Join-In

Senior Citizens Overcoming Barriers by Joining Fun Activities

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Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities
http://www.join-in-for-all.eu/

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1 About Join-In

Join-In aims at providing the methodology and the technologies for elderly persons to participate in social activities and have fun via digital media.

Loneliness in the elderly is a major problem in elderly care. Studies in Britain show that more than half of the people over the age of 75 live by themselves. Many of these suffer from loneliness and social isolation[1]. Activities offered by social services do, however, often not reach those most in need. Challenges for the elderly include: social deprivation, low self-esteem or physical inability. Social isolation and health are closely related and may lead to a variety of physical disorders and even depression. Studies have shown the correlation between loneliness and poor health. Especially the effects on immune system, the cardiovascular system and the onset of Alzheimer's disease could be shown[234].

The Join-In project aims at counteracting loneliness in the elderly by providing a concept, the methodology and technologies for elderly persons to participate in social activities.

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[1] Office of National Statistics: Older people,. Living arrangements. At: http://www.statistics.gov.uk/cci/nugget.asp?id=1264

[2] CARMA – Care for the Aged at Risk of Marginalization (QLK6-CT-2002-03421) - Recommendations and Guidelines to Policy Makers. (2005). http://www.egga.ee/RecommendationsFinalwCoverTOC.pdf Last accessed:2/10

[3] Sorkin D, Rook KS, Lu JL: Loneliness, lack of emotional support, lack of companionship, and the likelihood of having a heart condition in an elderly sample. Ann Behav Med. 2002 Fall; 24(4):290-8

[4] Tomaka J, Thompson S, Palacios R: The relation of social isolation, loneliness, and social support to disease outcomes among the elderly. JAging Health.2006 Jun; 18(3):359-84

Fig.1 Join-In Platform

Join-In is setting up a social platform for the elderly; it allows communication by TV, Tablet and PC. A multi-player serious game for the elderly is being developed. The interest in gaming is high in seniors: In a survey performed in Germany with 1200 participants, age above 61, two out of three PC users stated that they enjoy playing games regularly on the internet[5]. Studies[6] could demonstrate the increase of cognitive skills, reaction times, self-esteem and the sense of well-being in the elderly when playing computer games. Another positive effect is that gaming is multigenerational and enables the elder generation socialising with the younger one, e.g. grandchildren. The concept includes exercising either by exergames or by moderated exercises as physical activity -besides supporting good health- counteracts the feeling of loneliness, while loneliness leads to less physical activity[7]. Recent results indicate that exergames create physical benefits and counteract loneliness[8.] Join-In encourages contacts with peers in the region and with family and friends living further afield - if necessary facilitated by an assistant.

Active participation is vital if the individual is to profit from the Join-In developments. Yet motivation for participation among the elderly is a challenge. One of the problems is the heterogeneity of the elderly, among other things regarding interests and health. Join-In is developing a methodology for elderly persons to participate in social activities. This is based on a thorough user requirement analysis. User groups are set up in Germany, Hungary, Ireland and Norway. The lead user group is based in Munich. Based on the results of the user requirement analysis and the analysis of relevant studies and related work a methodology for setting up a social networking platform which will encourage and enable involving homebound senior persons in social networking activities being developed. Digital inclusion and factors hampering its acceptance -such as accessibility, motivation, lack of skills and confidence- will be tackled and form part of the methodology. The involvement of user groups in four different countries will help us to achieve a European solution which will also be useful in other countries.

The Join-In project web-page:

         http://www.join-in-for-all.eu

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[5] OE24.at. Deutsche Studie - Sechs von zehn Senioren spielen am Computer. http://www.oe24.at/zeitung/digital/article318942.ece. Last accessed: 2/10

[6] Basak C, Boot WR, Voss MW, Kramer AF: Can training in a real-time strategy video game attenuate cognitive decline in older adults? Psychol Aging. 2008 Dec; 23(4): 765-77).OE24.at

[7] Hawkley LC, Thisted RA, Cacioppo JT: Loneliness predicts reduced physical activity: Cross-sectional & longitudinal analyses. Health Psychol. 2009 May; 28(3):354-63

[8] http://www.theatlantic.com/technology/archive/2011/02/physical-video-games-may-help-the-elderly-psychologically/71184

2 Introduction

This document describes the design of the social cognitive control training games to be developed for Join-In. The design of these games is driven by the requirements elicited from initial interviews, questionnaries and playtesting with the user focus groups, and will be further refined by user trials. As many of the potential users are unfamiliar with the possibilities of the technology, a design and development approach was needed that would enable the users to become familiar with the technology to enable them to refine their requirements. To this end, an Agile software development methodology was considered most appropriate for the development of the games for Join-In. In particular, Scrum, an iterative and incremental agile approach was chosen.

A necessary consequence of the development approach chosen is that this document must be added to and refined after each iteration of a game. The incremental nature of the design and development process means that the complete game design cannot be available in advance of implementation, only the design for the current iteration can be available. This gives this approach the considerable advanatage that the games can be significantly refined from the feedback acquired in playtesting with user groups so that the final games are likely to be games that the user groups are enthusiatic about playing.

This document will refer to other Join-In deliverables including D2.1 (user requiremement analysis), D3.1 (computer based games for adaptation/development), D4.1 (system platform requirements), D5.1 (exergame requirements), and D5.2 (design and implementation of prototype exergame). Relevant existing equipment and platforms are described in D 4.1. The state of the art is detailed in D3.1 and D5.1.

This document is organised as follows. First, the requirements gathered so far are detailed. Next, candidate games and the degree to which they meet these requirements are discussed. This is followed by the detailed design of two games currently being developed, both of which have playable prototypes implemented.

3 Requirements for Games

In the intial phase of the project, D2.1(pp. 26-27) provided a list of technical requirements for the games. These requirements were considered during the intial design of the cognitive control training game. The following is a ranked set of preliminary technical and general requirements as provided by the user groups:

1. The possibility to play cooperatively and competitively
2. Layout graphics should be adequate for elderly
3. Communication with others
4. The rules should not be complicated
5. The possibility to choose difficulty and speed levels for each person
6. Should have only one centre of attention with no distractions
7. Should be beneficial for mental fitness
8. The possibility of following progress
9. Should allow for goal setting
10. Must allow pauses

The user requirements were initially defined based on consideration of the following:

- The state of the art with respect to serious gaming for elderly users
- The fact that physical and cognitive restrictions are common amongst elderly users
- Observations of gameplay and interviews (as per the technical requirements above)
- Questionnaires including questions about computer usage, gameplay and exercising (as per the technical requirements above)
- Definition of personas and scenarios (as detailed in D2.1)

The following list of more general requirements (adapted from the exergames requirements in D5.1) is also considered significant for the cognitive control training game:

1. Must be perceived as useful
2. Must be fun to play (motivation/flow)
3. Must allow for multiple users at different locations to play simultaneously
4. Should allow for multiple users to play together at the same location
5. Must give positive feedback
6. Must follow "design for all" principles, including
   a. Adjustable speed
   b. Possible to play with limited fine motor skills
   c. Both visual and aural feedback
7. Must have different levels of difficulty (DDA)
   This can be used to accommodate users (including friends and family) with different ability levels and allow them to play together in a meaningful way.
8. Must be safe to use
9. Should allow for a health professional to see progress

4 Accessing the Games

For Join-In, it is envisioned that a variety of games will be available to the user and that they will be accessible via a single portal. An appropriate reference game is the series of mini-games found in Dr Kawashima's Body and Brain Exercises that was tested with the user groups on the X-box 360 console.

