental label, which is provided by RIAA (n.d.), is a notice to consumers that recordings identified by this logo may contain strong language or depictions of violence, sex or substance abuse. Parental discretion is advised. TVPG (n.d.) designed a TV ratings system to give parents more information about the content and age-appropriateness of TV programs. These ratings, called the TV Parental Guidelines, are modelled after the familiar movie ratings which parents have known and valued for nearly 30 years. The ratings apply to all television programs, including those directed specifically to young children. Sports and news shows will not carry the Guidelines.

Gender group entertainment requirements: Carrie (1994) has studied the gender difference towards virtual reality entertainment preference. He found that the female preference sequence is virtual travel (Imagine being able to walk around and explore places like Paris), learning (Imagine being able to travel through the human body or into the earth's core), games, fitness exercise, while the male preference sequence is games, travel, learning, fitness exercise. Casual Games White Paper (2006) found that while the typical core gaming audience is male and aged eighteen to thirty-four, casual gamers tend to be both women and men between the ages of thirty-five and sixty-five, with a slight demographic skew towards women.

Language group entertainment requirements: A language entertainment group is composed by passengers who share the same language preference for the entertainment system interface and entertainment services. For non immigrants, it is obvious that their mother language is their first language preference. But, for immigrants, it is complicated. Extra and Yagmur (2002) and Buben (2006) have shown that their language preference depends on many factors, such as their age, (for example, for the Turkish immigrants in the Netherlands, the youngest pupils (4-5 years) report Turkish as their language of preference, the pupils of 8-13 years report Dutch. The oldest pupils (14-17 years) show a converging pattern of preference for one of the two languages), location (for example, for the immigrants in the United States, it is in the home where a non-English mother tongue is most likely to be used especially with immigrants parents who arrived as adults), etc. So we can't simply deduce a passenger's language preference by his nationality and mother language information, it must be defined by the passenger explicitly by him/herself.

For the passenger's individual entertainment preference, it is obvious that different passengers have different individual entertainment preferences. From the user's perspective, he/she wants to watch or listen to his/her favourite audio and video programs and play favourite games without much effort (e.g., interface and interactive devices are user-friendly and the user can easily find the desired entertainment services). At the same time, the confinement of the cabin environment, and long hours of travelling are opt to result in passenger psychological and physiological disturbances and even health risk, contextually selected entertainment services are supposed to be able to improve passenger's mood, health, reduce the stress. However, because the passenger's psychological modelling is still under investigation, the user's entertainment requirements under different psychological status will not be discussed in this deliverable.

During a complete flight, the passenger experiences take-off, flying and landing situations. However, different flight situations have different characteristics. The take off stage is the beginning of the journey and exerts weightlessness, acceleration, decompression, etc feelings on the passenger. During this period of time, the passenger needs some smooth music, comedy, etc entertainment services to reduce the stress and relax. At the later phase of a long flying trip, it is obvious that long hour of travelling make passengers lose of motivation to active entertainment. The landing stage is the final phase of a flying trip and exerts weightlessness, etc feelings on the passenger. Except for smooth music, comedy, etc entertainment services to reduce the stress and relax, if the passenger needs to transfers to another aircraft at the airport, he/she needs the transfer information of the airport; otherwise if it is the passenger's first trip to the destination city, the passenger wants to know the transportation information from the airport to his/her destination.

1.2 Users' in-flight office work infrastructure requirements

For business passenger, it is important to provide in-flight office work characteristics for him to drink, eat, keep contact with his social network, and do some paper works, etc. conveniently and comfortably. In the following, we will discuss the passenger's in-flight office infrastructure requirements from seat, food, table, communication, computer and its accessories perspectives.

Seat: In particular, *increased comfort* in air travelling is recommended by Beals et al (2003): all future planes should have more leg and elbow room for all passengers, not just 1st and 2nd class. Also, a modification will be made to the existing fleet to accommodate severely overweight people, since 1 out of every 3 people are obese. Special seats will be made available on all future flights for people weighing over 300 pounds to avoid infringing on the 'personal space' of regular passengers. Moreover, Lueder (2004) summarizes the last two decades and concludes that the focus has gradually shifted from identifying the best single sitting posture towards a more dynamic view of sitting and movement. While this emphasis on movement has helped avoid ergonomic risk factors, it also confused the issue. Movement is critical, but it is not the only consideration. Static sitting postures introduce ergonomic risk factors by constraining postures and promoting unnatural postures that deviate from the natural position of the spine. Each of these can negatively affect our health, comfort and effectiveness. Both large 'macro-movements' and fine-grained even continuous movements are essential for our wellbeing. The most effective way to maintain a seated posture for extended durations is to continuously cycle through a range of natural, centered and healthy positions. This requires a chair that allows users to dynamically shift between a range of stable postures. Although these conclusions are mainly done for office work environments, some of the ideas are also useful for cabin chair design.

Food: Beside the above mentioned seat design considerations, airliners should put a new food product in front of business and leisure travellers for its' longer distance flights. This requirement could become a significant and distinctive factor when passengers book their next flight. In the near future, all passengers should have the ability to order from a menu when booking flights online.

Table: In order to drink and eat, the user needs a table to put the food. While, the user also need a computer and its accessories to handle the paper work, and use the web mail services, etc. So the size of the table should be big enough to hold a normal laptop and one cup of drink; at the same time, it can be put horizontally or some angle with the seat flat surface in order to cater for user's seating postures; also, the table should be removable, if the user doesn't want to do office work, he can move it away.

Communication: In order to keep contact with his social network, the business passenger needs to send and receive electronic communication at any time and through a variety of means, including wired and wireless internet access, voice telephones, etc.

Computer and its accessories: Computer and its accessories are necessary infrastructures to support the passenger to do the office work and enjoy entertainment services. In the following tables, we list the user requirement on the computer and its accessories. The main result of these tables comes from Human Factors Design Specification for the FACE project (Crozes 2006).

Office characteristic / Point of view	**Keyboard of the computer**
Use	A keyboard shall be used for typing email, surfing on internet etc.
Physical Space	1 A keyboard shall require the less physical space as possible. 2. The user shall not have to store the keyboard if he wants to stop the office work.
Cleaning up	Easy to clean up.
Position	The layout shall be horizontally or some angle with the seat flat surface in order to cater to user's seating postures.

Office characteristic / Point of view	**Computer**
Hardware	Require Pentium-class processors to decode digital video; The passenger needs at least one USB port to upload his personal or working data.
Software	MS Windows operating system and the corresponding software such as MSN, etc.
Replaceable	Easy to be replaced by the passenger's laptop.

Office characteristic / Point of view	**Display screen of the computer**
Privacy screen	What is on the screen shall only be visible by the person in front of the screen.
Screen luminosity	Screen shall be adjusted individually: brightness and contrast.

Headset for audio sound
The user shall be the only one to hear what the headset plays. Size of the headset should be equal to: min = 13 cm, max = 17 cm to fit to any passenger.

Figure 1.1 Passenger's office work requirements for the computer and its accessories

2. Current in-flight service infrastructures

To allow each airline the freedom to configure its aircraft according to its budges and market demands, both airplane producers (Boeing and Airbus) and major IFE system providers provide customized IFE system to their customers. So it is hard to identify the current installed and commercially available IFE systems by the aircraft type. In this chapter, we first investigate the current IFE systems and in-flight office work infrastructure in the aircrafts of major airlines in the world. After that, we investigate the commercially available IFE systems which are provided by the major players in the development and manufacture of IFE systems. Finally we will check the current in-flight service infrastructures with the user requirements in the first chapter and conclude whether they can fulfill the user requirements.

2.1 *Current installed IFE systems*

In this section, we investigate the current IFE systems in business class which are already installed in the aircrafts of Lufthansa, Air France, British Airways, KLM, American Airlines, Delta Airlines, and Japan Airlines which spans three continents. In Europe, we investigate Lufthansa (n.d.), Air France (n.d.) and British Airways (n.d.) which rank top three of Europe Total Scheduled Passengers Carried in 2005 and Total Scheduled International Passengers Carried in 2005. We also investigated KLM (n.d.) which is the largest Dutch airline. In North America, we investigated American Airlines (n.d.) and Delta Airlines (n.d.) which rank number one and two of world Total Scheduled Passengers Carried in 2005 (WATS, 2006). In Asia, we investigated Japan Airlines (n.d.) which ranks number one of Asia Total Scheduled Passengers Carried in 2005.

For each airline, we first check what kind of entertainment services it provides, and then, we investigate the entertainment hardwares from the user's point of view.

