# Transhumance: a Platform on a Mobile Ad hoc NETwork Challenging Collaborative Gaming[1]

Isabelle Demeure [(a)], Annie Gentès [(a)], Julien Stuyck [(b), (c), (a)] Aude Guyot-Mbodji [(a),] Ludovic Martin

*(a) Institut TELECOM - TELECOM ParisTech - CNRS LTCI UMR 5141*
*(b) 3IE / EPITA*
*(c) Thales Communications*
{demeure, gentes}@telecom-paristech.fr, stuyck_j@3ie.fr, audeguyot@gmail.com, ludovic.martin@telecom-paristech.fr

## ABSTRACT

*The goal of the Transhumance project is to devise a software platform to support the execution of collaborative applications in a mobile ad hoc network. The application designed to demonstrate the Transhumance platform is a pervasive collaborative treasure hunting game named "Team Exploration". The paper presents this application. It describes the functionalities of the Transhumance platform. It then proposes an analysis of the mobile ad hoc network technology characteristics and potential for future collaborative games through the experience gained in designing and experimenting with the game "Team Exploration".*

**KEYWORDS:** design**,** collaborative games, MANet.

## 1. INTRODUCTION

The goal of the Transhumance research project is to devise a software platform that runs collaborative applications on a **M**obile **A**d hoc **Net**work (MANet) [1]. MANets are self-configuring networks of mobile nodes connected by wireless links. Because they do not require a pre-existing network infrastructure MANets should enable a whole set of new spontaneous services. An example of such service is a pervasive collaborative treasure hunting game named "Team Exploration". The game consists in finding a mysterious place of meeting thanks to clues scattered in Paris. Two teams are opposed. To win the game, one must gather as many clues as possible and be the first to reach the mysterious place. Gamers are given a handheld device with a WiFi card. It is used to execute the game, to communicate among team members and to collect the answers. The whole game is designed so as to let the players be disconnected from their team so that they can freely explore new premises. When a player comes close to another one a connection is immediately established. During the game, players will lose and get the connection, although, to validate an image, all members of the team must be connected. The game play relies both on solitary errands and on collective sharing. Strategies can be more "group oriented" - gamers stay within reach of each other - or more "independent" -with rare "get together" sessions. The game will be described in more details in Section 2.

Some earlier attempts such as JMobiPeer [2] were made to develop platforms for MANets such as the one we propose in Transhumance. However, none of the proposed solutions seem to adequately address major issues such as security and power management. The Transhumance platform provides applications with communication and deployment facilities as well as security mechanisms, data-sharing facilities and power management. We give a partial overview of these functionalities in Section 3. A more complete description of the Transhumance platform may be found in [3].

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The game "Team Exploration" was used as a demonstrator of the potential of MANets in general and of the functionalities developed in Transhumance in particular. The seamful design [4] of the demonstrator was conducted jointly by middleware specialists in charge of the design of Transhumance and by media designers familiar with game design. In the process, we discovered potential for new game concepts. Our experiments, in particular, point to new geographical and physical features that challenge traditional collaboration both in real and virtual games.

The remainder of the paper is organized as follows. Section 2 presents the game "Team Exploration". Section 3 gives an overview of the functionality of Transhumance. In Section 4, we propose an analysis of the MANet technology characteristics and potential for future collaborative games through the experience gained in designing and experimenting with "Team Exploration". We conclude in Section 5.

## 2. TEAM EXPLORATION GAME

In order to demonstrate the Transhumance platform functionality, we designed a pervasive collaborative treasure hunting game named "Team Exploration". Team Exploration involves two teams of four players each. Each player is given a PDA equipped with a wifi card. The Transhumance platform and the game run on the PDA.

We chose the historical Parisian area of "la Butte-aux-Cailles" as the site for our treasure hunt. La "Butte-aux-Cailles" is both the stage and the purpose of the quest.
**Figure 1** shows a screen shot of the game. The interface of the game is provided by a map of la Butte-aux-Cailles partitioned in 20 rectangles. On the left of this map, five pictures are displayed. The top one appears "blurred"; it is the place of final meeting.

The four pictures below correspond to photos that were taken in the area. Players have to find in which area (a rectangle on the map) each of the four pictures was taken. There is a limited time to localize the pictures and when a proposal is made it must be approved by the other members of the team through the game interface. After a delay of 10 min, the set of photos changes. The count down stops only if the player has validated an image with the other members of the team. The "blurred" photo is revealed when four other photos have been localized. Once a team has all the photos, its members must rush and reunite on the premises of the revealed place.