For the Join-In project, it was agreed amongst the partners that prototypes of an attention game, and a multiplayer memory card game would be developed initially.

In a final commercial release of the Join-In games, it is expected that the user will be able to choose between a variety of cognitive control training games (and exergames) via a single platform.

Figure 1 below is an example of the menu the (authenticated) users will see on the Join-In platform, where the games are accessed by selecting the appropriate balloon. The users must be authenticated on the social network before they can access the games.

Figure 1. Join-In portal main menu (Gedächtnistraining will activate the memory card game)

5 Design of Sustained Attention Game

5.1 Overview of the Game

This game is based on the cognitive Sustained Attention to Response Task (SART) test by Robertson et al. (Robertson et al., 1997), which uses a Go-No-Go signal detection task developed to measure lapses of sustained conscious attention. A typical SART test presents single digits approximately once a second for about two minutes. Volunteers are told to press a button after each number is displayed, except if that number is 3 (a distractor). This number only occurs on around 11% of presentations, and the user must concentrate to avoid responding to the distractor.

The Sustained Attention presents the player with four of five possible avatars, each with a different appearance. One of the avatars is wearing a crown and each avatar is attached to a balloon. The balloons (and avatars) move from the bottom of the screen upwards during which time the user must make a gesture before the avatars disappear off-screen. The response time window is approximately 3 seconds. If the avatar wearing the crown appears (Figure 2), the user must raise their right hand which is indicative of the 'Go' response in the SART test.

Figure 2. *The leftmost avatar is wearing a crown*

A marker on the right hand side of the screen is controlled by the player by raising their left or right arm. At the start of each round, the marker is drawn at the bottom right hand side the display. In Figure 3, the player responds by raising their right arm which causes the marker to 'latch' and register an input in the upper right quarter of the display.

Figure 3. *The player raises their right arm in response to the avatar wearing the crown.*

(In Figure 3, note the avatar wearing the crown is in a different position from Figure 2 as the game has been restarted).

If the avatar wearing the crown does not appear (Figure 4), the user must raise their left hand, which correlates to the 'No-Go' response.

Figure 4. *The player should raise their left hand, otherwise an incorrect response is recorded.*

The time window within which the player must respond may be regarded as a round. The game runs for ninety seconds during which time the player will experience approximately 30 rounds. The total number of correct and incorrect responses are reported to the player at the end of the game.

5.1.1   User Requirements

- **Requirement: beneficial for cognitive ability**
  A study by O'Halloran et al. (O'Halloran et al , 2011) suggests the SART test may provide a novel and valuable biomarker for falls in older adults. Some basic measurements can include:
    o   Number of correct responses
    o   Number of incorrect responses
    o   Mean response time

- **Requirement: must be fun to play**
  A standard SART test can be quite tedious for the participant, the challenge is to make it fun for the users. The Sustained Attention game contains a number of avatars instead of digits.   The prototype requires user responses to be given via the Microsoft Kinect system: the user must respond with a gesture (e.g. raise right hand) when a certain avatar is present (Go response), and respond differently (e.g. raise left hand or make no gesture) when a certain avatar is not present (No-Go response).

- **Requirement: Must have different levels of difficulty**
  As the user's performance improves, the time for which the pictures are visible decreases.

- **Requirement: The rules should not be complicated**
  The user interaction is simple and it merely involves the player raising his or her right hand in response to the stimulus presented on-screen.

- **Requirement: Should have only one centre of attention no distractions**
  The user must focus on four avatars only, there are no other entities in the game requiring the user's attention.

5.2 Game mechanics

The following section is a detailed description of the game mechanics which are the procedures and rules of the game.

5.2.1 Space

The game is played in two dimensions that consists of a foreground layer with avatars that move in a vertical direction and a background layer that scrolls left to right for a pleasing asthetic effect.

5.2.2 Objects

The player does not directly control any of the avatars and is simply required to respond to the presence of absence of one specific avatar (wearing a crown). The player has direct control over a marker that moves vertically (up or down) in response to the raising or lowering of the left or right arm. The marker turns green with an 'OK' symbol once it has moved upwards past a preset threshold. This action registers the players input for a given round. The four avatars appear simultaneously and move at a fixed speed from the bottom of the screen in a vertical direction. When the player gives a response by raising a left or right arm, a correct or incorrect response is given and the game changes state so that further inputs are ignored until the start of the next round.

5.2.3 Actions

The player actions are simply raise left hand or right hand for a given round. Currently, game progress is measured by the number of correct and incorrect responses to the onscreen stimulus. The game could be extended to measure the mean response time, so progress could be a composite measure of correct responses and response time.

5.2.4 Skills

The designers of the SART test interpret performance as reflecting the ability to sustain attention, which they define as "the ability to self-sustain mindful, conscious processing of stimuli whose repetitive, non-arousing qualities would otherwise lead to habituation and distraction to other stimuli" (Robertson et al., 1997). A further study by Manly et al., 1999 found that the response time associated with a correct response to no-go trials (i.e. where the participant must not respond to the stimulus) amongst neurologically healthy participants averaged at 380ms.

Relevant player skills are reaction time (for their age grouping) and accuracy.

5.2.5 Chance

The ordering of the four avatars is randomised every round so the user is forced to quickly scan all four before responding. Additionally, the avatar wearing the crown appears approximately 11% of the time so its appearance cannot be easily predicted.