2.1.1 Lufthansa

<table>
<tr><th>Entertainment service / Type of cabin</th><th>Video</th><th>Audio</th><th>Gaming</th></tr>
<tr><td rowspan="3">Business class</td><td>Contents:
65 video options with 30 cinema film;
25 TV programmes.</td><td>Contents:
24 Radio channels including many international channels;
A variety of 100 CDs.</td><td>Contents:
Tens of video games which include games of skills, action games, board games and strategy games as well as 11 language courses.</td></tr>
<tr><td colspan="3">Note:
The user friendly graphical user interface gives passengers a choice of nine different navigation languages (German, English, French, Italian, Spanish, Portuguese, Japanese, Chinese and Korean).</td></tr>
<tr><td colspan="3">Input devices:
Remote controller, the passenger can use it to select the desired video and audio entertainment programs and play games.
Output devices:
The high quality headphone with active noise cancellation;
10.4" personal screen.</td></tr>
</table>

Figure 2.1 Lufthansa's installed IFE system

2.1.2 Air France

Entertainment service / Type of cabin	Video	Audio	Gaming
Business class on long-haul flight	**Contents:** A choice of 12 recent films. These films are available in several languages (up to 9 depending on the movie: Chinese, English, French, German, Italian, Japanese, Korean, Spanish and Portuguese).	**Contents:** 10 different music stations.	**Contents:** Several video games.
	Input devices: A touch 10.4-inch video screen which allows some navigation by directly pressing options on the screen, and a remote control handset allowing for more navigational options and playing games. **Output devices:** 10.4-inch video screen.		

Figure 2.2 Air France's installed IFE system

2.1.3 British Airways

Entertainment service / Type of cabin	Video	Audio	Gaming
Business class	**Contents:** Classic and family movies, top TV comedy, drama, factual programmes and the cartoon network.	**Contents:** Radio channels hosted exclusively for British Airways by Stuart Maconie, Mark Lamarr and Charles Hazelwood; Some fantastic audio programmes from the archives of the BBC, and a library of up to 16 CDs.	**Contents:** Tens of video games.
	Note: Choice of entertainment contents depends on the type of aircraft, TV system, and route.		
	Input devices: A touch 10.4-inch video screen and a remote control handset allow the passenger to select the desired video and audio entertainment programs and play games. **Output devices:** 10.4-inch video screen.		

Figure 2.3 British Airways' installed IFE system

2.1.4 KLM

For KLM, Its aircrafts Boeing 777 and Airbus A330' business class entertainment system is different from aircrafts Boeing 747 Boeing 767 and MD11's.

<table>
<tr><th>Entertainment service / Type of cabin</th><th>Video</th><th>Audio</th><th>Gaming</th></tr>
<tr><td rowspan="2">Boeing 777 and Airbus A330 business class</td><td>Contents:
A wide selection of movies; television programmes which provide the passenger news, comedy, culture, lifestyle and travel, etc information;
Kids get their own K:TV channels.

Note:
The movies provide different languages, for example, some are in English/Dutch, and some are in English/Chinese.</td><td>Contents:
Hundreds of music tracks;
Specially created music programmes.

Note:
The passenger can create his/her music play list.</td><td>Contents:
Video games which the passenger can play himself/herself or with fellow passengers.</td></tr>
<tr><td colspan="3">Input devices:
Remote controller, the passenger can use it to select the desired video and audio entertainment programs and play games.
Output devices:
Personal video screen.</td></tr>
<tr><td rowspan="2">Boeing 747 Boeing 767 and MD11 business class</td><td>Contents:
Depends on each flight, KLM provide one to several movies;
Television programs.</td><td>Contents:
A wide variety of music on 12 video and 12 audio channels.

Note:
6 video and 9 audio channels on the Boeing 767.</td><td></td></tr>
<tr><td colspan="3">Input devices:
Remote controller, the passenger can use it to select the desired video and audio entertainment programs.
Output devices:
Personal video screen.</td></tr>
</table>

Figure 2.4 KLM's installed IFE systems

2.1.5 American Airlines

<table>
<tr><th>Entertainment service / Type of cabin</th><th>Video</th><th>Audio</th><th>Gaming</th></tr>
<tr><td rowspan="2">American Airlines 767-300 next generation business class (will be installed at the end of 2006)</td><td>Contents:
Hours of videos including movies, TVs and music video.</td><td>Contents:
Hours of music.</td><td>Contents:
Several games.</td></tr>
<tr><td colspan="3">Input and output devices:
The personal entertainment device which has its own display screen and input keyboard. The passenger can use it in the position of the seat back in front of him/her, or pop it out and put it in the most comfortable spot. Please refer to Appendix figure a.1 for a better understanding.</td></tr>
<tr><td rowspan="2">Current business class</td><td>First-run films and CBS Eye on American or up to 14 channels of audio programming on the main screen;

If you are travelling on a Boeing 777, you will enjoy a personal video monitor with 10 channels of programming.</td><td>14 audio channels.</td><td></td></tr>
<tr><td colspan="3">Input and output devices:
For Boeing 777, the input device is a remote controller and the output device is a video monitor.</td></tr>
</table>

Figure 2.5 American Airlines' IFE systems

2.1.6 Delta Airlines

<table>
<tr><th>Entertainment service / Type of cabin</th><th>Video</th><th>Audio</th><th>Games</th></tr>
<tr><td rowspan="2">Business class</td><td>Contents:
Different route different period of time provide several movies for the passenger to choose;

Television programming which includes news, travel stories, the latest situation comedies, classics from the past, dramas, and lifestyle programs from around the globe.</td><td>Contents:
Tens of audio channels ;

Different route different period of time provide some music programs for the passenger to choose.</td><td>Contents:
Classic arcade games.</td></tr>
<tr><td colspan="3">Input devices:
Remote controller
Output devices:
Personal video screen</td></tr>
</table>

Figure 2.6 Delta Airlines' IFE system

2.1.7 Japan Airlines

Entertainment service / type	Video	Audio	Gaming
Magic entertainment system	**Contents:** Movies, JAL's own video programs, the latest news. Note: The passenger can choose from a vast program selection and watch on his own personal video screen with a remote controller. There is a button on the controller for English/Japanese language transition.	**Contents:** Latest pop tunes; Traditional Japanese comic monologues (rakugo).	**Contents:** Board games, action-packed video games, etc.
	Input devices: Remote controller (refer to Appendix figure a.2): there are more than twenty keys on it for the game control, audio and video on command control. **Output devices:** 10.4" personal screen; Noise cancelling headphone.		

Figure 2.7 Japan Airlines' IFE system

2.2 Current in-flight office work infrastructure

Corresponding to section 2.1, in this section we investigate the current in-flight office work infrastructures in the business class cabin of Lufthansa, Air France, British Airways, KLM, American Airlines, Delta Airlines, and Japan Airlines.

Due to it is hard for us to get the detailed computer parameters from airlines, moreover, from the applications the computer supporting we can deduce whether it can fulfil user requirements in chapter one, so in the following tables, we will leave out the computer investigation.

2.2.1 Lufthansa

Office characteristic / Type of cabin	Seat & Table	Food	Communication
Business class on long-haul flight	The seat is ergonomically shaped and adapts to any body shape; The seat has massage function; Retractable armrests of the seat guarantee the passenger has ample room for his/her arms and shoulders; The seat pitch of up to 150 cm to the seat in front of the passenger, so there is lots of room for his/her legs; A practical storage pocket for your laptop and files, and an individual reading light, integrated into the seat; Every seat has a PC power outlet with no adaptor necessary. A large removable table.	Lufthansa offers on all long haul and selected Inner-European flights 21 different special meals. These need to be ordered by the passenger when making his flight reservation.	Broadband internet access.

Figure 2.8 Lufthansa's installed office work infrastructure

2.2.2 Air France

Office characteristic / Type of cabin	Seat & Table	Communication
Business class on long-haul flight	l´Espace Affaires seat, built with "lie-flat" technology offers a range of comfortable positions for: - relaxing, - working, - dining, - sleeping comfortably. The seat has massage function; fibre-optic reading lamp ; PC power outlet. A removable table.	Individual in-seat telephone.

Figure 2.9 Air France's installed office work infrastructure

2.2.3 British Airways

Office characteristic / Type of cabin	Seat & Table	Food	Communication
Business class	The seat can be easily adjusted, the passenger can choose his/her most comfortable position for working, eating or relaxing; It is the world's first fully (183cm) flat beds; In-seat power outlet. A removable table. Note: the above configurations are available on all 747 and selected 777 aircrafts.	For all long haul and some other flights, the passenger can book the meal by British Airways' website.	In-seat telephone.

Figure 2.10 British Airways' installed office work infrastructure

2.2.4 KLM

Office characteristic / Type of cabin	Seat & Table	Food	Communication
Boeing 777 and Airbus A330 business class	Sleep seat with 170-degree recline, 190-cm length, privacy canopy, massage setting; Laptop power outlet. A removable table.	For intercontinental flights, special meals can be ordered up to 36 hours before the departure. The passenger can call KLM to order the meal.	The Passenger can use the interactive controller and screen to send text messages to any mobile phone number or e-mail address anywhere in the world and receive replies right at the seat; Simply flip over the interactive controller, swipe the credit card through and the interactive controller doubles as a telephone.
Boeing 747 Boeing 767 and MD11 business class	Boeing 747 and MD-11: The seat is 150-degree recline, 60-inch seat pitch. Boeing 767: The seat is 135-degree recline, 55-inch seat pitch.		