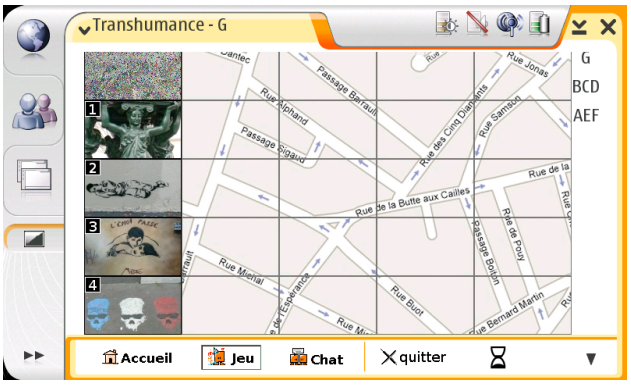


**Figure 1 - Screenshot of the Team Exploration Game**

One of the difficulties with the MANet technology is that players may lose connection with one another (if a player gets out of range of other players). The topology displayed on the right of the screen shows the connections to other players (and the number of hops to a player).

Transhumance gives the players a number of additional services such as a chat service. This service is tolerant to disconnections: if a user is out of reach for a while he will get a copy of the messages exchanged while he was out when he reconnects. Players are encouraged to develop strategies to stray away and meet again to share their information.

Note that most pervasive games such as Botfighters – a mobile version of counterstrike [5], Mogi where you collect virtual items in real places [6], Pirates! where your moves are used to sail to "islands" and to attack enemies [7], Can you See me Now [8], where on line gamers track real running players, rely on servers and geolocalisation. We designed a game that needs to interact with space and people but that is not geolocalised. Our purpose was to explore the specificities of a "pure" adhoc network in the game play. Our experience is therefore influenced by previous pervasive games that played with public places but is also distinct in so far as it relies only on people connections in a spontaneous network: a kind of local "netopia".

In the next section, we give an overview of the functionality of the Transhumance platform that were exploited in the Team Exploration game.

## 3. TRANSHUMANCE PLATFORM

As said before, a MANet is a self-configuring network of

mobile nodes connected by wireless links. In a MANet, each node may act both as an end user terminal and a router; hence, new routing algorithms have been designed [9]. Since nodes are mobile, the topology may evolve and the routes between nodes must be regularly revised. Figure 2 shows 5 mobile users who communicate over a MANet. Current links are indicated by lines, and links that were lost are indicated by dotted lines. For example, there is no direct link anymore between user3 and user4 but messages sent by user3 to user4, may be routed through user2's terminal. At times, nodes may be out of reach of each other and network partitions may occur (a network partition occurs when no route can be found between two nodes). This has two major consequences:

- Communications are not reliable.
- One cannot rely on a given node to play a specific role such as being a server, since any node may be out of reach. The services often implemented through servers must therefore be distributed.

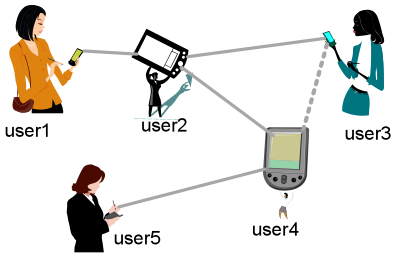


**Figure 2 - Routes between users**

The Transhumance platform is composed of a set of services to address the above identified MANets specificities. First, in order to deal with possible network disconnections, we developed a communication system in which messages can be made persistent (see Section 3.1). Since we target collaborative applications, Transhumance supports "groups" that correspond to the gathering of users sharing a common interest (see Section 3.2). Transhumance groups are also used to offer services such as the lightweight security mechanism that is provided to the members of a group (see Section 3.3).

Finally, Transhumance offers a number of additional useful services such as a chat service and a presence service. The chat is multi-user (one-to-one and one-to-many) and supports persistent messages in order to resist disconnections (messages may be kept for a given time or until delivered). The presence service displays the other Transhumance members accessible on the net and the number of hops (from a terminal to a next one) to each visible member.

### 3.1. Transhumance Communication Service

Transhumance provides end users with two types of communications: an event-based publish-subscribe communication system and a classical point-to-point and point-to-multipoint message-passing system. The event service provides functionalities to create and filter events. An event can be seen as a structured message, composed of the following fields:

- The event Type (advertisement, data, query, …).
- A network wide unique event Identifier.
- Keywords corresponding to the event Subject.
- The event data or Content.
- The event Lifetime.
- A Persistence flag indicates if the event is persistent (with delivery guarantee) or not.
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Users must subscribe to the kind of events they want to receive. The event service proposes filtering facilities. An application can create filters on the event subject, the sender, the content, etc. When an event is received, it goes through the filters and the event is notified to the corresponding subscribers.