5.3 Software design

5.3.1 Overview of system architecture
The block diagram below (Figure 5) provides an overview of the system architecture, showing key components.
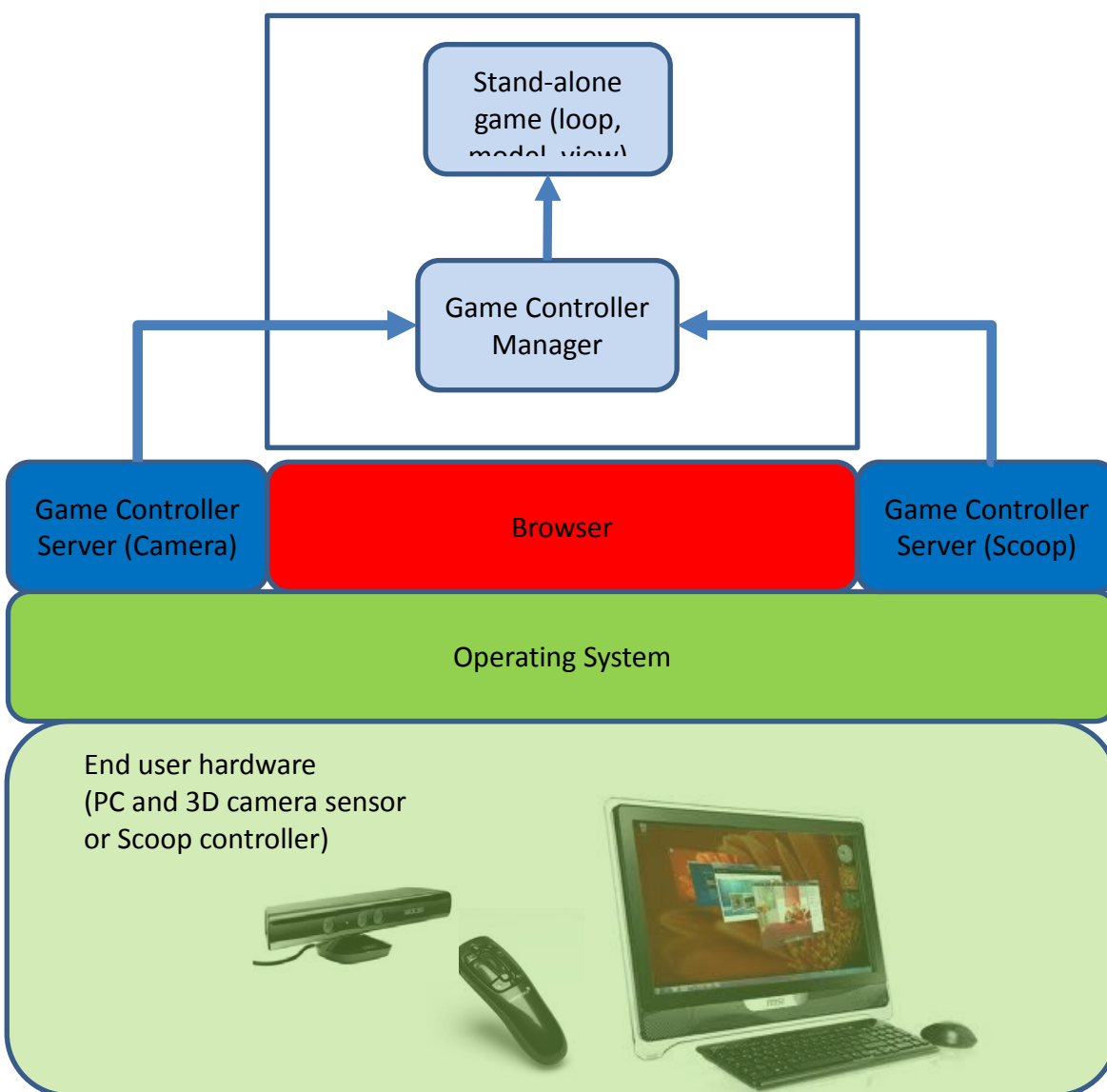
Figure 5. System architecture for the sustained attention game

Notes:

1. The Game Controller Server is a native application that runs on the host operating system on the end user hardware. A separate server application is required for each game controller that offers functionality beyond that of a traditional input device such as a mouse. For example, the server component developed to capture skeletal data from the Microsoft Kinect camera can track up to 20 joint positions in realtime. This data is transmitted to the Game Controller Manager, a Javascript application running inside the web browser, using the WebSocket communication channel.

2. The Game Controller Manager receives data from the Game Controller server and makes it available to the game. The Game Controller Manager will receive notification through a WebSocket message event that data is available from the server. The SART game can use either the Kinect camera controller or the Hillcrest Scoop controller as input devices.

3. At present, the Game is a standalone Javascript application that does not require hosting on web server. It is envisaged that the game will be further developed and integrated into the social platform if so desired by the user groups (the immediate focus of the developers is on the multiplayer memory card game as described in section 5).

6 Design of Memory Card game

6.1 Overview of the Game

The memory card game, also commonly known as the game of 'concentration', is a turn based card game. The game consists of ten pairs of cards arranged in four rows of five cards. Initially, the cards are all placed face down. Each player takes turns to try and match pairs of cards by selecting the two cards they wish to 'turn over'. When two cards are matched, they remain drawn in a 'face up' position and form no further part of the game. A player is rewarded for a successful match by getting another turn. The game ends when all ten pairs have been matched and the winner is the player with the most matches.

6.1.1 User Requirements

- **Requirement: must be fun to play**
  To introduce an element of friendly competition and fun, the game makes use of rounds, where the overall result is based on the outcome of a number of rounds, for example first to win 3 games.

- **Requirement: layout graphics should be adequate for the elderly**
  The game interface is minimalist and consists of four rows of five cards. Both player names and scores are displayed at the top with a turn indicator.

- **Requirement: should have only one centre of attention no distractions**
  The player must select two cards on their turn and must try to memorise which cards are uncovered when it is not their turn. There are no other in-game events they must manage or respond to.

- **Requirement: beneficial for cognitive ability**
  It is now widely accepted that there is nothing fixed in the trajectory of how brain functions evolve as people age. The brain possesses a characteristic known as neuroplasticity which refers to an ability to change itself over time, for example, learning by adding or removing connections between brain cells (neurons) and adding new neurons. A study by Small (Small et al. 2006) demonstrated that frequent memory exercises, such as playing memory games can help strengthen and improve memory.

  The memory card game will make use of a part of memory called visuo-spatial memory which deals with the storage and manipulation of the spatial relationships among objects within the field of vision. Studies have shown that visuo-spatial memory has limited capacity and that when presented with more than a few simple objects, human observers store a

high-resolution representation of a subset of the objects and retain no information about the others (Zhang et al 2008).

Jimison (Jimison et al., 2007), developed a model of cognitive performance for a memory card game that uses the notion of a "leaky" memory buffer. A hypothetical working memory size was computed from the average "life expectancy" of the items in the memory buffer derived from a survival function. A card that has been seen at a given location would enter the buffer and remain there until its match would be uncovered. When the matching cards are removed from the board, the corresponding cards are dropped from the buffer. The observed average memory buffer size was normalized for an individual player to obtain a metric of memory.

