Caractérisation géographique de l’environnement d’exécution pour la conception d’un système d’information mobile et distribué

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1 Adaptive GIS & case study
   - Adaptive GIS design
   - Case study

2 Geographic description of the execution context
   - Regions of interest
   - Mobility constraints
   - Context equivalence

3 Design process integration
   - Interactive system design
   - Integration of contexts groups
   - Prototyping the user interface

4 Conclusion, discussion
Overview

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   - Adaptive GIS design
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3. Design process integration
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4. Conclusion, discussion
Adaptive GIS definition [PRC06]

GIS should integrate additional constraints such as:

- Mobility and distribution, wireless communications
- Multiple users and simultaneous usages, different data sources

These constraints:

- dynamically evolve over time
- are first defined at running time.

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Integrates such contextual constraints, and derives user-oriented views
Adaptive GIS definition [PRC06]

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→ Example of a distributed GIS design
Case study: windship regatta system [CDF^{+}07]

- Windship race championship held once a year at French Naval Academy
- Innings occur offshore, often windships cannot be seen
- Need for a real-time tracking and documentation system
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System design requirements

- Several mobile components, wireless communications
- Dynamic architecture, distributed platform

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Regions of significance

Several types of regions are derived from system components:

- $U_x$: User region, where the user interacts with the system
- $D_x$: Data region, where the data are available
- $P_x$: Processing region, where the data are processed
- $S_x$: Source region, where the data are coming from

These regions have specific properties:

- They are mobile, may intersect or not
- They rely on servers and wireless communications
- At the component level: intersection = communication

The execution context is given by the set of intersecting regions of interest.
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Regions of significance: case study

3 component regions: $U_1$, $D_1$ & $P_1$
1 origin region, around the tracked ships: $S_1$

Execution context at $t_0$: $\{P_1 \cap D_1 \neq \emptyset, S_1 \cap D_1 \neq \emptyset\}$
Execution Context

An execution context summarizes ...

\[
\{ \text{the system architecture} \}
\]\n
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... By considering the set of intersecting regions of interest.

**In an adaptive system, at the functional level:**

- Each execution context encompasses specific system behaviours
- These behaviours must be integrated at design level
- These leads to \(2^N\) execution contexts
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**In an adaptive system, at the functional level:**

- Each execution context encompasses specific system behaviours
- These behaviours must be integrated at design level
- These leads to \(2^N\) execution contexts → **Complex problem**
Execution context : case study

Considering several contexts ...

... every context means a specific system behaviour :

- User + Data vs. User + Data & procedures vs. User alone, etc.
A well defined design of a system implies:

- to derive the regions of interest;
- to define the set of execution context.

However ...

- The Description of each per-context behaviour is complex
- But, several contexts might generate a similar behaviour at the user level

→ Mobility constraints reduces the set of contexts
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→ **Equivalency rules** groups similar contexts according to behaviour
Assumption: “It is usually possible to restrain a region of interest to a given area of mobility”

**Given a region of interest** $R_x$

- $\zeta_{R_x}$: set of possible $R_x$ locations during the system runtime.
  - When $R_x$ is a part of $\zeta_{R_x}$, $R_x$ is *mobile*.
  - When $R_x$ equals $\zeta_{R_x}$, $R_x$ is *stable*.

Several contexts are not physically plausible.

Then, the amount of plausible contexts ranges between:
  - 1 when all $N$ regions are *stable*.
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Consequence at the contexts level:
- disjunction of $D_1$ and $P_1$ is not plausible
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Diagram showing the context representation.
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Equivalency properties [PRC09]

Assumption: “same behaviour at the functional level = same context on a design point of view”

In an interactive system:

The adaptivity is oriented towards the user.
2 equivalent contexts derive the same set of functionality at the user level
A set of properties produces user-side equivalencies between contexts

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Equivalency properties: case study

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When the source region is not defined\(^1\):

From the user point of view, in both contexts, the source region \( S_1 \) is not intersecting.

\(^1\) \( S_1 \) spatial extension is undefined when data are unreachable to the user.
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From the 11 remaining configurations ...

