

Analysis and Evaluation of Activity-Travel Pattern in an Era of IT

Urban Transportation Research Unit, Institute of Environmental Studies/Department of Urban Engineering, The University of Tokyo. (http://ut.t.u-tokyo.ac.jp/index_e.html)

Understanding mechanism of individual travel behavior in urban space is essential for urban transportation planning and policy. Conventionally, travel is considered a derived demand from the desire to engage in activities at certain locations. Hence, understanding the relationships between travel behavior and daily activity engagement is effective in estimating individual and household responses to policy measures and to changes in environmental constraints. We have been developing the integrated system for data collection, analysis and evaluation of individual/household activity-travel patterns in urban space using Information Technologies (IT) and Geographic Information System (GIS).

Constraints to Activity-Travel Pattern

Individual/Household

- Individual/Household characteristics (household structure, residential location, travel mode availability, etc.)
- Activity demand

Urban Environment

- Land use (activity opportunities)
- Transportation network
- Institution

Data collection

Choice Set of Alternative Activity-Travel Patterns

Space-time Accessibility

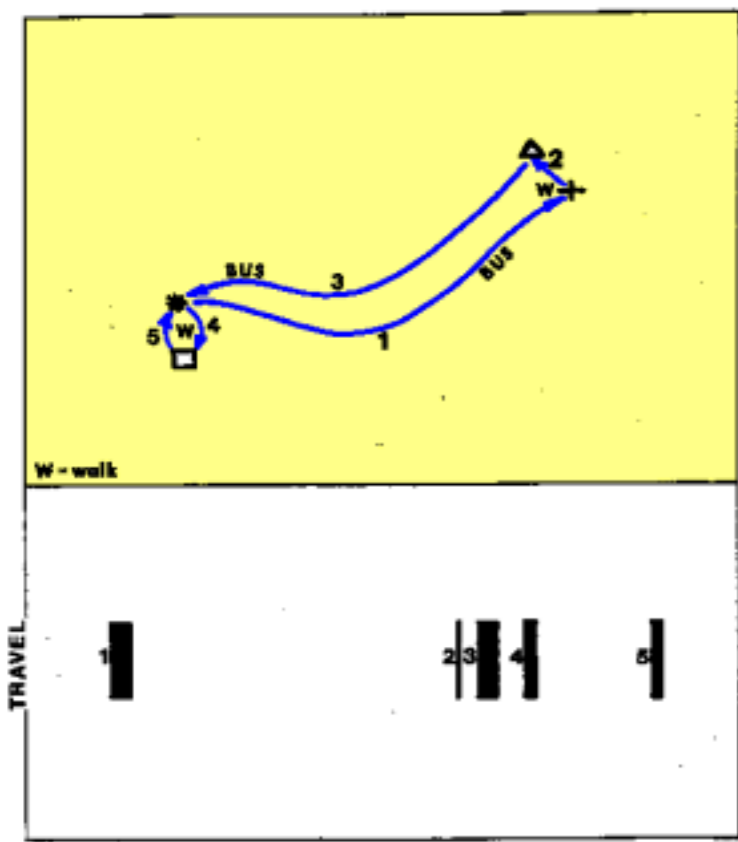
- Spatio-Temporal Constraints
- Interactions between Household Members
- Activity Scheduling

Analysis Evaluation

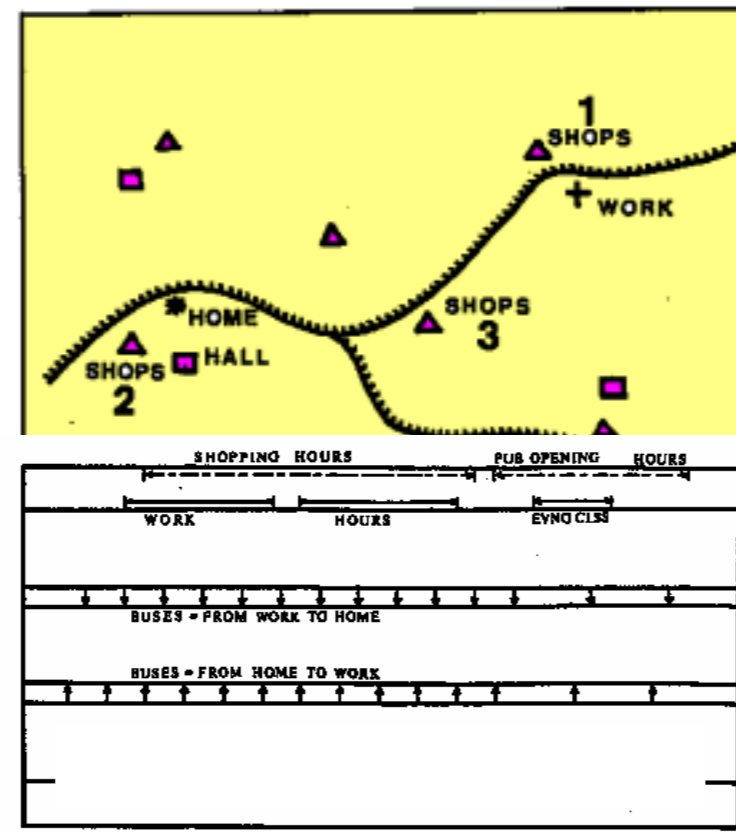
Activity-Travel Pattern **Space-Time Path**