The memory card game will use a model that will continually evaluate the player's performance. After every turn, the player is scored based on the 'soundness' of their move. In an ideal scenario, a player will make no mistakes by picking a matching card that he has previously seen, or picking a card at random that has not yet been uncovered. We define a move in the game as the turning of a second card in an attempt to form a matching pair. Most moves that do not result in a matching pair may be considered erroneous. The degree of error associated with a move is based on:

- the time elapsed since the matching card was seen (the smaller this is, the more significant the error)

- how many times it has been seen so far (the bigger this is, the more significant the error)

- the number of cards currently in visuo-spatial memory (the smaller this is, the more significant the error)

An algorithm will weigh the above three measures to compute a score between 0 and 100 after each turn and the players performance will be computed as the average of this score in a single game. The performance data will be stored in the social network as part of the player's profile.

- **Requirement: longevity of game**
  The card game consists of multiple themed decks, where each deck has a number of pairs of cards.
  Players can create their own decks of cards, using images or photographs which may depict a story they could recount to other players. The Join-In platform will offer users the ability to upload and tag images that they may wish to share publicly (through the memory card game or other means).

- **Requirement: must have different levels of difficulty**
  For players of significantly different skill levels, there are several ways in which difficulty can be adapted. For multiplayer competitive games, it is important to try to achieve a state of equilibrium so that players of unequal skill levels each have fair chances of winning. For

example, the game may seamlessly grant a weaker player certain bonuses while a much stronger opponent may have one or more penalties applied. A Dynamic Difficulty System (DDA) has been designed for this purpose and is described further in section 5.2.7.

- **Requirement: the possibility to play cooperatively and/or competitively**
In competitive mode, the goal of the game is for the player to match more pairs of cards than the opposing player.

   The cooperative play mode requires two players to match all the cards within a fixed number of turns. Communication between players will be facilitated by the social network with a Voice-Over-IP service. The number of turns (within which the game must be won) is calculated from the combined skill level of the players.

- **Requirement: not to feel pressured while playing**
There is no time restriction placed on a turn which is conducive to users not feeling pressured while playing.

- **Requirement: known elements ease access to the game**
The majority of elderly people in the user groups have experience of cards games such as this one, providing a significant motivational aspect to start users playing the games.

- **Requirement: The rules should not be complicated**
The rules of the game are simple: the player is required to match a pair by turning over any two unmatched cards. The winner is declared as the player with the most matches once all the cards have been paired.

- **Requirement: Must allow pauses**
The game implicitly supports this requirement. The card is turn based, with no restrictions on the amount of time a player has to make their move.

- **Requirement: The possibility of following progress**

   The game will record metrics about the player's performance on a continuous basis during play. The purpose of these metrics is to give an indication of the player's visuospatial memory and to provide them with positive feedback when they improve. Their progress can be measured by a number of metrics such as:

   - Current skill level (this should correlate well with visuospatial memory).
   - Chart of skill level over last *n* games played.
   - Number of games won and lost to date.
   - Number of games lost against players in a similar skill level group.
   - Number of games won against players in a similar skill level group.
   - Average winning margin (i.e. average of (winning score – losing score)).
   - Average losing margin.
   - Co-operative play: lowest number of card turns to win.

   The metrics are computed by the game and stored on a database on the social network. The data is recorded after each turn and after each game as appropriate (in both single and multiplayer modes).

Summary of requirements

Requirement	Supported in prototype
[TOP 10 RANKED REQUIREMENTS]	
The possibility to play cooperatively and competitively	○
Layout graphics should be adequate for elderly	●
Communication with others	●
The rules should not be complicated	●
The possibility to choose difficulty and speed levels for each person	-
Should have only one centre of attention no distractions	●
Should be beneficial for the mental fitness	●
The possibility of following progress	-
Should allow for goal setting	-
Must allow pauses	●
[OTHER REQUIREMENTS NOT RANKED BY USERS]	
Must be fun to play	○
Longevity of game	-
Must have different levels of difficulty	-
Not to feel pressured while playing	●
Known elements ease access to the game	●

Legend:

   - = **Not supported at present**

   ○ = **Partially supported**

   ● = **Fully supported**

6.2 Game mechanics

The following section is a detailed description of the game mechanics which are the procedures and rules of the game.

6.2.1 Space

The boundaries of the space in which the game is played is restricted to the area in which the cards are drawn. Play occurs in two dimensions as the cards are arranged in a grid like manner. The digital game mirrors the physical game but provides a number of distinct advantages:

- Dynamic Difficulty Adjustment system which means the game can increase or decrease the difficulty of the gameplay in line with the ability of the player.
- the ability to play with different images or photographs that have meaning for the players
- the automatic collection of performance metrics that will enable the player to monitor his or her progress over time.

6.2.2 Objects

The memory cards are the sole objects the player can engage with. Each memory card belongs to a 'deck' of ten unique cards, where the other ten cards are simply duplicated by the game. Each memory card has an associated image which the player must attempt to match with another card.

Each card can be in one of two states: face down or face up. The image for each card by default is not shown, which means the card is drawn face down. A state change occurs from face down to face up when the card is selected by the current player. The opposing player will also see the state change occur without interacting with the cards.

When a pair of cards is matched, the state for both cards will change to the face up position and remain that way until the end of the game. The card states are known to both players at all times.

6.2.3 Rules

The player is required to match more pairs of cards than their opponent in order to be declared the winner in a single game. It is possible that there may be a tie for first place. The game is turn based which alternates between both players. A player is allowed to turn over at most two cards. However, a successful match is rewarded with another turn for that player.

The rules of the game and the player interaction are very simple thus players should feel in control at all times. Feeling in control is one of the characteristics of flow which is discussed in deliverable 3.1.

The principal of risk/reward is straightforward. A player is rewarded for matching a pair with an increased score and another turn. The risk is that an incorrect guess will give the opposing player given information about an unknown card that will enable them to form a pair. A player can adopt a certain strategy to minimise this risk which is discussed in the next section 'Skills'.

6.2.4 Skills

As the game progresses, the location of various cards will become known to both players. The more skilled player is expected to have a better short-term memory capacity for visual information.

It is common strategy for a player to turn over a card they are sure of first, but then have difficulty in locating its pair. A better strategy is to turn over a less certain card first so that the more certain card can be left face down if there is no match.

An optimum strategy can be developed quite to maximise a players chance of winning, working on the assumption that both players will recall every card uncovered in the game. Assume that of the remaining cards in play, n are known to the player and the remaining t cards are unknown. The player will initially select an unknown card from t and pair it with one of the cards from n if it makes a match. If the card does not match any known card, one of the n known cards should still be chosen in order to reduce the information provided to the other player.