... to 5 groups of equivalent execution contexts
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User-centred design: from scenario to prototype

Scénarios nominal & alternatif

(c) Concepts diagramme de classes

(b) Tâches Arbre des tâches

(g) Arbre des tâches annoté

(d) Architecture des composants

(f) Déploiement des données & procedures

Tiers métier et données

Contexte d'usage

Utilisateur

Plateforme

Environnement

(g) Interface abstraite

(h) Interface concrète

(i) Interface finale

Tier client
User-centred design: example scenario

**Table:** Nominal scenario

“The race documentation system runs on a user’s PDA and allows her/him to follow the regatta in real-time. The PDA provides manipulation tools, and a map of the race area where the racing ships are regularly re-located. The user may be interested in several ships, or alternatively by other user interests, to set her/his own area of interest. If she/he is interested in a specific ship, information (year, name, crew and pictures) and real-time data (location, speed and heading) on this ship are provided. When being close enough to the race area, the user takes and shares ships pictures with other users.”

These scenarios reflect **user tasks** and the **data manipulated**.
User-centred design: example task-tree

- Follow Regatta
  - Set the user area of interest
    - UserInterestArea
  - Interest in several ships
    - Ship
  - **Select another user area of interest**
    - UserInterestArea
  - **Specifiy ship to focus on**
    - Ship
    - FocusShip
  - **Detail ship information**
    - FocusShip
  - Take and share a picture
    - Picture
  - Render real-time data
    - RealTimeData
  - Render information
  - Render static data

- Interaction Task
- Abstract Task
- System Task

- Output Concept
- Input Concept

"then" or"
User-centred design: bridging the gap

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→ Is the scenario situation dependent?
→ What is the system behaviour when situation changes?
User-centred design: bridging the gap

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User-centred design: bridging the gap
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UC Design: plug in the geography [PCRC08]

- **Environnement géographique**
  - Description des régions d'intérêt
  - Raisonnement spatial
  - Association & étiquetage
  - Arbre des tâches contraint

- **Scénario nominal**
  - Tâches d'arbres
  - Concepts diagramme de classes
  - Arbre des tâches annoté

- **Scénarios alternatifs**
  - Tâches alternatives

- **Architecture des composants**
  - Procedures SGBD
  - Déploiement des données & procédures

- **Tiers métier et données**

- **Tier client**
  - Utilisateur
  - Interface abstraite
  - Interface concrète
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- **Contexte d'usage**
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- **An input towards personalization [PRC08, PRC07]**
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One behaviour per group of context

Designers, along with users and staff, give each group of equivalency a proper behaviour.

"when accessing the system outside regions $D_1$ or $P_1$, the user is warned that he has to reach regions $P_1$ or $D_1$ for the system to be fully functional. The system provide guidance instructions towards these regions."
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“When being close enough to the race area, the user takes and shares ships pictures with other users.”
Design primitive: the task tree

Scenarios derives the task and data tree. The execution contexts annotate the possible actions.
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Interactive system design
Integration of contexts groups
Prototyping the user interface
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From the task tree: **processing methods**, **data handling** code, and **user interaction** layer are implemented.
Sketching the interface: case study

“A user is walking along the shoreline and is accessing information via the regatta tracking system and his PDA. Tracked boats return from high sea to the harbour”

![Diagram of user interface and scenario]
Sketching the interface: case study

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From a description of a system environment:
- the execution context are derived and grouped;
- these groups are integrated within a design framework;
- the annotated task tree favors prototyping.

The designed interactive system is:
- **robust**: it runs in every “situation”
- **consistent**: the user level is derived from a single task tree
- **efficient**: it fits the data and the processes available

At the case study level: the system is available everywhere, and provides functional flexibility.
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Discussion

Perspectives:
- Context equivalence: properties generalization
- Levels of adaptivity: user context, appliance context.
- HCI & ergonomics: transition between different behaviours

Thank you for your attention
Time for questions...
Discussion

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http://www.aromate.org/research.html