- Revealed Preference (RP)
- activity diary survey
- positioning technologies (GPS, PHS, etc.)
- Stated Preference (SP)
- computer-assisted self-interviewing (CASI)

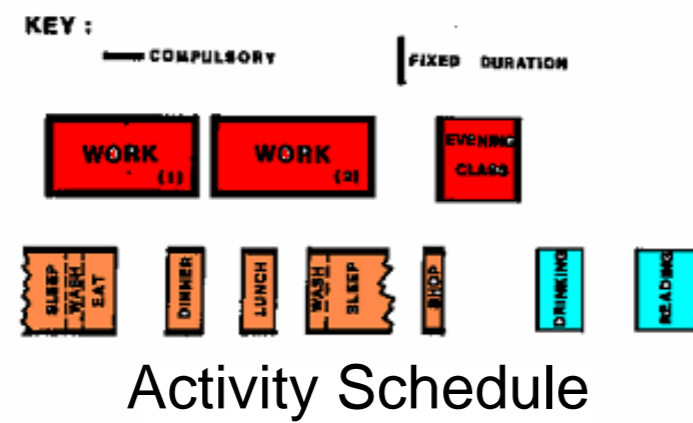
Individual Activity-Travel Pattern in Urban Space and Time



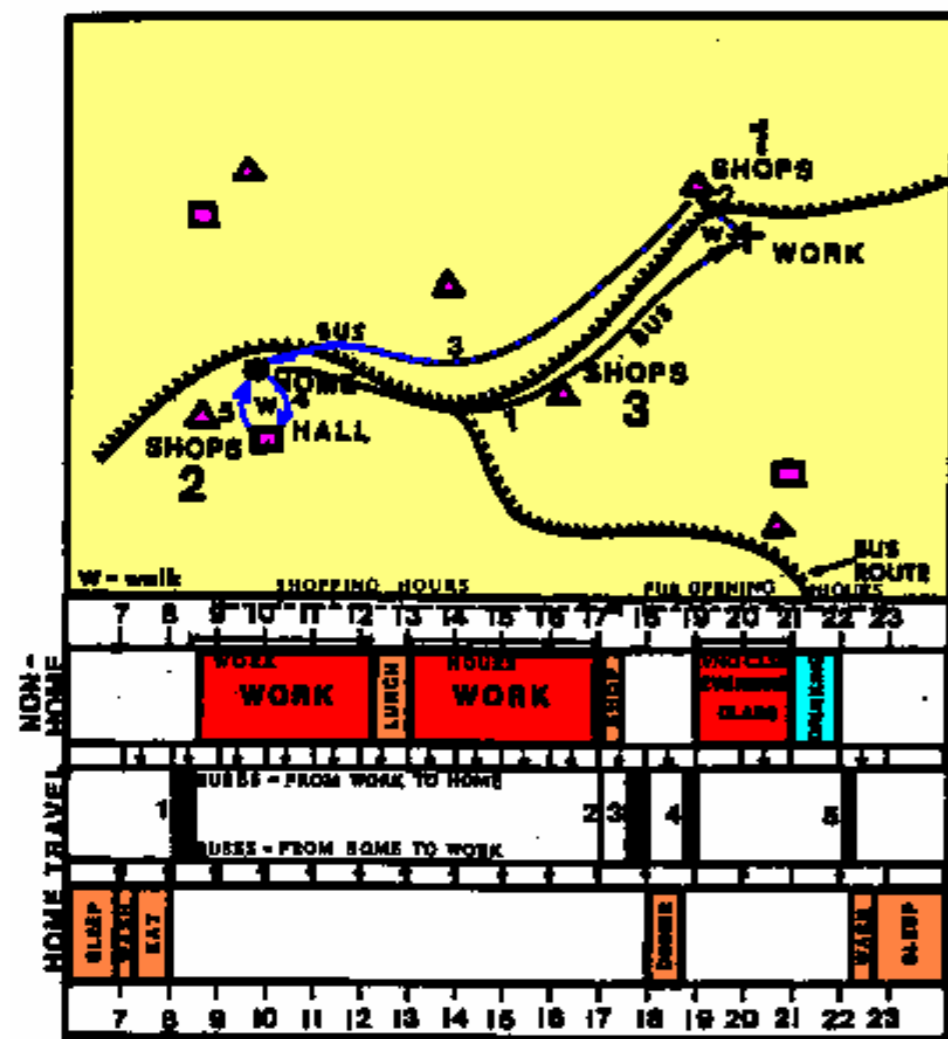
Travel Pattern



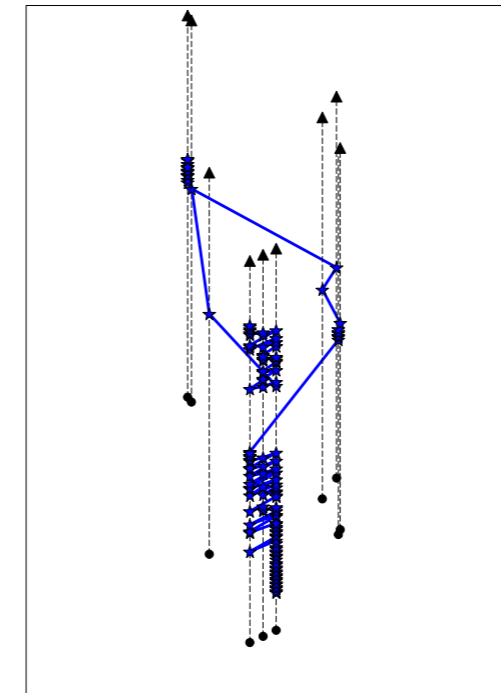
Transportation Network and Activity Opportunities