Figure 2.11 KLM's installed office work infrastructure

2.2.5 American Airlines

Office characteristic / Type of cabin	Seat & Table	Food	Communication
Current business class	The seat: Increased recline with a 60 inch pitch ; Additional legroom; Advanced lumbar support; Ergonomic seat controls; Six-way adjustable leather headrest; Complete under-calf support; Individual laptop power outlet. A removable table.	American Airlines offers special meals to meet specific dietary needs at the passenger's request on select flights. The passenger can call American Airlines' offices to book the meal.	Individual satellite telephones.
American Airlines' 767-300 next generation business class (will be installed at the end of this year)	Newly designed electronic controllable seat where lean back to relax, sit up to work or lie flat to get some welcome shut-eye. And in between, if the passenger want to find his/her favourite position again, use the convenient memory feature; A privacy divider between the seats can be raised for additional privacy as well as shoulder room, especially when in a reclined or bed position; Two-source lighting illuminates the work table while an overhead light gives more generalized illumination; Individual laptop power outlet. A big removable table.		Individual satellite telephones.

Figure 2.12 American Airlines' installed office work infrastructure

2.2.6 Delta Airlines

Office characteristic / Type of cabin	Seat & Table	Food	Communication
Business class	Ergonomic seat with 60 " of pitch and recline a full 160°; Individual reading light; Increased console space; Battery-saving Empower™ system and power outlet allows the passenger to use laptop. A removable table.	Delta Airlines offers special meals to meet specific dietary needs at the passenger's request on select flights. The passenger can call Delta Airlines' offices at least 12 hours before the scheduled flight departure to book the meal.	Personal in-seat telephone

Figure 2.13 Delta Airlines' installed office work infrastructure

2.2.7 Japan Airlines

Office characteristic / Type of cabin	Seat & Table	Food	Communication
Business class	JAL Shell flat seat: Roomy seat pitch where the maximum seat pitch is 157 cm; A built-in massage function; Reading lights for each seat and can be adjusted to illuminate in any direction, at any angle; Each seat is equipped with a power outlet for plugging in laptop computers. A removable table.	JAL offers a wide range of special meals on long haul flights. The passenger can contact JAL or travel agents at least 24 hours prior to departure to book the meal.	Internet service: The passenger can use their own personal computer and WLAN card to access the internet service in real time; A telephone is installed in the controller of every seat, for placing credit-card calls.

Figure 2.14 Japan Airlines' installed office work infrastructure

2.3 Commercially available IFE systems

In this section, we will investigate the commercially available IFE systems which are provided by three major players Matsushita, Rockwell Collins and Thales.

2.3.1 Matsushita

Panasonic Matsushita (n.d.) X-series IFE system is the first IFE system to be based on the research of passenger preferences and consumer trends worldwide. The X-series delivers high-speed communication tools and state of art entertainment, including audio/video on demand, in-flight email, internet access and ever-increasing digital entertainment options for passengers. Some of the X-series features are as follows:

- **Audio &Video-On-Demand:** Personal IFE display device let users start, stop, pause, fast-forward, and rewind video, as well as search for movies of interest by keywords, titles and more. When selecting movies, passengers can view scenes from a choice of multiple camera angles. And for more audio pleasure, users can create, sort, and store audio personal play lists.
- **Games:** An expansive library of PC and Nintendo games covers nearly every game genre – puzzle, classics, trivia, action, adventure, strategy and more. Plus multiplayer options engage any number of passengers in friendly competition, from one-on-one bouts to cabin-wide trivia challenges.
- **E-Books & Audio Books:** A virtual library of electronic books, across a broad range of categories, is right at the passenger's fingertips for on-screen reading and listening.
- **Information:** Flight information includes detailed flight status information – position, path, altitude, and arrival time; live text news information includes timely, regionalized news content across multiple categories – World News, Sports, Business, Financial Markets, Weather, and Tech News. Updated every hour via SATCOM; destination information which include hotel, sightseeing, restaurants, shopping and other destination information, as well as geographical and cultural data; detailed maps information where aircraft and city maps display more detail, including elevations and points of interest.

Interactive maps offer zoom capabilities**;** gate information which includes connecting gate details and airport maps boost efficiencies inside the terminal and at check-in counters.

- **Connectivity:** Internet/Board intranet. Telephony: Voice over Internet Protocol (VoIP) converges voice and data transmission, providing faster, clearer digital connectivity.

2.3.2 Rockwell Collins

Rockwell Collins (n.d.) provides several TES series IFE systems. Among them eTES has not only all the benefits of TES - like Audio/Video on demand and interactivity but also with the same high-speed network connectivity they enjoy at home and in the office. Some of the eTES features are as follows:

- eTES is the first IFE system to adopt the proven broadband cabin industry standard Data Over Cable Service Interface Specifications (DOCSIS) Level 1.1 into its Ethernet network. eTES can provide data delivery bandwidth up to an amazing 1.6 Gbps.
- The system provides dynamically built menu pages. Menu choices are generated based on each request, creating a truly individualized passenger experience. For example, all eTES pages will be created in French, if that is the language selected by the passenger; banner ads for Paris-based restaurants and tourist attractions can be automatically generated should the flight's destination be Paris.
- Passengers are in complete control to select from the options provided to them. Movie title, language choice, start, stop, fast-forward, rewind and pause controls are all at their fingertips. Not only will passengers enjoy content delivery the way they want it, but airlines will also know exactly what they are listening to and watching. eTES collects usage statistics to assist airlines in determining an optimal content mix, thereby minimizing content costs and maximizing passenger satisfaction.

2.3.3 Thales

TopSeries is Thales's (n.d.) premier family of IFE systems that provide integrated solutions for entertainment, email, Internet access and in-seat laptop power. The latest system is I-5000 where all digital video and audio on-demand with greater bandwidth use a Gigabit Ethernet network. Some of its features are as follows:

- Functionality: Unlike other systems, the TopSeriesTM efficient design integrates broadband communications, in-seat power, and entertainment capability onto one platform. At the core of the system architecture, TopSeriesTM incorporates the web paradigm to promote the development of cost-effective applications for both passengers and airline operations.
- Ingenuity: TopSeriesTM revolutionizes an airline's cost of ownership bringing long-term expenses to a new low. The system's unique modular design can simultaneously support overhead, in-seat distributed and on-demand content distribution on a single aircraft. This approach accommodates maximum fleet commonality, installation flexibility, and future upgrade potential. System components are universal which simplifies installation, minimizes spare inventories, reduces training requirements, and significantly lowers overall weight and space requirements.

2.4 Conclusion

In this chapter, we first investigated seven major airlines' current installed IFE systems and office work infrastructures. We can draw the following conclusions:

1. All these airlines provide video/audio on demand systems. Using the remote interactive controller, the passenger can browser the menu and select the desired audio/video programs from the provided options. However, to find the desired program is not easy, firstly, the passenger needs to know how to use the interactive controller. Secondly, if the passenger is not familiar with the company's defined entertainment categories and the available options are many, he/she is forced to browse numerous selections before being able to find the desired audio/video program.

2. All the airlines we investigate did not fully explore the passenger's entertainment requirement implied by his/her personal information, bio signal and the aircraft fly situations, etc. Thus they can't provide situational awareness and personalized entertainment services to the passenger.

3. Most of the airlines provide the passenger a mobile office with an ergonomically designed seat, phone and internet access, etc. However, more efforts need to be done to provide the passenger a better office work infrastructure. For example, none of the airline we investigated provides a keyboard for user to input email content instead some of them provide the interactive controller which is far away from user's normal input habit.

In one word, the current installed in-flight service infrastructure can't fully fulfill the user requirements we investigated in chapter one.

The commercially available IFE systems provided by the major players Matsushita, Rockwell Collins and Thales are trying to address the gaps between the user requirement and current installed IFE systems. For example, Rockwell Collins eTES is trying to provide personalized entertainment services to the passenger by dynamically built personalized menu pages, collecting usage statistics to assist airlines in determining an optimal content mix, etc. Matsushita X-series IFE system is based on the research of passenger preferences and consumer trends worldwide and tries to provide the passenger desired entertainment services. Thales TopSeries I-5000 IFE system's modular and functionality based design make it more flexible and extendable. However, as shown in figure 2.15, these systems still did not explore the passenger's implicit entertainment requirements implied by his/her personal profile, bio signal and the aircraft flight situations, etc., not to mention making the entertainment system interface and contents adapt to these implicit entertainment requirements to provide the passenger situational awareness and personalized entertainment services.