6.2.5 Chance

The game arranges cards into decks of ten unique cards per deck. When the game commences, a deck is chosen at random and the images within that deck are shuffled to ensure the same sequence of cards is not presented each time. The player will also be given the choice to play the card game with their own custom images or photographs. In this case, the game will simply select ten images at random from the collection provided by the player.

These are the only random elements in the game and are necessary to provide an interesting challenge to players of different skills.

6.2.6   Dynamic Difficulty Adjustment (DDA)

A player's skill level is computed as the average of their performance score from each game, i.e. it will be a number in the range 0 to 100. The difficulty system takes into account the difference in skills between two players. For example, if player one has a skill level of 70 and player two has a skill level of 30, the game calculates the difference as 40. Player one has a handicap value of -40, indicating they should have a minor penalty applied to moves, and player two and handicap of +40 indicating they should have a minor bonus applied to their moves. The following table illustrates the bonus/penalty system for players with various skill differences:

Skill Difference	+	-
0-10	no bonus	no penalty
20-30	slight bonus *Example:* *All cards are revealed to the player* *for a brief period of time at start of* *game.*	no penalty
40-50	minor bonus *Example:* *Once the player turns the first card,* *the matching card is one of four* *possibilities highlighted. This bonus* *is disabled when there are two or* *less remaining pairs to match.*	no penalty
60-70	moderate bonus	moderate penalty

	Example: *Combination of slight bonus and* *minor bonus.*	*Example:* *The player will only see their* *own card selections; the cards* *turned over by the opposing* *player are not revealed.*
80-90	major bonus (assistance) *Examples* *Once the player turns the first card,* *the matching card is one of two* *possibilities highlighted.* *or* *The player gets two chances to pick* *the second card.*	major penalty *Example:* *The player will only see their* *own card selections; the cards* *turned over by the opposing* *player are not revealed.* *The cards selected by the* *player are turned face* *down after a shorter than* *usual period of time.*

Users have also expressed a desire to be able to choose difficulty levels. For example, players with very similar skill levels may wish to play without the DDA system. In this case, users will be given an option to select one of three preset difficulty levels at the start of a game: easy, medium or hard. For 'easy' play, the game operates as normal for both players with no bonuses or penalties. In the case of 'normal' play, the moderate penalty will apply to both players. On 'hard' difficultly, the major penalty will apply to both players.

6.3 Player Profile

A player profile consists of the following:

Player ID	Unique identifier of player
Name	Player's name (not unique)
Profile picture	A picture a player selects as a representation of themselves
Friends list	A list of a player's friends who he or she can invite to play
Skill level	A model that represents the player's skill. This will be used to dynamically adapt the difficulty of the game to the player.
Performance data	Data showing how well the player performed. This includes metrics such as the number of games won and lost overall and against players in a similar skill level group, the average winning and losing margin overall and against players in a similar skill level group. Some of the data will be graphically presented to enable the player to see their progress over time, for example a chart of skill level of the last *n* games played.

6.4 User stories

To help in the planning of games, different user stories have been defined. Each user story is presented below with a title, description, conditions of satisfaction and, where appropriate, a storyboard.
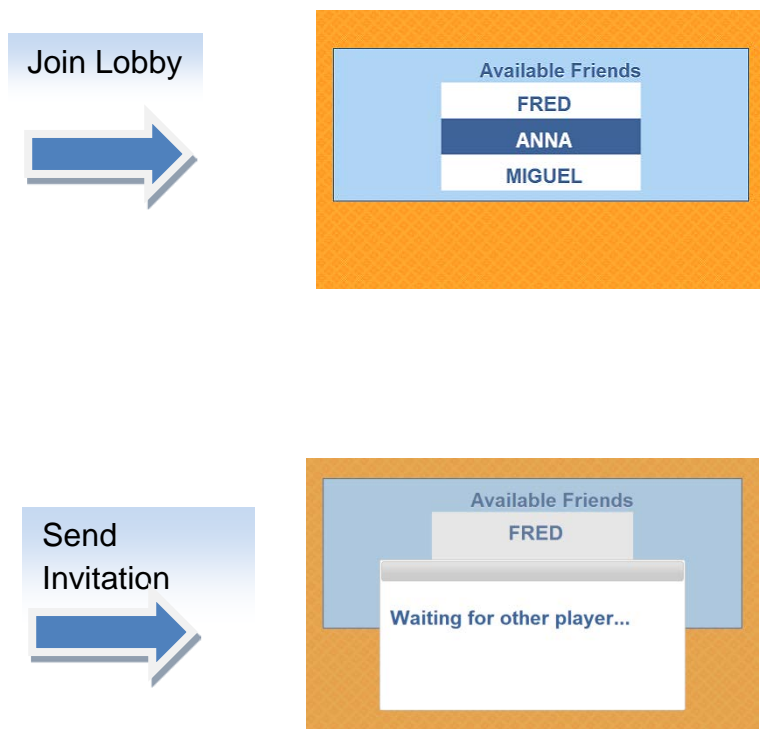
Title: View friends online
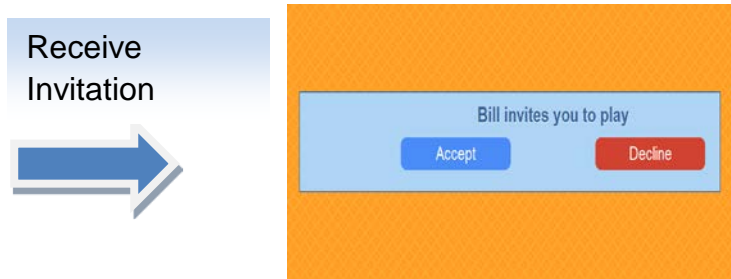I want to see which of my friends are online so I can invite them to play a game with me.

Conditions of satisfaction

- I can join a game lobby.
- I can see my friends who are currently online in the lobby.
- I can invite a friend to play.
- I can receive an invitation to play from a friend.
- I can decline an invitation to play.

Storyboard

Join Lobby

Available Friends
FRED
ANNA
MIGUEL

Send Invitation

Available Friends
FRED
Waiting for other player...