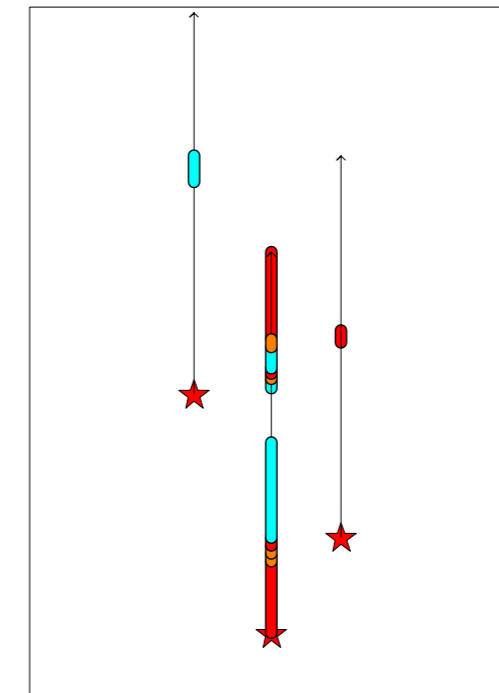
Activity Schedule



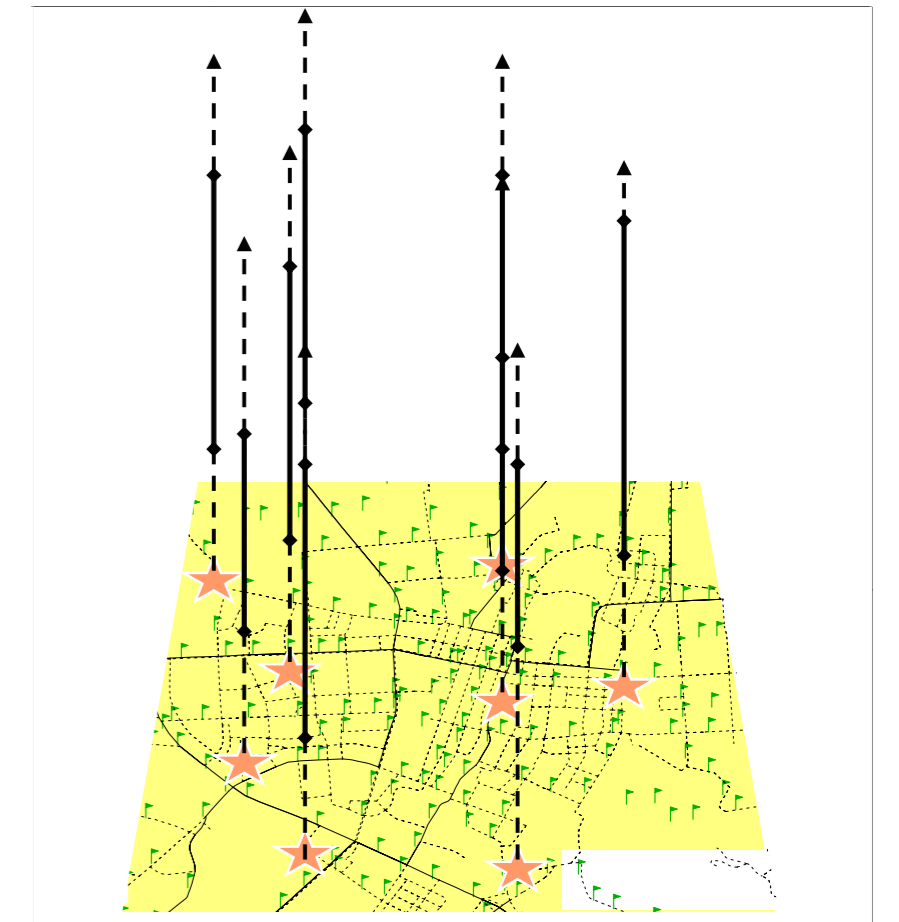
Household Activity-Travel Simulator (HATS) Display Board (see Jones et. al., 1983)



Travel Pattern (by GPS, PHS, etc.)