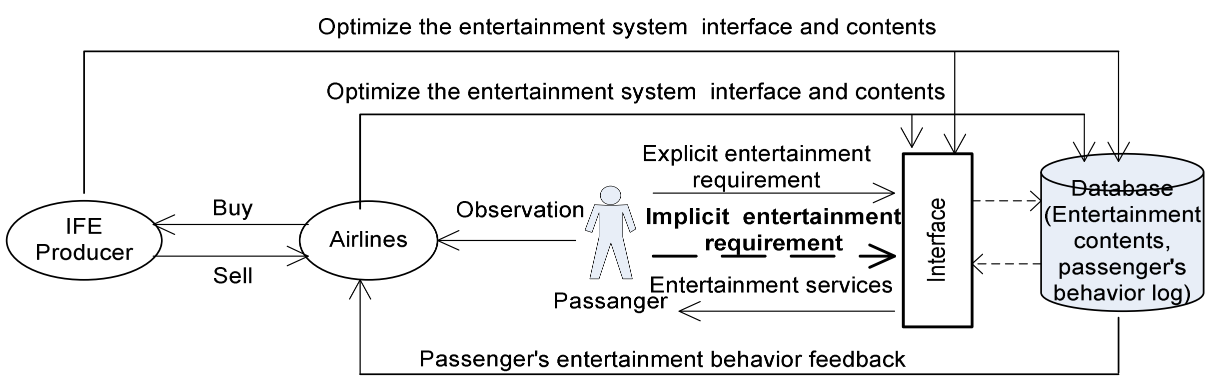

Figure 2.15 The adaptive relation between IFE producer, Airlines, Passenger and IFE system

3. Enabling Technologies

In chapter two, we have seen that if the passenger wants to enjoy the desired entertainment services, he/she must take a lot of efforts to browse the menu before being able to find them. From the adaptive system point of view, the IFE systems we investigated are user-adaptive systems where user and task characteristics are considered for adaptation. Context is any information that can be used to characterise the situation of an entity; an entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves (Dey and Abowd 1999). It is a powerful and longstanding concept in human-computer interaction. Interaction with computation is either by explicit interaction (e.g., pointing to a menu item), or implicit interaction (context). Implicit interaction (context) can be used to enrich or interpret explicit acts, making explicit interaction more efficient. Thus, by carefully embedding context-adaptive computing into the IFE systems, it can serve the passenger with minimal effort to get desired entertainment services. In this chapter, we will first investigate the state of the art of adaptive systems especially focusing on context-adaptive systems. Then the state of the art of user profiles is investigated. Finally we will also present other related technologies that could bring enhanced entertainment and office work experiences to the passenger.

3.1 Adaptive systems

First**,** we describe the state of the art for context-adaptive information systems reflecting the current needs of the user. Context-adaptive information systems reflect more than classical user-adaptive systems where user and task characteristics are considered for adaptation. In context-adaptive information systems the usage episode is additionally defined by the time and the location, by the physical and social environment and the technical infrastructure and eventually by relevant situational characteristic such as sound, light or movement. To begin with, the rationality of adaptive systems and the concept of context-adaptiveness will be described. Based upon the description of the three functions of adaptivity, i.e., (1) the interaction logging, (2) adaptation inference and (3) adaptation performance, we describe user-adaptive and context-adaptive systems and the role sharing between the system and the user during the adaptation process. At the end, the state of the art of application examples are presented for context-adaptive systems to understand the utility of context-adaptiveness in different fields of information and communication services.

Adaptivity of information systems has been discussed and developed since the early days of computing. It implies the adaptation of system functionality and interaction to the individual user needs. During task accomplishment both user and usage characteristics have been used to identify a misfit or a suboptimal fit between the user and the current system configuration. User characteristics together with task characteristics for individual help messages established a popular application of adaptive systems known as context-adaptive help systems (Fischer, Lemke et al. 1984; Kemke 1987; Schröder, Frank, et al. 1990). Technologies including location for specific information services for the current user position in the physical space established another popular application class recently known as location-aware services (Borriello, Chalmers et al. 2005). Oppermann (2005) shows how context-adaptive systems include user, task and location characteristics but goes beyond these dimensions and also includes characteristics of the physical environment (objects), the social environment (people) and the technical environment (devices, infrastructure, connectivity). The extension of user-adaptive systems to context-adaptive systems follows the progress of technical developments allowing identifying characteristics of these additional dimensions by specific sensor technologies.

3.1.1 From user-adaptiveness to context-adaptiveness

Classical user-adaptive systems are understood as intelligent systems adapting to user needs (Edmonds 1981). User-adaptive systems analyse the interaction of users with the system to adapt the system to the individual user. User-adaptive systems consider four characteristics of the system behaviour to be adapted to the user: (1) the information and service selection (content needed by the user), (2) the functionality (features needed to perform tasks), (3) the information presentation (modality and coding needed to receive the content), and (4) the human-computer interaction (methods needed to enter commands or data and to receive information and services). First user-adaptive systems compared to user-adaptable systems are discussed. Following Oppermann (2005) we present then the extension from user-adaptive to context-adaptive systems by considering additional determinants of adaptation in particular during user mobile activities. We will discuss the difference between context-adaptiveness and situation-adaptiveness the latter specifically considering a single episode in the activity process. Finally we will discuss three functional steps during the adaptation process: (1) interaction logging (Rauterberg 1993), (2) adaptation inference (Schröder, Frank, et al. 1990) and (3) adaptation performance (Bartneck et al. 2006; Salem, Rauterberg 2006).

Adaptiveness and adaptability and the concept of shared initiative: User-adaptive systems automatically perform adaptations based on the evaluation of the user behaviour and assumed user needs and consider user characteristics such as knowledge, interests, preferences, (dis-)abilities as well as task characteristics e.g. type of task, repetitiveness, state and phase of the task performance. Adaptive systems are complementary to adaptable systems where users can adapt system features manually based on the users' own identification of their needs. Adaptable systems provide adaptation methods and tools that are under the control of the user instead of the system. This distinction can be more fine-grained and complemented by activities dedicated to the specific actors. Before an adaptable or adaptive system is delivered to the user the requirement engineers, the designers and the implementers have done their work to produce a system that is useful, usable and satisfactory for the users. If this job has been done perfectly there is no need for adaptability or for adaptiveness. But this ideal case will seldom occur (Rauterberg 1996). The tasks will be divers, the users will be heterogeneous and the tasks and the users' competence and expectations will evolve. These dynamics limit the customization of the system characteristics to the users during the lifetime of the system. For specific goals of users no specific tools may be efficiently developed because there are only a limited number of clients or the time between the user needs and a professional development is too short. Adaptations or new features will be needed after the development phase. Therefore adaptive and/or adaptable tools and methods are implemented in the development phase by the developer for adaptations in the usage phase. In the adaptable case the system provides these tools and methods to be detected, initiated and performed by the user. The users as actors select, perform and apply adaptability tools and methods to customize the system to their specific needs. In the case of adaptive systems, adaptation tools and methods are proposed, initiated and/or performed by the implemented adaptation mechanisms automatically. There are adaptive systems where the user gets adaptation proposals from the adaptive system before the adaptation is performed by the system. The user can accept or reject the proposed adaptations and if needed modify the results before he or she finally uses the accepted ones. There are users who are experienced and competent enough to work autonomously with both kinds of adaptations, i.e., they know when and how to adapt the system and they know if and how far they should accept or modify the proposed adaptive effects. But there are a lot of users – in particular occasional users – who need support for adaptation tools and methods and consultancy for the adaptation process and its side effects. Adaptive and adaptable systems are not mutually exclusive approaches but both can be combined to enlarge the end user's capability to be effective, efficient, but also autonomous without being under the exclusive control of the system. Adaptive and adaptable systems together provide means for end-users to adapt their genuine working tools. Both methods increase the match between user needs and system attributes once the development of the system has been finished. Adaptive systems can propose adaptation steps to the user who can reject, accept or monitor the adaptation proposals; the user can also initiate an adaptation that is then performed by the system to reduce the practical adaptation workload for the user. Such shared initiative and shared control approaches have been proposed for adaptive information systems (Oppermann 1994). The adaptive aspect of system's adaptations is focussed in this overview. The combination of adaptive and adaptable features establishes a chance for the user to receive proposals and support for adaptations by the system but remains in control about the process and its results.