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities
http://www.join-in-for-all.eu/

Receive
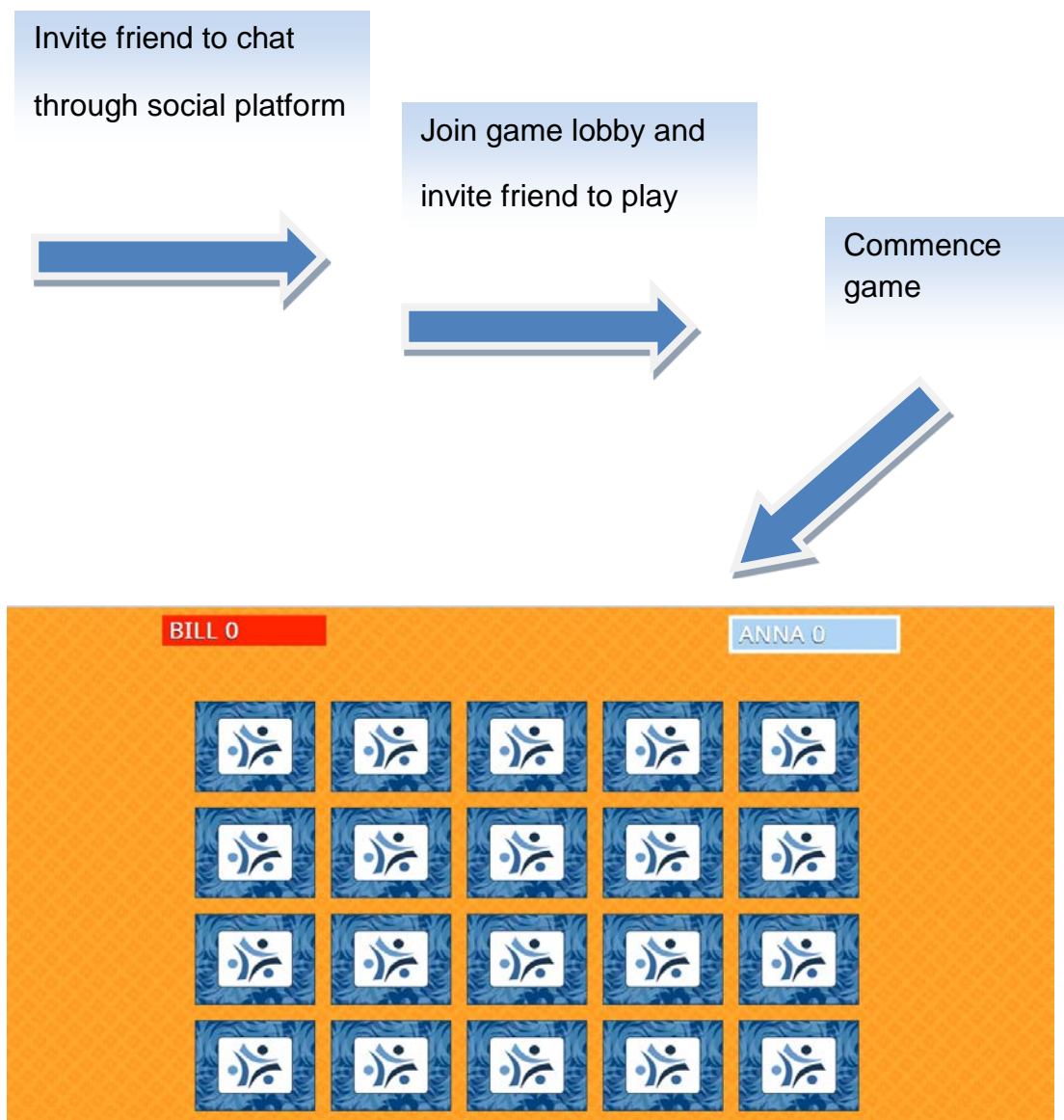Invitation

Bill invites you to play

Accept   Decline

Title: Compete against other players

I want to be able to compete against other players so that I can socialise and enjoy some friendly competition.

Conditions of satisfaction

- I can play a card game with a friend.
- I can chat during play.

Storyboard

Invite friend to chat

through social platform

Join game lobby and

invite friend to play

Commence
game

Title: Play without time limit

I do not want a time limit placed on my move so I have ample time to think and make my turn.

Conditions of satisfaction

- The game will not force me to take my turn within a predefined amount of time.

Storyboard
- Not applicable
Title: Select and Turn a Card with a Single Click
I want to select a card with the controller by pointing and single clicking so that the game is easy for me to play.

Conditions of satisfaction

- I can select a card with a single click.
- I can see the picture on the card after the single click.

Storyboard

Left-click card with scoop controller
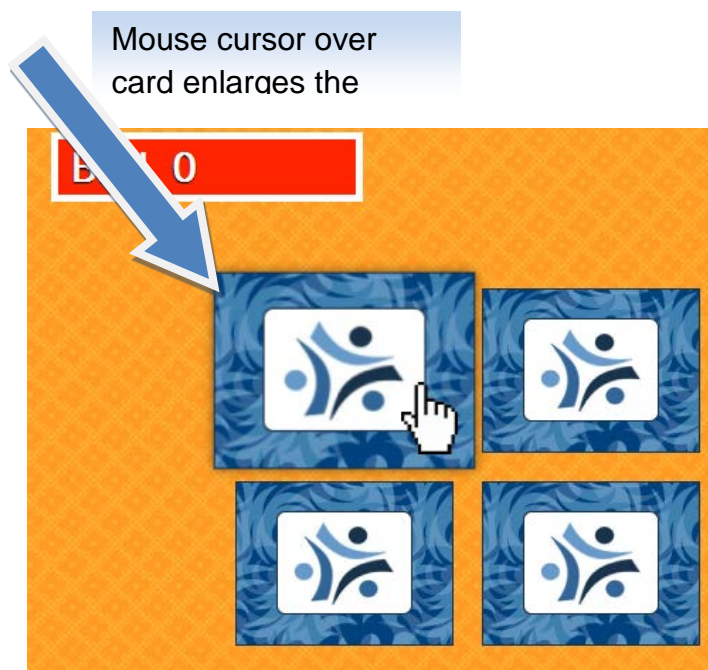

Card is shown 'face-up'

Title: Highlight Card when the Mouse Hovers Over it

When I move the mouse pointer over a card I want that card highlighted so it is obvious to me what selection I am about to make.

Conditions of satisfaction

- I can see that the card is highlighted when I hover over it

Storyboard

Title: Audio Confirmation on Match
I would like to hear an audio confirmation when I match two cards so it is obvious to me that I have successfully matched a pair.

Conditions of satisfaction

- I hear an audio confirmation when I match two cards

Storyboard

Not applicable

Title: See Other Player(s) Card Selections

I want to see the other player(s) making their card selections so that the game is more fun to play.

Conditions of satisfaction

- I can see the other player hover over cards
- I can see the card(s) that the other player turns
- I hear an audio confirmation when another player matches two cards

Storyboard

(Both players see exactly the same game screen).

Title: Compare Scores with Other Players

I want a scoring system for matching cards so that I can compare scores to other players.

Conditions of satisfaction

- I can see my score for matched cards
- I can see the other player(s) scores for matched cards

Storyboard

Player 'Bill' successfully matches two cards.
Both players see each other's score.