Activity Schedule



Transportation Network and Activity Opportunities (GIS database)

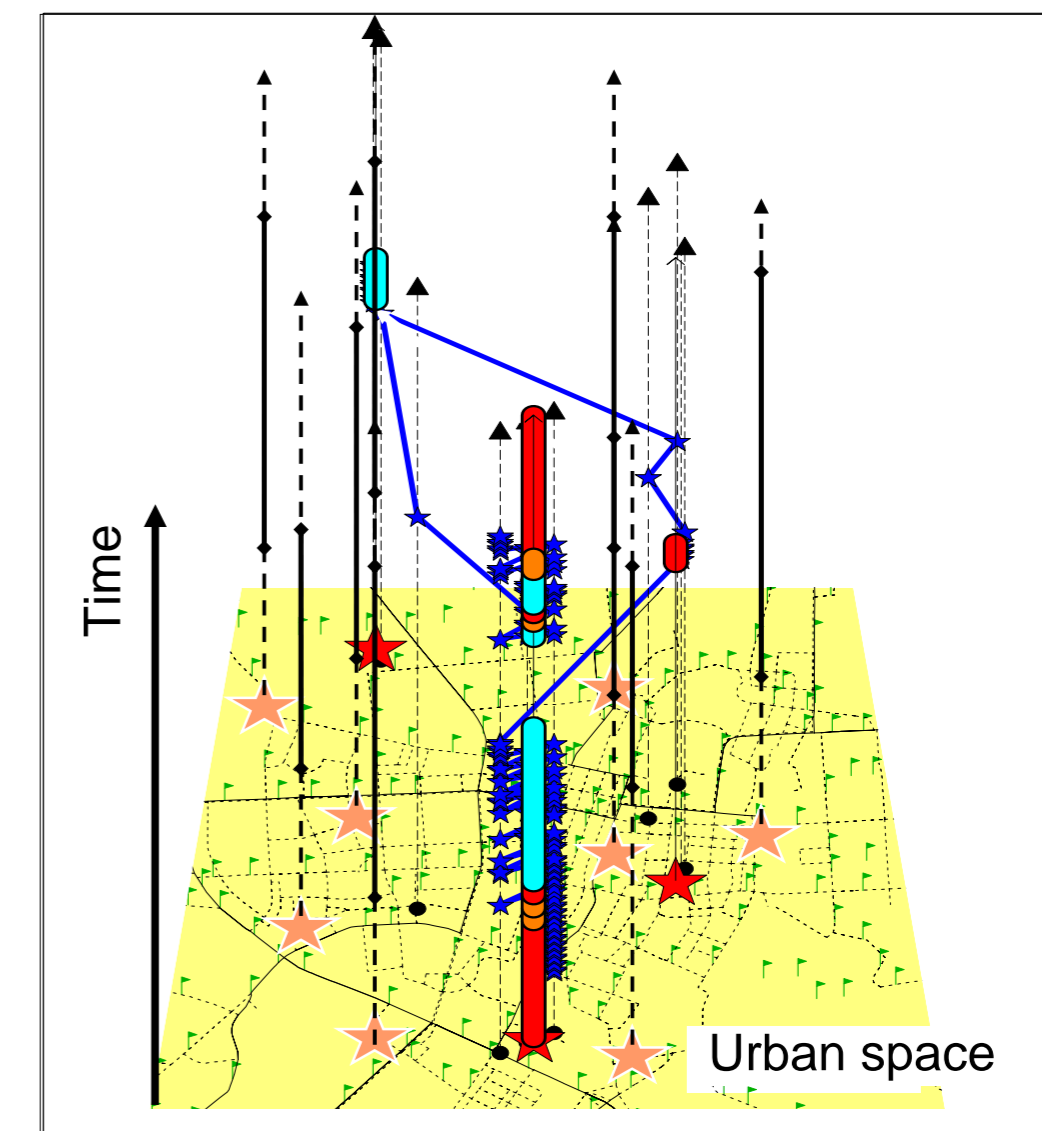
Positioning Technology

The Internet

GIS



The basic concept of our research is "activity-based approach" originated from TSU (Transport Studies Unit at Oxford University).