Context adaptiveness: During the history of user-adaptive systems the spectrum of dimensions included into the analysis of adaptations for user needs has been extended. In the eighties, the focus of user-adaptive systems was a user model defined by personal characteristics and preferences together with a task model defined by task characteristics (Edmonds 1981; Kobsa and Wahlster 1989). Later, in the nineties interests developed beyond user-adaptiveness and moved more generally to context-adaptiveness: Context may be defined as "any information that can be used to characterise the situation of an entity; an entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves" (Dey and Abowd 1999). In this abstract definition "any" information that is relevant to characterise the situation of an entity is used to specify context. This abstract definition is correct, meaning that for different domains and different purposes "context" has specific definition elements. At the begin computers were only used for business and at the workplace. In the later development of the information technology computers were also used in the leisure time and at other places than the workplace. So other dimensions made sense to be included into the definition of the context of use. An abstract definition of context in the definition by Dey and Abowd is still correct but it may be simply helpful for a focused and comprehensive view to explicitly name prominent dimensions in the definition of context. Four dimensions often are considered for the context: (1) the location of the user in either the information space or in the physical space, (2) the identity of the user implying the user's interests, preferences and knowledge, (3) the time (time of working hours, weekend, etc.) and (4) the environment of the current activity (Schilit, Adams et al. 1994; Dey and Abowd 1999). These dimensions are currently exploited for embedded, ambient or disappearing computing (Streitz and Nixon 2005). The most prominent dimension is the location because the availability of small and portable devices and location awareness technologies allow variant use at different places. Information and communication systems more and more support mobile activities during the whole process distributed over time, location and social communities including mobile and static episodes. Considering the whole process of activities allows the system to take more and more observations about the usage into account. These observations include the user's interaction with the system, his/her navigation in the physical and information space and his/her interaction with other users and with artefacts in the environment. Beyond user and task models also models of the navigation behaviour, models of the domain and the environment are needed to analyse and evaluate the complex history of the user. Physical sensors integrated into mobile devices like GPS-modules for localisation, motion sensors attached to the users hips and weather sensors placed in the environment enlarge the input for the inference models used to conclude adaptation needs. Thus, compared to user-adaptive systems context-adaptive systems can reflect the development of external elements beyond the characteristics of the user und the task. To summarise, context in the current development phase of the information and communication technology can be defined by the characteristics of (1) the user, (2) the task, (3) the time, (4) the location, (5) the physical and social environment and (6) the technical infrastructure in a given usage history. To select and prepare the appropriate information content, the appropriate functions, the appropriate information presentation and the appropriate interaction methods for the given context: the user characteristics are relevant to know about the knowledge, the habits, the preferences, the interests and the handicaps of the user; the task characteristics are relevant to know the next steps with the preconditions and follow-ups during the task performance; the time characteristics are relevant to know whether the situation is embedded in the working or private time of the user, whether a date or a duty is scheduled for the user with specific content requirements or announcement demands; the location characteristics are relevant to know about the probable objects in the vicinity of the user and to infer about other elements of the context (physical and social environment and the infrastructure); the location can be represented by a symbolic description (in chair) or by the absolute physical position (common geographical coordinates of latitude, longitude and altitude) or by relative physical position in a separate environment; the physical environment is relevant to know the requirements and constraints for information and communication services caused by noise, dark versus glare of the light, or working circumstances; the social environment is relevant to know about other people around with confidentiality or privacy needs, user communities with specific roles and information needs; the technical infrastructure is relevant to know about the current devise of the user and the peripherals for displaying or printing data or wired or wire less networks for transmitting data. Context-adaptiveness includes the momentary (current) values of these characteristics of the context. As a dynamic concept context-adaptiveness also includes their evolution over time; it includes the development of the values of the specified variable all along the history of the user.

Situation-adaptiveness: In the literature context-adaptiveness is sometimes also called situation-adaptiveness or situation-awareness (Katz 1994; Kirste 2001). Oppermann (2005) regards situation-adaptiveness as a part of context-adaptiveness. Situation-aware systems concentrate on the momentary profile of context variables. Thus, the situation can be defined as the relevant context characteristics at a specific point in time and space. Similarly Brezillon distinguishes context and situation awareness: "In our definition, the contextual knowledge is dependent on the situation (date, location, and participants). It is a sub-part of the overall context" (Brézillon 2002). Situation awareness does not include the long term development, i.e. the history, of context variables but infers adaptations based on the momentary values of these variables while context-adaptive systems analyse the whole history of the usage process in order to establish a continuous profile for the user. The described difference between context and situation is an analytical one. Actually, no situation exists without history and, on the other side; each process can be subdivided in periods with sequences of momentary situations. The basic idea of context- and situation-awareness is the same. The situated action approach (Suchman 1987; Nardi 1996) stresses the concrete situation of activity. The context-adaptive approach (Dey and Abowd 1999) includes the dynamic aspects in a long term process. Pragmatically, the main criterion for applying situation or context-adaptiveness may be the accessibility of data about short-term or long-term values of the user, the task and the other context variables. With the possibility of continuously tracking the user during the process of use context-adaptive systems can go beyond situation aware systems not being limited to adaptations to a specific point in time. Because context-adaptiveness includes situation- adaptiveness, context-adaptive systems can work even if a lack of long-term context data restricts observation and evaluation of the usage process to one specific moment.

Process steps of context-adaptiveness: Within the adaptation process three steps can be distinguished. (1) The interaction logging function records and categorizes all incoming interaction events according to predefined dimensions of characteristics of the usage process. (2) The result of this recording and categorisation is reported to a central adaptation inference function. (3) This adaptation inference function analyses the incoming interaction event messages, evaluates them according to predefined rules and algorithms and generates specific adaptation activities to be performed. The adaptation performance function consists of adaptations modifying or complementing the system's content and service selection, the systems functionality, the system's presentation methods and the system's interaction techniques. The interaction logging function indicates the observation of the user who performs a task with the system registering all relevant information and records this data in a systematic and continuous way. The adaptation inference function refers to the intelligent analysis of the accumulated data through statistical methods and learning algorithms. Hereby, different models about the user, task, environment, domain, and system represent the knowledge needed for drawing inferences. The adaptation performance function transfers the results of the inferences into respective options of operations adapting the functions or the interface of the system to the user's current needs. This understanding of the adaptation process can be applied to structure the functions of a context-adaptive system. Compared to a user-adaptive system the complexity of a context-adaptive system increases by including more variables to be observed such as the location, time, environment, domain, physical conditions and social actors. In particular external sensors are needed to observe the location, the physical and social environment and the technical infrastructure to establish a profile of the current context. In particular the interaction logging step is more complex in the case of a context-adaptive system than in the case of a user-adaptive system. The adaptation inference and the adaptation performance function reflect these additional variables to adapt the content, the presentation and the interaction to the given context.

3.1.2 Application of context-adaptive systems for mobile services

There are several areas of application for context-adaptive systems. Three areas are of prominent importance: (1) mobile shopping assistants, (2) mobile tour guides, and (3) mobile learning assistance. Mobile shopping assistants help users to find specific locations for products or sevices for currents needs (Bohnenberger, Jameson et al. 2002; Kaasinen 2003). A plausible example is the cheapest gasoline stations in the vicinity of the user (Kaasinen 2003). Mobile guides as the second area of application for context-adaptive systems can help users to find a specific destination or to find items of interest along a path in the physical space (Abowd, Atkeson et al. 1997; Cheverst, Davies et al. 2000; Sparacino 2002; Petrelli and Not 2005). The central task for mobile guides is to map the interest profile of the user with the attribute profile of the environment. City guides (Abowd, Atkeson et al. 1997; Cheverst, Davies et al. 2000) and museum guides (Baber 2001; Goßmann and Specht 2001; Sparacino 2002; Petrelli and Not 2005) are the main domains for mobile tour assistants. Mobile learning assistance is a third important area for context-adaptive systems (Klann, Humberg et al. 2005). Mobile learning reflects the current location to specify the learning demand of the user to perform his or her task. Mobile learning has close relations to mobile guide; both have to instruct the user. For mobile guides the goal is more interest driven by the person of the user and more curiosity or fun oriented. For mobile learning assistance the goal is more task-driven by the job of the user and more performance oriented. Fraunhofer IIS has developed several context-adaptive guiding systems: HIPS (Oppermann, Specht 1999), CRUMPET (Schmidt-Belz, Laamanen et al. 2003), LISTEN (Terrenghi, Zimmermann 2004) and SAiMotion (Oppermann, Eisenhauer et al. 2004). In all these systems the current location of the user and corresponding domain objects in the environment were continuously identified and mapped to the interests and tasks of the user. In HIPS and CRUMPET user adaptivity was used as the central concept, but the location and the physical environment was considered as central dimensions additionally to the user profile. In SAiMotion situation as the central concept was used, but the process of an excursion or visit prepared at home, performed on site and evaluated after the return that constitutes the dynamic concept of a context was considered as a central dimension additionally to the momentary situation. We will describe two of the mobile guides in more detail.

Situation-awareness in Motion (SAiMotion): In SAiMotion a nomadic information system was developed to support the preparation, the conduction and the evaluation of trade-fair visits. The goal of the systems was a simple information presentation adapted to situation, location, environment, environment, task and user. “Simple” means on the one hand adapting the selection and presentation to the context (a task, location, situation and user adapted choice of information); “simple” means on the other hand information presentation based on an intuitive interaction with the SAiMotion system. SAiMotion aimed to provide an exhaustive situation model identifying and using all relevant parameters for proactive information supply and user interaction. Information about the exhibitors were matched and presented according to the interest profile of the visitor. The system supports the scheduling of appointments, suggests personalized tours of the exhibition, and gives directions to points of interest. In situations without time pressure, the system suggests exhibitors and exhibits in the vicinity of the user matching the interest of the visitor but not being on the explicit tour list. The debriefing after the fair visit is supported through annotated tour data (electronic leaflets) and personal notes. The final integrated version of the SAiMotion system was developed for and applied and evaluated at the MEDICA 2003 in Duesseldorf. Results of the evaluation supported the expectation that the contextualised fair guide extends existing media in information rich environments. The system functionality and the interaction methods of the system have been accepted and appreciated by the users while more precise localisation and more comfortable interaction in the information space of a fair was expected (Oppermann, Eisenhauer et al. 2004).