In order to address transient disconnections and network partitioning Transhumance supports event persistency (an event may be kept for a given time or until it is delivered to all its subscribers). Contrary to other event systems that rely on a single broker to handle event publications and subscriptions, Transhumance uses a distributed approach to implement the event broker. This choice is made to avoid having a single point of failure and a performance bottleneck (the single broker and its links to neighbors). The proposed system takes into account node mobility and the resulting changes in network topology relying on the way the OLSR (Optimized Link State Routing) routing protocol [10] used in Transhumance handles topology changes.

### 3.2. Transhumance Groups

In Transhumance, users sharing a common interest gather into communities called groups. Users may get a list of existing groups and their attributes (e.g. keywords describing the common interests and services attached to the group). They may create new groups, and join one or more group(s). Members of a group may communicate with each other through the group communication service. They may also use services attached to the group; an

example of group service is a multi-user chat. In the next section we describe a lightweight security mechanism attached to groups.

### 3.3. Transhumance Security System

One of the Transhumance challenges is to provide a decentralized security model for services and applications in mobile ad hoc networks. Following [11], the Transhumance security model is group-based. Existing group security proposals concentrate on contributory key agreement protocols that are too costly both in terms of bandwidth and computation for pocket-PC based MANets [12]. Moreover, they are not designed to be easily integrated in an access control system. Transhumance security comprises authentication, key management, and encryption.

Authentication deals with the admission of new members in a security group. A security group is a set of peers with no hierarchical structure that share a secret: the group public key. This key is distributed within the shared space. A new user admitted in a group is given the group key. Any user may ask any member of a given group to let him enter the group. By co-opting the requester, the group member acts as a trust authority. Once in a group, a member is considered as trustful as the other members and may in turn act as an admission authority.

Key Management maintains the overall secrets necessary to apply the proposed security model and deals with the distribution of the keys within the shared space.

Encryption offers a set of security functions to encrypt, decrypt and sign applicative data, ensuring confidentiality and integrity. It relies on the key management which provides the right cryptographic keys.

## 4. ANALYSIS: NEW OPPORTUNITIES FOR GAME DESIGN

The game was based on previous MANets experiences and a state of the art in pervasive games using, in particular, analyses of space organization and mutations [13] but also Pergame Conferences [14] [15] [16]. It was also designed to explore the technical specificities of Transhumance that would be relevant for the gameplay. A collaborative work with media researchers, information and game designers considered the technology and its potential in terms of game play and collaborative incentive.

In the next section, we present the protocol of test. In Section 4.2, we analyze what the platform and its game may bring into the field of game design in terms of co-presence and sociability. In Section 4.3, we analyze how users reconsider the overlapping of personal and public spheres through the MANet and finally, in Section 4.4, we discuss how hopping can be considered as a personal responsibility.

### 4.1. "Creative" Evaluation

During the Transhumance project, we addressed the specificities of an evaluation process with an emerging technology. Indeed, studies of uses were largely developed in sociology to observe well established practices [17]. New methodologies are currently being developed to assess emerging practices in a context of continuing innovation. In this context, we tried to adapt our tests to the specific challenges related to a demonstrator. In particular, we tried not only to assess usability questions [18] but also to develop new associations, new scenarios, expectations and needs for future gaming applications. The qualitative method used is close both to assessing and creative methodologies.

First, users have to test a device that they are not familiar with and that is not entirely the focus of the research. In other words we do not test the Nokia 770 but a new platform of services. Nonetheless, the assessment is global and makes it difficult to sift between what is specific of the project from what partakes of the device. Then, testers are used to highly sophisticated interfaces and games and demonstrators in research projects are not up to the quality of these final products. Again, the question is how to evaluate such artifacts without denying the qualities of the prototype. We therefore decided to organize a protocol of tests that would shift from the question of assessment to the question of contribution. First, we recruited people with competences in direct relation to our project: designers, man-machine interface researchers, communication researchers, semioticians, town planning and geography researchers, mobility sociologists, economists. Each tester was questioned on her academic and professional background, game habits, mobility practices. This first battery of questions helped us in creating a user profile. Then we did four tests with a different version of the same game. The rest of the protocol was founded on opened questions that we adapted to the profile and the expressed interests of the testers. We collected the feed back on the experience of the game and

also probed the gamers so that they would suggest new services, game improvements, adaptation of the platform. The test is thus divided on the one hand in a traditional set of assessing questions and on the other hand on a creative session with the users [19]. Such protocol changes the position of the tester who becomes collaborators in the definition of the emerging technology. Based on a constructivist approach of the interview, the test also benefits from creativity techniques: analogies, comparisons, shift of emphasis, new scenarios of use, etc. [20].