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities
http://www.join-in-for-all.eu/

Title: Cooperative play

I would like to play a cooperative game with a friend so that we can both work together to match all the card pairs.

Conditions of satisfaction

- There is a fixed number of turns to match all cards.
- Before the game commences, the number of turns is calculated from the combined skill level of the players.
- Each player receives a turn as during competitive play.
- I can chat during play.

Storyboard

(Not available in prototype)

Title: View/Upload Different Sets of Cards

I would like a different set of pictures to match each time I play a new game so that the game does not get repetitive.

Conditions of satisfaction

- I can choose different decks of cards each time I play
- I can upload pictures to the game

Storyboard

(Not available in prototype)

Title: View Player Details

I want to see the name and profile pictures of all players in the game so that it is obvious to me whose turn it is.

Conditions of satisfaction

- I can see the name of the players in the current game
- I can see the picture of the players in the current game

Storyboard

The current turn is indicated by a white border around the player name (in this example 'Bill'). The player profile picture will be added in a future release.

Title: Set the Number of Rounds in a Game

I would like to set the number of rounds for each game so that all players have an opportunity to win.

Conditions of satisfaction

- I can see the number of rounds played in the current game
- I can see the number of rounds remaining in the current game

Storyboard

(Not available in prototype)

Title: View the Number of Rounds Each Player has Won

I would like to see how many rounds each player has won so that I can keep track of progress.

Conditions of satisfaction

- I can see the number of rounds won by me in the current game
- I can see the number of rounds won by the other players in the current game

Storyboard

(Not available in prototype)

Title: Measure Player Performance

I would like the game to continually measure my performance so that I can see whether I am improving or not.

Conditions of satisfaction

- My player skill level is adjusted after each game.
- My performance statistics are updated after each game.

Storyboard

(Not available in prototype)

Title: View Player Performance

I would like to view my game performance so that I can monitor my progress over time.

Conditions of satisfaction

- I can view my player skill level and performance statistics.
- An improvement in any aspect of my (monitored) game performance will be highlighted to me.

Storyboard

(Not available in prototype)

Title: Dynamic Difficulty adjustment.

I would like the game to be less challenging for me if I am competing against a more skilled player, or vice versa if I am competing against a less skilled player.

Conditions of satisfaction

- The game provides assistance for me if I am playing against a more skilled opponent, where the level of assistance is decided by the skill difference.
- The game imposes a penalty against me if I am playing against a less skilled opponent, where the degree of penalty is decided by the skill difference.

Storyboard

(Not available in prototype)

Title: Static Difficulty adjustment.

I would like to configure the game difficulty so that I can play on the same difficulty setting as my opponent.

Conditions of satisfaction

- Before a competitive game starts, I can select a difficulty setting of easy, normal or hard.
- During play, both players experience the same level of game difficulty.

Storyboard

(Not available in prototype)

Title: Single Player

I would like the opportunity to play against an computer opponent so that I can improve my gameplay in multiplayer games.

Conditions of satisfaction

- I can select a difficulty setting of easy, normal or hard.
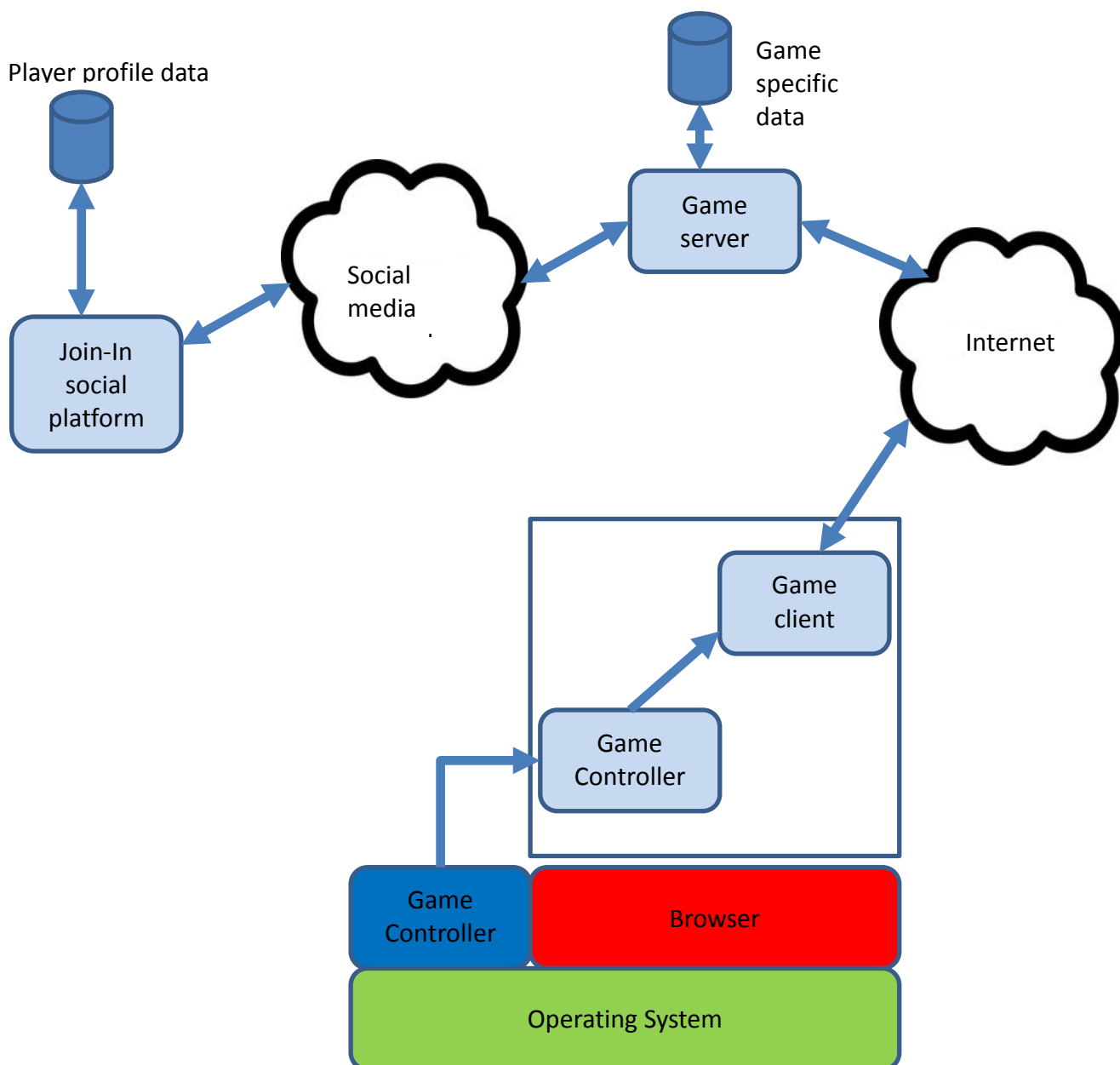- My game performance data and skill level is updated after each game.