3.2 State of art of user profiles

3.2.1 Environment awareness

User profiles were suggested as an improvement for a variety of applications. From query enhancement (Korfhage 1984) and digital libraries (Amato 1999), the personalisation of websites (Goel 2002), and enhanced interpersonal communication (Lukose 2003). Current trends are the integration of user profiling in the delivery of services for an aware environment such as customized museum tours (Oppermann 2005; Bartneck et al 2006), or exhibitions (Kraemer and Schwander 2003). Environment awareness for multiple users is based on (1) the environment awareness of individual users, (2) the adaptation to the users as a group and as individuals. The User profiles must contain user preferences regarding the service to be offered (see Figure 3.1). The merger algorithm must be adaptive and react to users changing interests. Such changes in interest can be detected from group and individual behaviour.

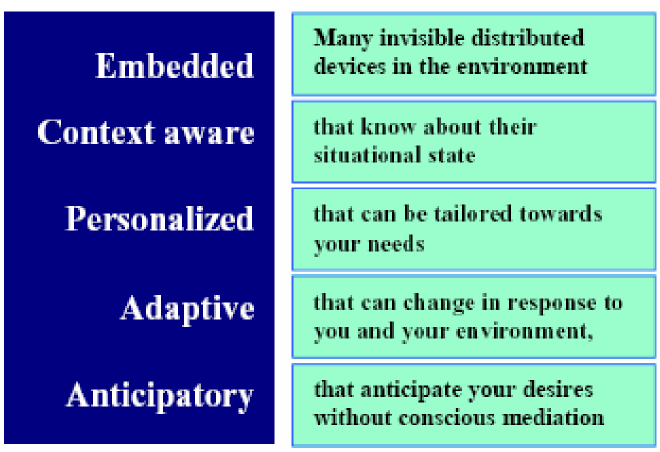

Figure 3.1: Aspects of Ambient Intelligence (taken from de Ruyter 2003).

Quiroga and Mostafa (2002) conducted an experiment to see how relevance feedback could be used to build and adjust profiles to improve the performance of filtering systems. Data was collected during the system interaction of 18 graduate students with SIFTER (Smart Information Filtering Technology for Electronic Resources), a filtering system that ranks incoming information based on users' profiles. The data set came from a collection of 6000 records concerning consumer health. In the first phase of the study, three different modes of profile acquisition were compared. The explicit mode allowed users to directly specify the profile; the implicit mode utilized relevance feedback to create and refine the profile; and the combined mode allowed users to initialize the profile and to continuously refine it using relevance feedback. Filtering performance, measured in terms of Normalized Precision, showed that the three approaches were significantly different. The explicit mode of profile acquisition consistently produced superior results. Exclusive reliance on relevance feedback in the implicit mode resulted in inferior performance. The low performance obtained by the implicit acquisition mode motivated the second phase of the study, which aimed to clarify the role of context in relevance feedback judgments. An inductive content analysis of thinking aloud protocols (Quiroga and Mostafa 2002) showed dimensions that were highly situational, establishing the importance context plays in feedback relevance assessments. Results suggest the need for better representation of documents, profiles, and relevance feedback mechanisms that incorporate dimensions identified in this research.

3.2.2 Merging techniques

Currently there are three merging techniques used: Boolean logic, Vector space model and probabilistic model (Chen 2000). Collaborative filtering systems have also been used (Kohrs 2000), (Ko 2003). Boolean logic is based on the merging of the profile by similarity reinforcement of the profile parameters and at the same time the mutual exclusion of conflicting parameters. The Boolean logic has it limitations, as the weighting of the parameters is difficult to include. The vector space model has more potential for weighting. Essentially each parameter of the user profile is associated with a dimension in a vector space. The weighting is translated into a coordinate along each dimension. Limitations of this technique lie in the lack of scope for predictability and merging. Finally the probabilistic model, which relates to the assessment of the frequency of occurrence of a parameter, has limitation in that there is not always a correlation between the frequency and the importance of a parameter.

3.2.3 Conflict resolution techniques

Our understanding of conflicts is that of occurrences when there is a contradictory set of NRDs, or there is an overlapping set of NRDs. Some of the conflicts can be easily resolved when they involve desires or requirements. The environment can either make a decision based on the ranking of the desires and requirements as available in the user profiles or could assess the comparative ranking of the users. However difficulties arise when needs or requirements are contradictory or overlapping. Two metaphors could be used the "intrusive butler" or the "reserved housemaid". With the "intrusive butler" the system will assess the history of the NRDs in conflict and if for example there is a track record of regular occurrence and fulfilment of one of the NRDs then it would take precedence. In the case of a "reserved housemaid" configuration the environment will suggest the fulfilment of the various NRDs using extra resources such as a different room or in the case of the TV programme to record on VCR one of the alternative to be shown later. Suggesting a relocation for the users could avoid them entering into conflict.

3.3 User bio signal modeling

For detailed state of art of user bio signal modelling, please refer to work package 1 deliverable 1.1.

3.4 Other technologies

Virtual keyboard: Virtual keyboard (Virtual Devices Inc. n.d.) is a full size keyboard with a virtual mouse of light projected on to any surface. This means that it can't be broken, never needs cleaning (no spread of infection), sets up with no wiring, and takes up no room when not in use since it disappears. It is keyless, button-less, and switch-less – nothing to collect dirt. The virtual keyboard works just as a traditional keyboard. Touching a key's image generates a unique electronic signal corresponding to the key's image that was touched.

Wii: The Wii is a video game console released by Nintendo (n.d.) Company in November, 2006. A distinguishing feature of the Wii console is its wireless controller, the Wii Remote. It is a one-handed controller that uses a combination of accelerometers and infrared detection (from an array of LEDs inside the Sensor Bar) to sense its position in 3D space. This allows users to control the game using physical gestures as well as traditional button presses. The controller connects to the Wii console using Bluetooth, and features force feedback, 4KB non-volatile memory and an internal speaker; the console also notably features WiiConnect24, which enables it to receive messages and updates over the Internet while consuming very little electrical power.

3.5 Emerging business model

For many years, in order to foster customer loyalty, airlines offer a passenger rewards such as bonus miles, speedy services, free hotel, etc. if the passenger has applied a club or reward cards from them. However, most of the rewards services the airline provides are just simple repetitive services not "improved services" which means to provide more personalized user services based on the observation of his/her past behaviors on board.

The adaptive system related technologies make it possible to provide the passenger "improved services". For example, the more time a passenger spent on board of an airline's craft, the better user profile and bio signal model can be built based on the mining of the passenger's past behaviors. Thus the more personalized services can be provided by the user profile and bio signal based adaptive systems.

4. Conclusion

In the first chapter, we investigated the user in-flight service infrastructure requirements. In the IFE part, we investigated the user implicit entertainment requirements implied by the passenger's age, gender, etc. personal information and different fly situations. Due to the passenger's psychological modelling is still under investigation, the user's implicit entertainment requirements implied by his/her psychological status have not discussed in this deliverable. For the passenger's explicit entertainment requirements, from user's point of view, he/she wants to find and enjoy his/her preferred entertainment services during the trip without much effort (e.g., browse the entertainment menu via user-friendly interaction devices and can easily find the desired entertainment services); in the in-flight office work part, we investigate the passenger's in-flight office work infrastructure requirements from seat, food, table, communication, computer and its accessories perspectives. We conclude that: (1) The passengers' entertainment requirements are personalized and situation-awareness; they want an entertainment system that can fulfil their implicit entertainment requirements intelligently and fulfil their explicit entertainment requirements efficiently. (2) The business passenger needs a mobile office infrastructure for him/her to drink, eat, do some paper works, and keep contact with his/her social network, etc. conveniently and comfortably.

In chapter two, we first investigated seven major airlines' current installed IFE systems and office work infrastructures. We draw the following conclusions: (1) all these airlines provide video/audio on demand systems. Using the remote interactive controller, the passenger can browser the menu and select the desired audio/video programs from the provided options. However, to find the desired program is not easy, firstly, the passenger needs to know how to use the interactive controller. Secondly, if the passenger is not familiar with the company's defined entertainment categories and the available options are many, he/she is forced to browse numerous selections before being able to find the desired audio/video programs; (2) all the airlines we investigated did not fully explore the passenger's implicit entertainment requirement implied by his/her personal information, bio signal and the aircraft fly situations, etc. Thus they can't provide situational awareness and personalized entertainment services to the passenger; (3) most of the airlines provide the passenger a mobile office with an ergonomically designed seat, phone and internet access, etc. However, more efforts need to be done to provide the passenger a better office work infrastructure. In one word, the current installed in-flight service infrastructure can't fully fulfill the user requirements we investigated in chapter one. The commercially available IFE systems provided by the major players Matsushita, Rockwell Collins and Thales are trying to address the gaps between the user requirement and current installed IFE systems. However, to our best knowledge, these systems still do not explore the passenger's implicit entertainment requirements implied by his/her personal profile, bio signal and the aircraft fly situations, etc., not to mention making the entertainment system interface and contents adapt to these implicit entertainments to provide the passenger situational awareness and personalized entertainment services.