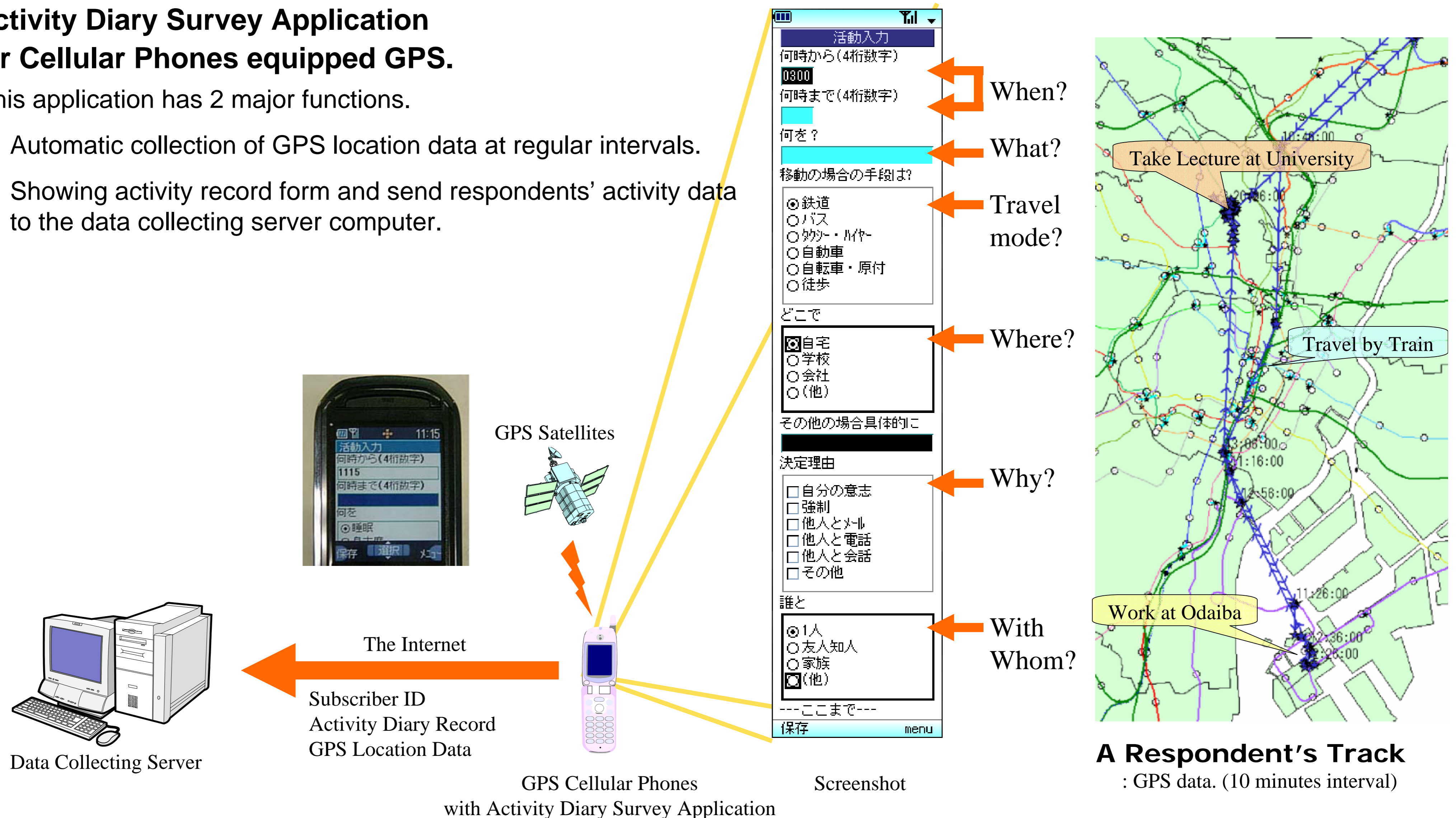
Concept of GIS Data Use in Our Research

GPS Mobile Phone-Based Activity Diary Survey System

Activity Diary Survey Application for Cellular Phones equipped GPS.

This application has 2 major functions.

1. Automatic collection of GPS location data at regular intervals.
2. Showing activity record form and send respondents' activity data to the data collecting server computer.



System Image

The Internet-Based Travel Survey System with Web-GIS #1: Mode and Route Choice

Internet-based travel survey system

We developed this system to support multi-modal transportation planning with relocation of large-scale facilities. This system collects respondents' SP data. Web-GIS software was used to reflect geographical locations and transportation network data.

Sample below is a imaginary route choice of students of The Univ. of Tokyo after new campus (Kashiwa campus) building is completed.

Question : Which route will you choose after new railway station is open?