Another challenge was to observe an activity in mobility and with a large group of participants [21]. We wanted to question and observe each player and to get an overall idea of their team strategy. Team Exploration was therefore first tested with engineering students, then with sixteen diversely profiled users and observers [22]. Each tester was paired with an observer. Testers were asked to verbalize what they were doing, and observers could ask questions when the user was too engrossed in the activity to report. The experiments were filmed to get a better idea of the physical behavior of the testers. We specifically tested the "multi-hop experience" asking them to create the longest line possible, with as many hops as they could. They used the topography of the area to augment their chance of success. They also used the chat to reorganize themselves, comment the game, joke together, try the different set of written answers. Then we did a first game to get them used to the interface of the Nokia. Eventually we deployed the whole game in La Butte aux Cailles. After the interviews, we gathered all the notes and did a qualitative analysis, looking for convergences in the answers but also for ideas, metaphors, expressions, that would enrich our vision of the technology, change the emphasis on the project or suggest new developments.

### 4.2. From Geo-localization to Co-Presence

An important feature of our platform is that, contrary to most pervasive games, it is not using geo-localization technologies. Nonetheless the game is localised since only people within MANet reach can play with each other.
Before actually playing, people gain immediate access to Transhumance services. In particular one gets an idea of whom is virtually around. But in MANets people are also visibly around. There is a physical proximity that has to be taken into consideration by the users. Our first experiments showed that users appreciated that some real presence would be at stake and not only virtual ones. But they questioned the modality of this co-presence. On the one hand, it could be perceived as a breach of their personal space, even threatening. On the other hand, they appreciated the feeling of being apart from the crowd and sharing a secret activity. From then on, our question was how to develop scenarios that would manage this ambivalent feeling towards virtual and real co-presence. We also wanted to promote social interactions like in Road Rager [23], to address "orchestration" issues as in "Can you See Me Now" [24] [25], to explore location awareness [26], and more generally to augment social interactions [27]. We decided to exploit at least two levels of grouping: the general interface and the selected community interface. The general interface service was called « presence service ». It acts as a radar that explores who is on line and eventually gets the profile of these people. One can also chat immediately. This first step is traditional in ad hoc applications. Mobiluck, for instance, launched a service « closer to my friend » that acts as an MSN and measures the distance between you and the person in your list of contacts. In our game, players can feed false information to the other team through this channel. There is a second channel of communication: a chat that is restricted to the team members. Players of the same team can exchange information securely.

These two channels were perceived as a way not only to secure information within a group but also a way to diversify one's activity and therefore to leave an uncertainty as far as the occupation of a Transhumance user is concerned. In other words, because there are different services, users can be discreet about what they are really doing. Such discretion was felt to contribute to the feeling of privacy. Who is doing what is part of the incentive to join a collective activity in an urban setting but participants prefer the signs of their participation to be discreet. As users might eventually see each other, this discretion is partly provided by a dispersion of users in subgroups related to different activities. Suggestions were made that people of the same group might not appear anymore on the general interface. There should therefore be degrees of virtual sociability through the management of different channels and groups. The security protocol relying on trust reinforces of course this perception of the privacy issue.

### 4.3. Testing Bodies and Distances to Manage Space

We discovered that a MANet platform led to expectations about an enriched relationship to the city. People who played the game wanted to know how to remember the

experience or how to prolong it. For that reason, we not only had to help them orient themselves to find the clues, but we also had to build an affective relationship to the place.

First, in the interface, we provided a map of the historical Parisian area, la Butte-aux-Cailles. The map delineates the contours of the game so that players will orient themselves and won't stray too far away.

Then, the feeling of getting to know the city intimately was based on the discovery of fine details (different from a tourist approach of major buildings). The question of scale is very important. Testers were not looking for what was obviously there (a bakery, swimming pool, etc.) that they could find without virtual help. They were looking for a complementary insight in the city, a tool that would pinpoint hidden or discreet signs. We made a photo reportage on street art, including such artists as Misstic[2], or Space Invaders[3]. This led to a new reading of the area even from people who thought they knew the place. They appreciated that the place would not only be a stage for their activity but almost an actor in the activity.