In chapter three, based on the observation that most of the current IFE systems are user-adaptive systems where user and task characteristics are considered for adaptation. We investigated the state of the art of adaptive systems especially focusing on context-adaptive information systems. In context-adaptive information systems the usage episode is additionally defined by the time and the location, by the physical and social environment and the technical infrastructure and eventually by relevant situational characteristics such as sound, light or movement. We first described the rationality of adaptive systems and the concept of context-adaptiveness. Then based upon the description of the three functions of adaptivity, i.e., (1) the interaction logging, (2) adaptation inference and (3) adaptation performance, we described user-adaptive and context-adaptive systems and the role sharing between the system and the user during the adaptation process. At the end, the state of the art of application examples is presented for context-adaptive systems to understand the utility of context-adaptiveness in different fields of information and communication services. After that, user profile and bio signal which are important context information that implies user implicit entertainment requirements are investigated. In user profile part, we first describe the role of user profile in awareness environment, after that we describe the current ways to get user profiles and their advantages and disadvantages. Finally we present the current user profile merge and conflict resolve techniques if there is a contradictory set of NRDs. For the user bio signal modelling part, we refer it to work package 1 deliverable 1.1. At the end of this chapter we also checked other related technologies that can bring enhanced entertainment and office experiences to the passengers. We conclude that a new adaptive framework which includes the user profile modelling, bio signal modelling, adaptive algorithms, etc. needs to be proposed as the theory foundation of the IFE systems to fulfil the passenger's implicit entertainment requirements intelligently and explicit entertainment requirements efficiently.

Reference

Abowd G. D.; Atkeson C. G. et al. (1997). Cyberguide: A Mobile Context-Aware Tour Guide. *Wireless Networks* 3, pp. 421–433.

Air France, (n.d.). On board information. Retrieved November 20, 2006 from Air France's Web site: http://www.airfrance.us

Aliabadi F. et al. (2006). Proposal for Smart tEchnologies for stress free air travel.

Amato G.; Straccia U. (1999). User Profile Modelling and Applications to Digital Libraries. In *ECDL '99*, Springer Verlag LNCS 1696, Abiteboul,S, Vercoustre, A-M, (Eds.), pp. 184-197.

American Airlines (n.d.). On board information. Retrieved November 20, 2006 from American Airlines' Web site: https://www.aa.com/content/travelInformation/ duringFlight /main.jhtml?anchorEvent=false

Baber C.; Bristow H. et al. (2001). Augmenting Museums and Art Galleries. *Human-Computer Interaction INTERACT '01*, pp. 439-447.

Bartneck C.; Masuoka A.; Takahashi T.; Fukaya T. (2006, in press). The Learning Experience with Electronic Museum Guides. *Psychology of Aesthetics, Creativity, and the Arts*.

Beals T.; Tucker M.; Vick M. (2003). A case study of DELTA Airlines. Report from Creative Media Services. Retrieved November 8, 2006 from Creative Media Services' Web site: http://www.creative-media-services.com/CMS_Delta_Airlines_Case_Study.pdf

Bohnenberger T.; Jameson A. et al. (2002). Location- Aware Shopping Assistance: Evaluation of a Decision-Theoretic Approach. In: *Mobile Human- Computer Interaction*, Pisa: Springer Verlag LNCS 2411, pp. 155-169.

Borriello G.; Chalmers M. et al. (2005). Delivering REAL WORLD - Ubiquitous Location Systems. *Communications of the ACM* 48 (3), pp. 36-41.

Brézillon P. (2002). Modeling and using context: Past, present and future. Technical Report, University Paris, 2002.

British Airways (n.d.). On board information. Retrieved November 20, 2006 from British Airways' Web site: http://www.britishairways.com/travel/onboard/public/en_gb

Buben G.; Rumbaut; Douglas S.; Massey F.; Bean D. (2006). Linguistic life expectancies: immigrant language retention in Southern California. *Population and development review*, 32 (3) 447-460, September, 2006.

Casual Games While Paper (2006). Retrieved November 10, 2006 from the International Game Developers Association's Web site: http://www.igda.org/wiki/index.php/ Casual_Games _ SIG/ Whitepaper

Chen P.; Kuo F. (2000). An Information retrieval system based on a user profile. *Journal of Systems and Software*, 54, 3-8.

Cheverst K.; Davies N. et al. (2000). Developing a Context- aware Electronic Tourist Guide: Some Issues and Experiences. In: *Proceedings of the Conference on Human Factors in Computing Systems*, the Hague, Netherlands, pp. 17-24.

Crozes S. (2006). Human Factors Design Specification for the FACE project. Thales.

de Ruyter B. (2003). Challenges for End-User Development in CE devices. Paper presented at 10th International Conference on Human - Computer Interaction. In: *Proceedings of 2nd International Conference on Universal Access in Human - Computer Interaction*, Crete June, Greece, pp. 22-27.

Delta Airlines (n.d.). In-flight services, Retrieved November 20, 2006 from Delta Airlines' Web site: http://www.delta.com/traveling_checkin/inflight_services/index.jsp

Dey A.K.; Abowd G.D. (1999). Towards a better understanding of Context and Context-Awareness. College of Computing, Georgia Institute of Technology. Technical Report, 1999.

Dumur E.; Barnard Y. & Boy G. (2004). Designing for comfort. In: D.de Waard, K.A. Brookhuis, and C.M. Weikert (Eds.), *Human Factors in design* (pp.111-127). Maastricht, the Netherlands, Shaker Publishing.

Edmonds E. A. (1981). Adaptive Man-Computer Interfaces. In: *Computing Skills and the User Interface.* (Eds. Coombs, M. C.; Alty, J. L.) London: Academic Press, pp. 4-10.

ESRB (n.d.). Game ratings. http://www.esrb.org/ratings/index.jsp

Extra G.; Yagmur K. (2002). Language diversity in multicultural Europe: Comparative perspectives on immigrant minority languages at home and at school. Management of Social Transformations, Discussion Paper 63, United Nations Educational, Scientific and Cultural Organization.

Fischer G.; Lemke A. et al. (1984). Active Help Systems, In: Readings on Cognitive Ergonomics - Mind and Computers. In: *Proceedings of the 2nd European Conference, Gmunden (Austria),*1984, pp. 116-131.

Goel M.; Sarkar S. (2002). Web Site Personalization Using User Profile Information. In *AH 2002*, LNCS 2347, De Bra, P, Brusilovsky, P, Conejo, R, (Eds.), pp. 510-513.

Goßmann J.; Specht M. (2001). Location Models for Augmented Environments. In: *Ubicomp Workshop on Location Modelling for Ubiquitous Computing, Atlanta, USA*. pp. 83-88.

Heeter C. (1994). Gender differences and virtual reality: a non-user survey of what women want. *Virtual Reality World*, March, 1994. Retrieved December 20, 2006 from Web site: http://commtechlab.msu.edu/publications/files/gender.html

Japan Airlines (n.d.). On board information. Retrieved November 20, 2006 from Japan Airlines' Web site: http://www.jal.co.jp/en/inflight/inter/executive/

Kaasinen E. (2003). User needs for location-aware mobile services. *Pers Ubiquit Comput* 7, pp. 70–79.

Katz R. H. (1994). Adaptation and Mobility in Wireless Information Systems, Improving communication through "situation awareness". *IEEE Personal Communications* (First Quarter), pp. 6–17.

Kemke C. (1987). Representation of Domain Knowledge in an Intelligent Help System. In: *Human-Computer Interaction – INTERACT '8.* (Eds. Bullinger, H.-J.; Shackel, B.; Kornwachs, F.) Amsterdam: Elsevier Science Publishers B.V. (North-Holland), pp. 215-220.

Kirste, T. (2001). Situation-Aware Mobile assistance. In *Frontiers of Human-Centred Computing, online Communities and Virtual Environments*, R. A. Earnshaw, R. A. Guedj, A. v. Dam, and J. A. Vince, Eds. Springer-Verlag, London, pp. 99-115.

Klann M.; Humberg D. et al. (2005). iManual - Mobile Endgeräte als kontextsensitive integrierte Bedien- und Hilfesysteme. *Wirtschaftsinformatik* 47(1), pps. 36–44.

KLM (n.d.). On board information. Retrieved November 20, 2006 from KLM's Web site: http://www.klm.com/travel/nl_en/travel_information/on_board/ index.htm

Ko S.J. (2003). Group Typical Preference Extraction Using Collaborative Filtering Profile. In *EC-Web 2003*, LNCS 2738, Bauknecht, K., Min Tjoa, A., Quirchmayr, G., (Eds.), pp. 414-423, 2003.

Kobsa A.; Wahlster W. (1989). *User Models in Dialog Systems*, Berlin: Springer.

Kohrs A.; Merialdo B. (2000). Using category-based collaborative liftering in the active webmuseum. In *Proceedings of the IEEE Intl. Conf. on Multimedia* – Vol. 1, 2000, pp. 351-354.

Korfhage R. (1984). Query Enhancement by User Profiles. In *Proc. of the joint BCS & ACM Symposium on Research & Development in Information Retrieval*, pp. 111-121.