Time variables

Cost variables

地図上でクリックするとクリック地点が地図の中心になります。
一番右の欄に所要時間と通勤手当支給額を月あたりの費用を表示しています。

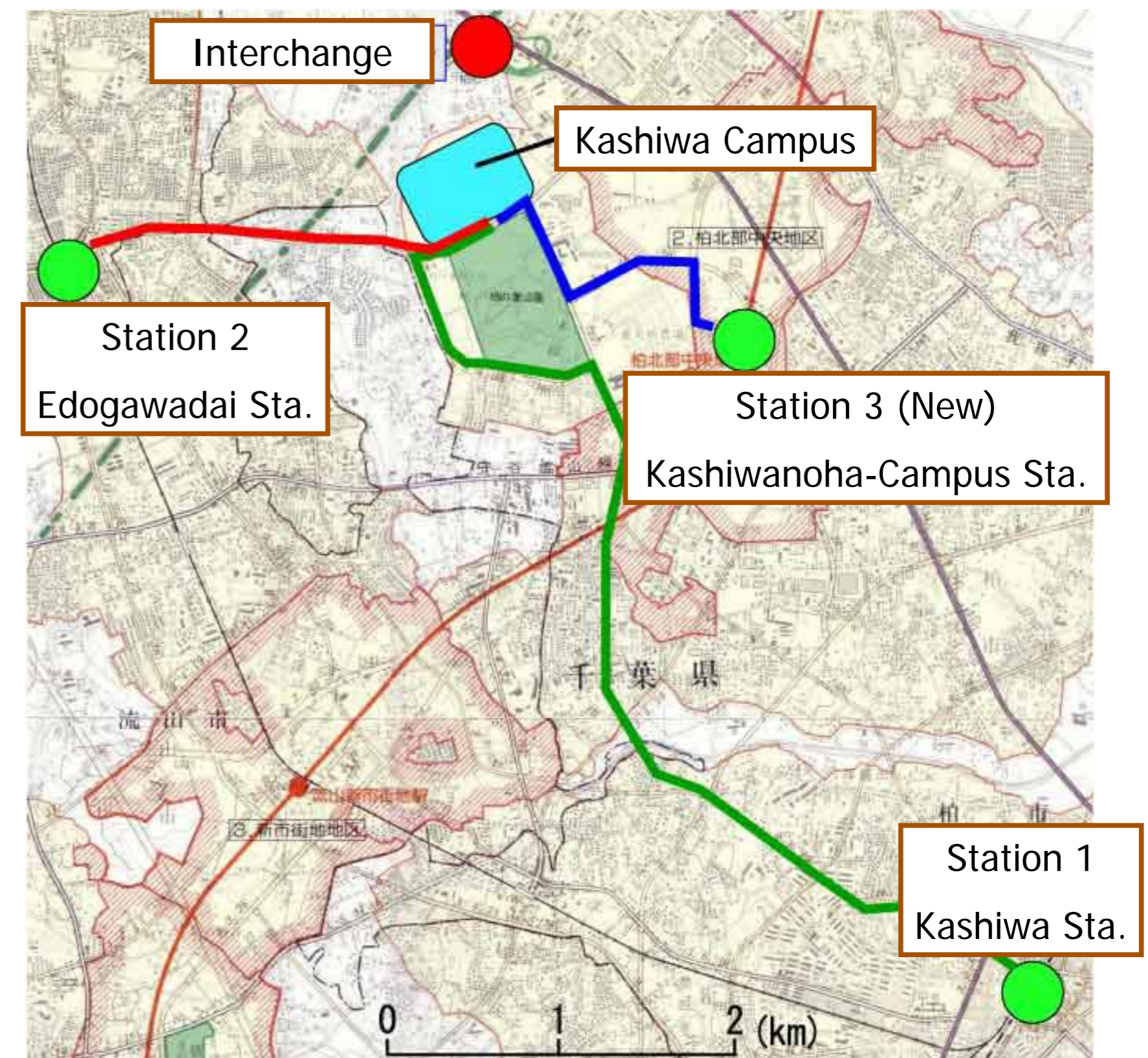
経路	所要時間	通勤手当支給額	費用
経路(1) 柏駅まで鉄道41分 費用22650円	キャンパスまでバス30分 費用12600円	通勤手当支給額 35250円	費用0円
経路(2) 江戸川台駅まで鉄道 53分 費用45510円	キャンパスまで自転車15分	通勤手当支給額 45255円	費用505円
経路(3) 柏北部中央駅まで鉄 道44分 費用43920円	キャンパスまで自転車12分 費用1200円	通勤手当支給額 43920円	費用1200円
経路(4) 東京駅まで鉄道14分 費用11680円	国立がんセンターバス停まで高 速バス50分 費用28000円	通勤手当支給額 39680円	費用0円
経路(5) キャンパスまで自動車 50分 自動車 (有料道路利用) 燃料費10920円	通行料金47040円	通勤手当支給額 44460円	費用13500円
経路(6) キャンパスまで自動車 80分 自動車 (有料道路非利 用) 燃料費11340円		通勤手当支給額 11340円	費用0円

柏キャンパスに出かける際に1~6のどの経路を利用しようと思いませんか？

- 経路1(柏駅利用)
- 経路2(江戸川台駅利用)
- 経路3(柏北部中央駅利用)
- 経路4(高速バス利用)
- 経路5(自動車、有料道路利用)
- 経路6(自動車、有料道路非利用)

経路選択

Screenshot (Route Choice)



Detail Map around Kashiwa Campus

The Internet-Based Travel Survey System with Web-GIS #2: Route and Parking Choice

It is very important to provide dynamic traffic information such as VICS, ATIS and Parking Guidance Information(PGI), and it is indispensable to understand the change of travel pattern by providing with dynamic information.

Paper-based survey cannot describe dynamic traffic services. Computer-based imaginary survey techniques have been developed to collect respondents' SP data.

In this system, origin and final destination are given. Some information are given while respondents are traveling in the imaginary space.

Imagine you are driving now to buy something at a department store.

Set location of your home.

- 拡大
- 縮小
- 中心
- マウスクリックで住所入力をする

指定された住所が見つかりました。この地点でよい場合は、このまま送信ボタンをクリックしてください。訂正なされる場合は、マウスクリックで住所入力をするか、もう一度住所検索をお試しください。

住所検索を行う

馬場通り 4 丁目 1 番 13 号

デバッグページ表示

送信

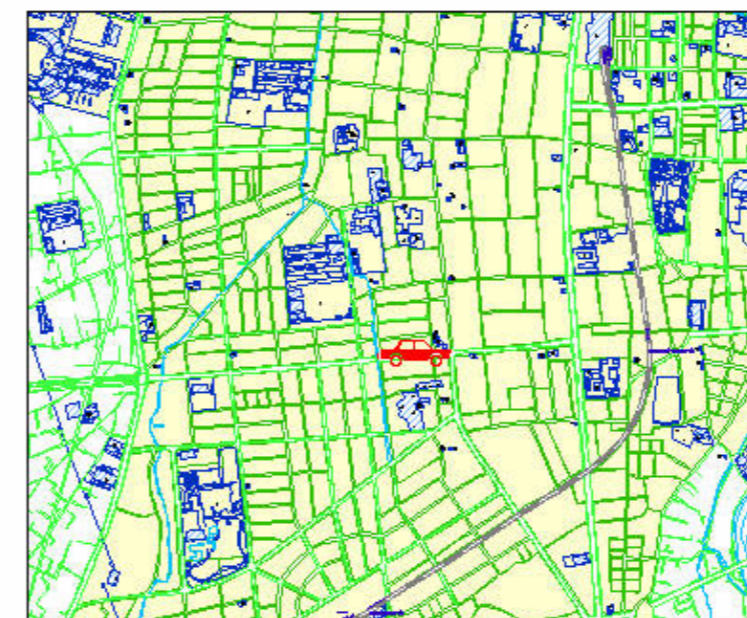


Click where your home is
or
Input address.