Eventually, we had to find a balance between pushing players to spread in the neighbourhood to find clues as quickly as possible and keeping them together to accelerate the exchange and validation process [28]. The game design involved the laying out of all the potential strategies: staying together, organising groups of two, splitting in all directions, at different times during the party. Each strategy has its drawbacks and we wanted to see how people would manage their exploration of the area and the disconnections: using the service of events to make sure that the message would eventually reach the others, giving themselves local appointments to avoid looking for each others for hours, etc.

The game did therefore bring another reading of the city in terms of cultural specificities but also in terms of covered territory. Players thought about the distances between each other. They manoeuvered their enlarged presence. They tested the elasticity of the coverage by taking careful steps and watching the signals or lack of. A new experience of distances has to be explored. Due to the limited coverage of the devices, users fall in between proximity and long distance relationships. MANet is therefore in between seeing each other almost within arm reach and being connected to someone close but that we do not see. The challenge is to explore the meaning of this new distance. In particular, a distance that is not solely a question of measured space but of people connected to each other and connecting each other.

[2] Photographies of Misstic murals may be seen at http://www.missticinparis.com/

[3] http://en.wikipedia.org/wiki/Space_Invaders

### 4.4. A Chain of Solidarity

MANet is a non centralized architecture and a hop structure. Our first tests proved that people were very sensitive to their responsibility in broadcasting messages to others. For users, receiving, emitting and at the same time transmitting and providing connection was a new and potentially interesting feature of this technology. The heart of the matter is how to create a chain of connected people that will forward messages or shared documents. Not only did they use the metaphor of a bubble to express their feeling of enlarged personal scope, they emphasized that they could be dismayed by the use of their own device – and in particular its battery – to cater to someone's else need of connection. Yet they would be willing to share their device capacity in particular circumstances: what would be these special occasions led us to the Transhumance game. It was important to include this chain of solidarity in the game play and to materialize it on the interface. Therefore, each found clue has to be approved of by other members of the team, which makes communication essential between players, hence its name: "Team exploration". This rule was also made to ensure that the game could not be played on one's own. We also discussed how we could best show people connected while not giving the false impression that we would know their actual position (behind or in front of us for example). This led to an interface that shows who is connected to us and at how many hops. This concept was born out of an accident. During the tests, people could suddenly see the routing interface and took an interest in it. To show the workings of this specific type of networks gave a hand to the users who otherwise could not grasp its workings and moreover could not play with it [29] [30].

### 4.5. Choreography of Players

This led us to envisage games that would rely on players relative connections and rebounds. This train of thoughts was explored with a game designer as he offered to turn gamers into pawns that according to their places would lose or win points as in a living Go. We imagined that according to our place in this chain of solidarity we would be able to compose some music or to create shapes.

## 5. CONCLUSION

In this paper we have introduced Transhumance, a software platform for the support of collaborative applications in a mobile ad hoc network. The application designed to demonstrate the Transhumance platform is a pervasive collaborative treasure hunting game named "Team Exploration". We have presented both the game and the Transhumance platform.

Through the experiments conducted, we learnt that the MANet technology emphasizes certain traits of pervasive gaming that might no be as clearly visualized in geo-localized games. Mainly, it emphasizes the physical implications of players in relation to each other. The technology is felt as an enlargement of the personal sphere that is both and at the same time interesting and worrying. This questions the concept of spontaneous networks and reorients it as selective and selected networks. The possibility to hop in or out of the general view is particularly important to avoid frontal contact. It reintroduces a measure of uncertainty that is felt reassuring in the physical space. "Team Exploration" also shows that the architecture of the network must not necessarily be hidden. On the contrary, our tests show that people would rather know how and who distributes his or her information. There is a potential of services that would rely on the explicit organization of the MANet, contrary to most other network representations so far. On a more anthropological level, MANets change the way we perceive people. On the one hand, people in urban settings are no longer passers-by. Each person can be considered as a "broadband resource". On the other hand, people could resent that some would not allow the use of their PDA to hop. In any event, the boundaries between technical and human infrastructures are blurred. People matter in more than one way… Scenarios of games were at one point considered that would play on such transactions. Eventually PDAs in a MANet are felt to be a transitional area between private and public spheres. This zone is not only useful, it is perceived as a chance to enrich exchanges with a specific place and other people.

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