Kraemer R.; Schwander P. (2003). Bluetooth based wireless Internet applications for indoor hot spots: experience of a successful experiment during CeBIT 2001. *Computer Networks*, 41(3), pp. 303-312.

Livaditi J. (2002). A Media Consumption Analysis of Digital TV Applications**.** Media Consumption Analysis of Interactive Television Applications (UITV Article). Retrieved December 20, 2006 from Web site: http://uitv.info/articles/2002/09Livaditi/

Lueder R. (2004). Ergonomics of seated movement: a review of the scientific literature. Report of Humanics ErgoSystems Inc.

Lufthansa (n.d.). On board information. Retrieved November 20, 2006 from Lufthansa's Web site: http://www.lufthansa.com/online/portal/lh/de/ info_and_services?tl=1&l=en

Lukose R.; Adar E.; Tyler J.; Sengupta C. (2003). SHOCK: Communicating with Computational messages and Automatic Private Profiles. *In Proc. WWW 2003*, May 20-24, 2003, Budapest, pp. 291-300.

Matsushita (n.d.). IFE systems. Retrieved November 25, 2006 from Matsushita's Web site: http://www.mascorp.com/products.html

MPAA (n.d.). Film ratings. http://www.mpaa.org/FilmRatings.asp

Nardi B. A. (1996). Context and Consciousness: Activity Theory and Human-Computer Interaction. Massachusetts Institute of Technology Press.

NATO (n.d.). Movie rating system. http://www.natoonline.org/ratingsabout.htm

Nintendo (n.d.). Wii information. Retrieved November 27, 2006 from Nintendo's Web site: http://wii.nintendo.com/

Oppermann R. (1994). Adaptively supported Adaptability. *International Journal of Human-Computer Studies* 40 (3), 544–472.

Oppermann R. (2005). From user-adaptive to context-adaptive information systems. *i-com* 3, 4-14.

Oppermann R.; Eisenhauer, M. et al. (2004). *Abschlussbericht SAiMotion - Situation-Awareness in Motion*. Sankt Augustin: Fraunhofer Gesellschaft.

Oppermann R.; Specht M. (1999). A Nomadic Information System for Adaptive Exhibition Guidance. *Archives and Museum Informatics. Cultural Heritage Informatics Quarterly* 13 (2), 127–138.

Petrelli D.; Not E. (2005). User-centred Design of Flexible Hypermedia for a Mobile Guide: Reflections on the HyperAudio Experience. *UMUAI (Special Issue on User Modeling in Ubiquitous Computing)*, pp. 85-86.

Quiroga M. (2002). An experiment in building profiles in information filtering: the role of context of user relevance feedback. *Information Processing and Management* 38, pp. 671–694.

Rauterberg M. (1993). AMME: an Automatic Mental Model Evaluation to analyze user behaviour traced in a finite, discrete state space. *Ergonomics*, 36(11), pp. 1369-1380.

Rauterberg M. (1996). Umfrage zur individuellen Arbeitsweise mit dem Textverarbeitungs-programm MsWORD. In: *Tagungsunterlagen des 4. GI-Workshops Adaptivität und Benutzer-modellierung in interaktiven Softwaresystemen--ABIS'96* (VEW AG; Rheinlanddamm 24, D-44139 Dortmund, pp. 8.1- 8.8). Dortmund.

RIAA (n.d.). Parental advisory label program. http://www.riaa.com/issues/parents/advisory.asp

Rockwell Collins (n.d.). IFE product catalog. Retrieved November 25, 2006 from Rockwell Collins's Web site: http://www.rockwellcollins.com/ecat/at/ xxProductList.html?smenu=3

Salem B.; Rauterberg M. (2006, in preparation). Results of a wizard of oz experiment for a smart exhibition booth.

Schilit B.N.; Adams N. et al. (1994). *Context-Aware Computing Applications*. In: *Workshop on Mobile Computing Systems and Applications,* Santa Cruz, CA, pp. 85-90.

Schmidt-Belz B.; Laamanen H. et al. (2003). Location-based mobile tourist services – first user experiences. In: Frew, Andrew J.; Hitz, Martin; O'Connor, Peter (Eds.)*, Information and Communication Technologies in Tourism 2003*, Proceedings of the International Conference in Helsinki, Finland, 2003, (pp. 115-123) Springer.

Schröder O.; Frank K.-D.; Kohnert K.; Möbus C.; Rauterberg M. (1990). Instruction-based knowledge for a functional, visual programming language. *Computers in Human Behavior*, 6(1), 31-49.

Sparacino F. (2002). The Museum Wearable: real-time sensor-driven understanding of visitors interests for personalized visually-augmented museum experiences. In: *Museums and the Web (MW 2002)*, Boston. Retrieved December 20, 2006 from Web site: http://www.archimuse.com/mw2002/abstracts/prg_165000836.html

Streitz N.; Nixon P. (2005). Disappearing Computer. *Communications of the ACM* 48(3), 33–35.

Suchman L.A. (1987). *Plans and Situated Actions*. Cambridge, UK: Cambridge University Press.

Terrenghi L.; Zimmermann A. (2004). Tailored Audio Augmented Environments for Museums. In: *International Conference on Intelligent User Interfaces & Computer-Aided Design of User Interfaces,* Island of Madeira, Portugal January 13–16, 2004, pp. 334-336.

Thales (n.d.). IFE systems. Retrieved November 25, 2006 from Thales's Web site: http://www.thalesgroup.com/all/pdf/ife_brochure.pdf

TVPG (n.d.). TV ratings system. http://www.tvguidelines.org/ratings.asp

Virtual Devices Inc. (n.d.). Virtual keyboard. Retrieved November 27, 2006 from the Web site of Virtual Devices Inc.: http://www.millennia-3.com/virtualdevices/index2.htm

WATS (2006), World Air Transport Statistics Special 50th Edition, International Air Transport Association.

Appendix – IFE system’s input/output devices

Figure a.1: American Airlines’ (n.d.) 767-300 next generation IFE system in business class

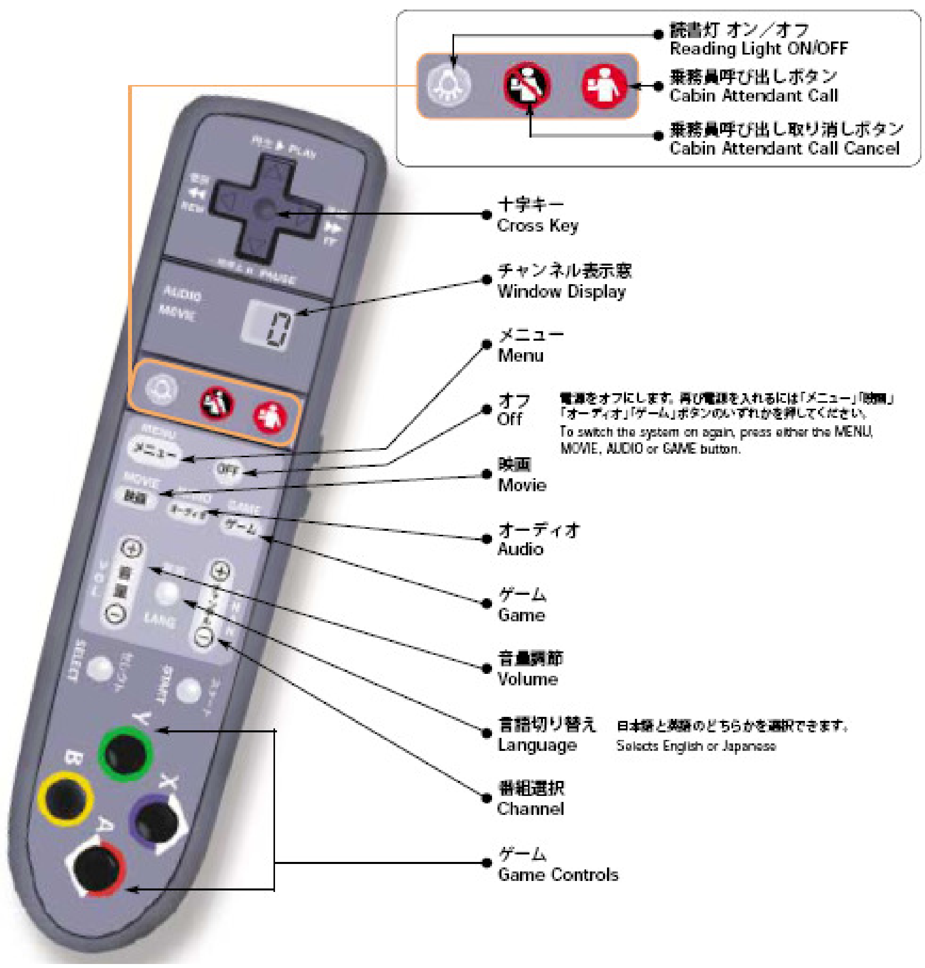

Figure a.2: Japan Airlines’ (n.d.) remote controller in business class