Imaginary Parking Information Board
is shown sometimes.

前方に駐車場情報が表示されています。



時間 15:02
速度 25km/h
Velocity

どの地区で駐車しようと考えていますか？

- A地区
- B地区
- C地区
- D地区

Select where you'll park

次の交差点ではどうしますか？

- 直進する
- 左折する
- 右折する

Select which direction you'll turn to at the next crossing.

運転を続ける

GIS-based Activity-Travel Simulator #1: Simulation Model for Activity Planning (SMAP)

SMAP was developed as an innovative integration of GIS and a feasible activity-travel pattern generation model.

MapInfo GIS software was used as the system platform. MapBasic programming software was used for customizing MapInfo.

The activity-travel pattern generation model could enumerate feasible activity-travel patterns under spatio-temporal constraints of the individual's scheduled activities and opening hours of activity opportunities.

With the introduction of two persons' activity schedule constraints, not only private travel modes but also car-passenger mode availability was explicitly dealt with in the model.

The initial application of SMAP was aimed to understand constraints that affect travel behavior of the elderly households and their responses to the changes of the constraints in a local city.

- *Travel demand side*
 - Activity schedule (activity diary with space-time constraints)
 - Individual/household characteristics (e.g., mode availability, travel cost budget, the maximum walking time)
 - Travel tracking data collected by positioning technologies (e.g., GPS, PHS)
- *Transportation supply side*
 - Travel times between two locations (calculated from road and public transport network)
- *Activity opportunity side*
 - Locations and opening hours of opportunities

Generate alternative activity-travel patterns and/or test the feasibility of the patterns based on space-time prism constraints

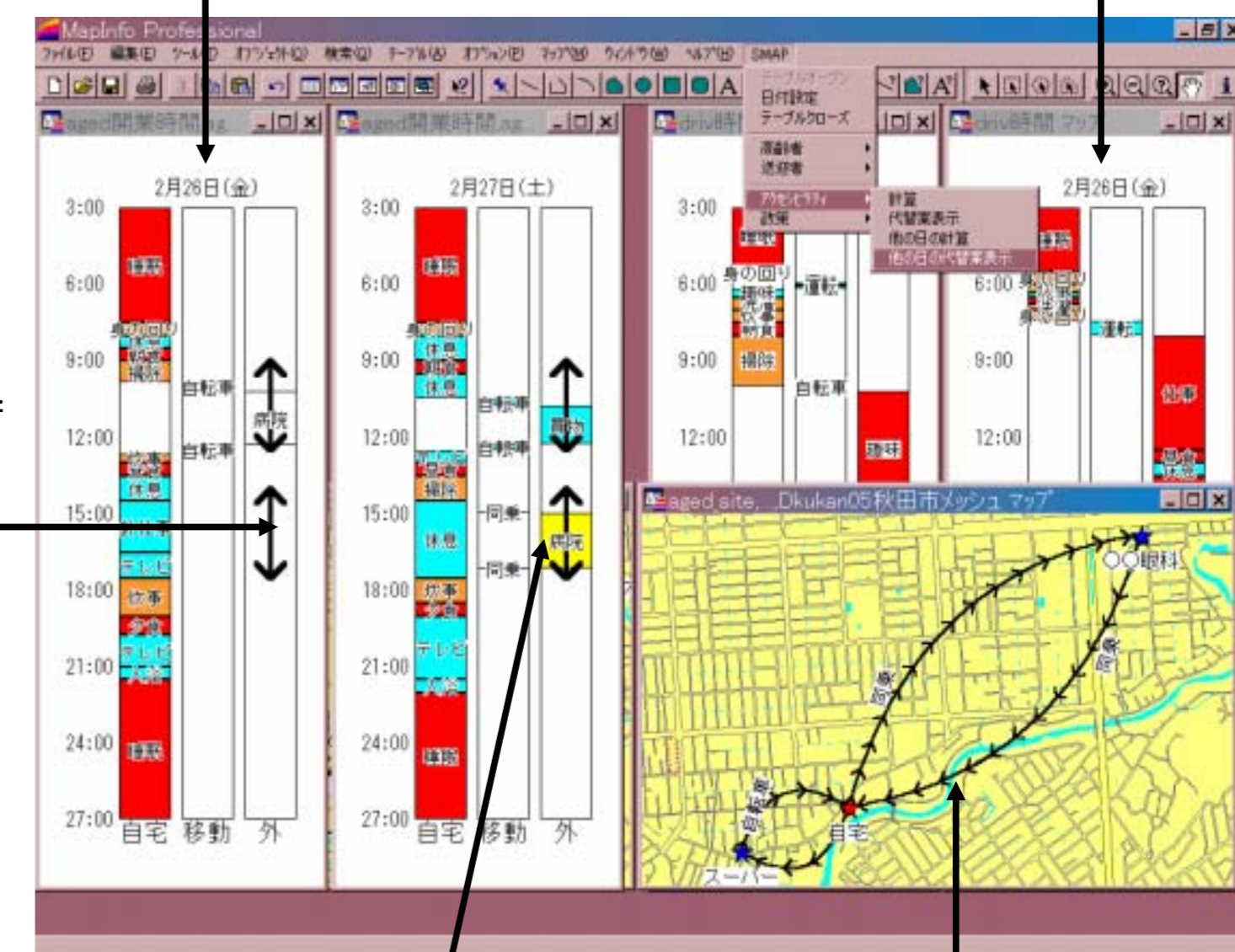
Represent spatio-temporal component of activity-travel patterns on GIS