Storyboard

(Not available in prototype)

6.5 Software design

6.5.1 Overview of system architecture

The block diagram below (Figure 6) provides an overview of the system architecture, showing key components.

Figure 6. System architecture for the memory card game

Notes:

1. The Game Controller Server is a native application that runs on the host operating system on the end user hardware. The purpose of this server application is to continuously supply data from the controller, such as position, orientation etc. directly to the Game Controller module running in the browser. This exchange of data takes place using the WebSocket communication channel.

2. The Game Controller Manager is a Javascript application running inside the browser. The purpose of this module is to receive data from the Game Controller server and make it available to the Game Client. The Game Controller Manager will receive notification through a WebSocket message event that data is available from the server.

   At present, the Memory card game uses the Scoop controller as a substitute for a traditional mouse (the Scoop Controller is described in deliverable 4.2, section 4.2.1). The Scoop is a device that conforms to the USB HID class specification and presents itself to the host operating system as an ordinary mouse device. If user testing indicates finer control is required over the cursor movement, then the Game Controller Server/Game Controller Manager modules can be used for this purpose.

3. The Game client includes several components. The memory card matching logic and the management of the client states (described in 4.5.2 below) are in separate Javascript modules. The physical presentation of the client HTML pages are described in a CSS (Cascading Style Sheet) module. The Game Client uses the WebSocket communication protocol to exchange messages with the Game Server.

4. The Game Server operates as Software as a Service (SaaS) in the cloud. It will use the Social Media Connector API (see deliverable 4.2, section 5) to interface with the Join-In social platform for a range of services including player authentication and to retrieve custom card images that the player may wish to use in a game. At present, the Game Server is independent of the social platform and manages a list of players using the names supplied by the Game Clients. The Game Server also manages its own data store, specifically to manage a stock set of images for the card game.

6.5.2 High-level design entities

The following state transition diagram (Figure 7) describes the various states of the client and server entities and the various events that cause the transition to another state for both entities.
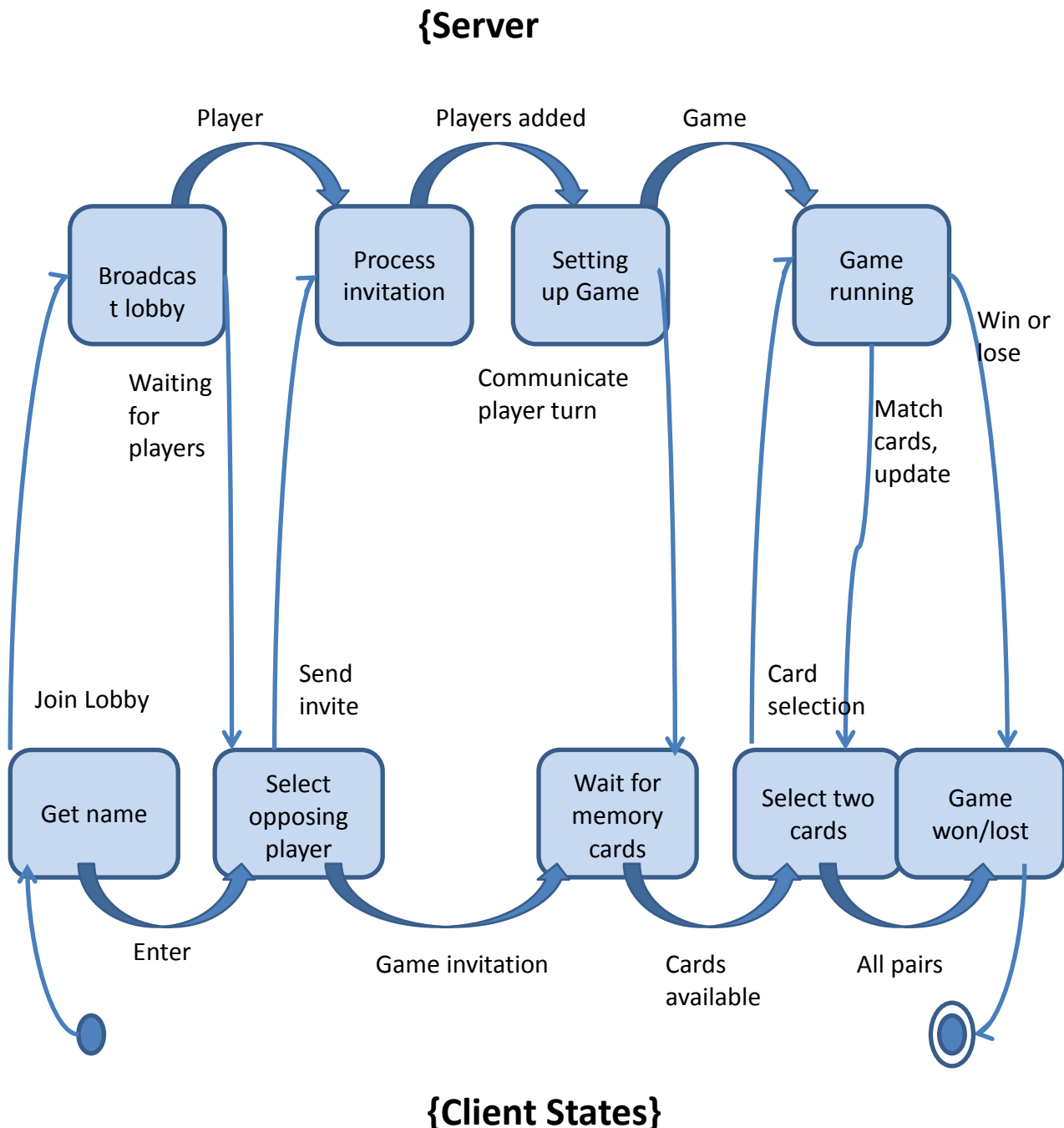
{Server

{Client States}

Figure 7. Client/Server state transition diagram

Notes

1. A client landing page is provided for the player to input their name as the game server is not yet integrated with the social platform.

2. The client is then redirected to the game lobby which shows a list of players waiting for a game. The lobby system is dynamic in that the server pushes updates to each client as players join and leave the lobby. Any given player will only see other players who are configured as friends in the social network.

3. Once two players have agreed to play, they are added to a paired list of players by the server which will manage multiple concurrent games.

4. Once a game is established, the server manages the subsequent game states (player turn, which card is currently selected, scores for each client) and keeps both clients synchronised.

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