Basic Structure of GIS-based Activity-Travel Simulator

Representation of activity pattern of individual X on the timeline

Representation of activity pattern of individual Y on the timeline

Opening hours of the opportunity engaged in the target activity



The target activity

Representation of travel pattern of Individual X on the map

Screenshot of SMAP

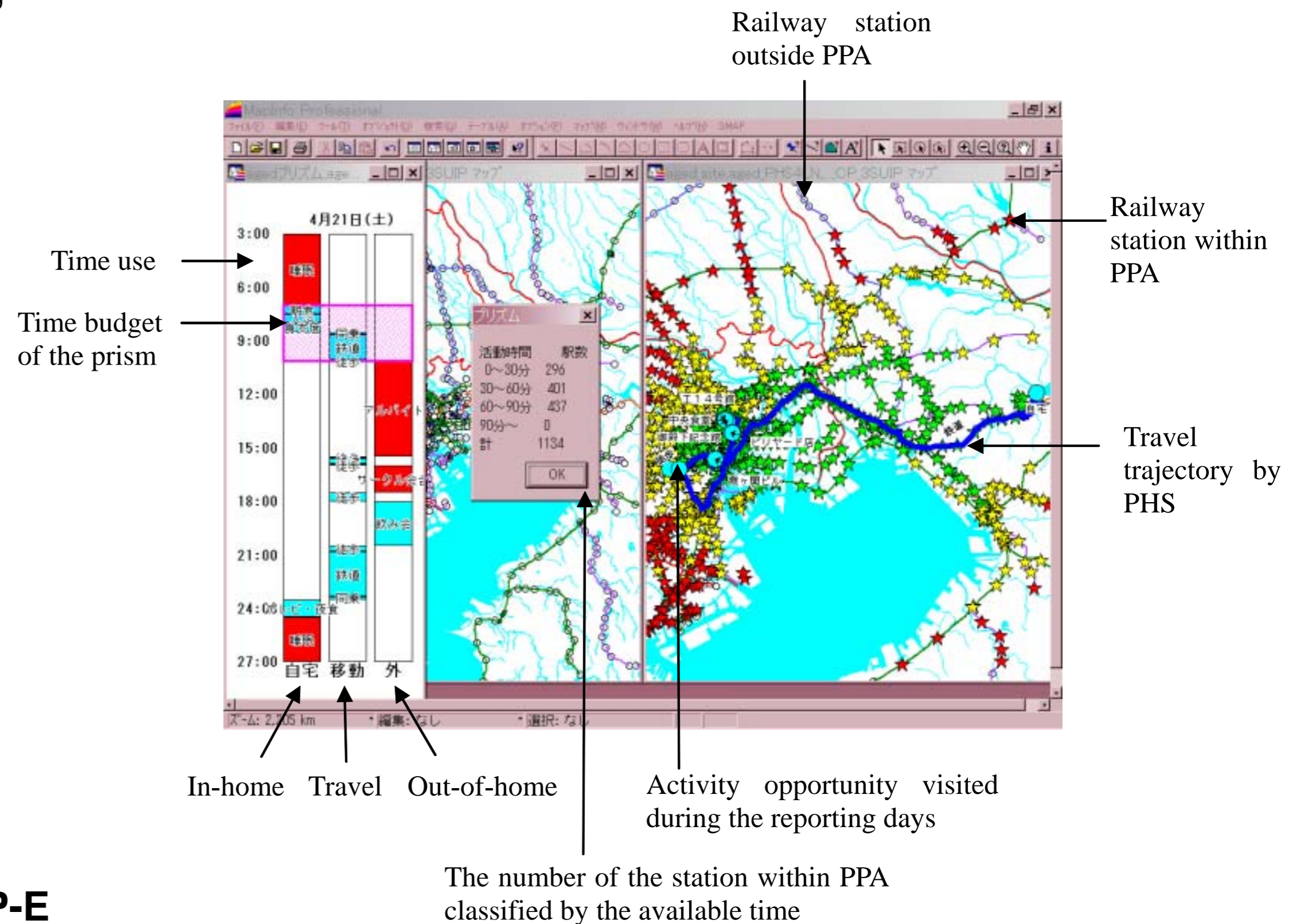
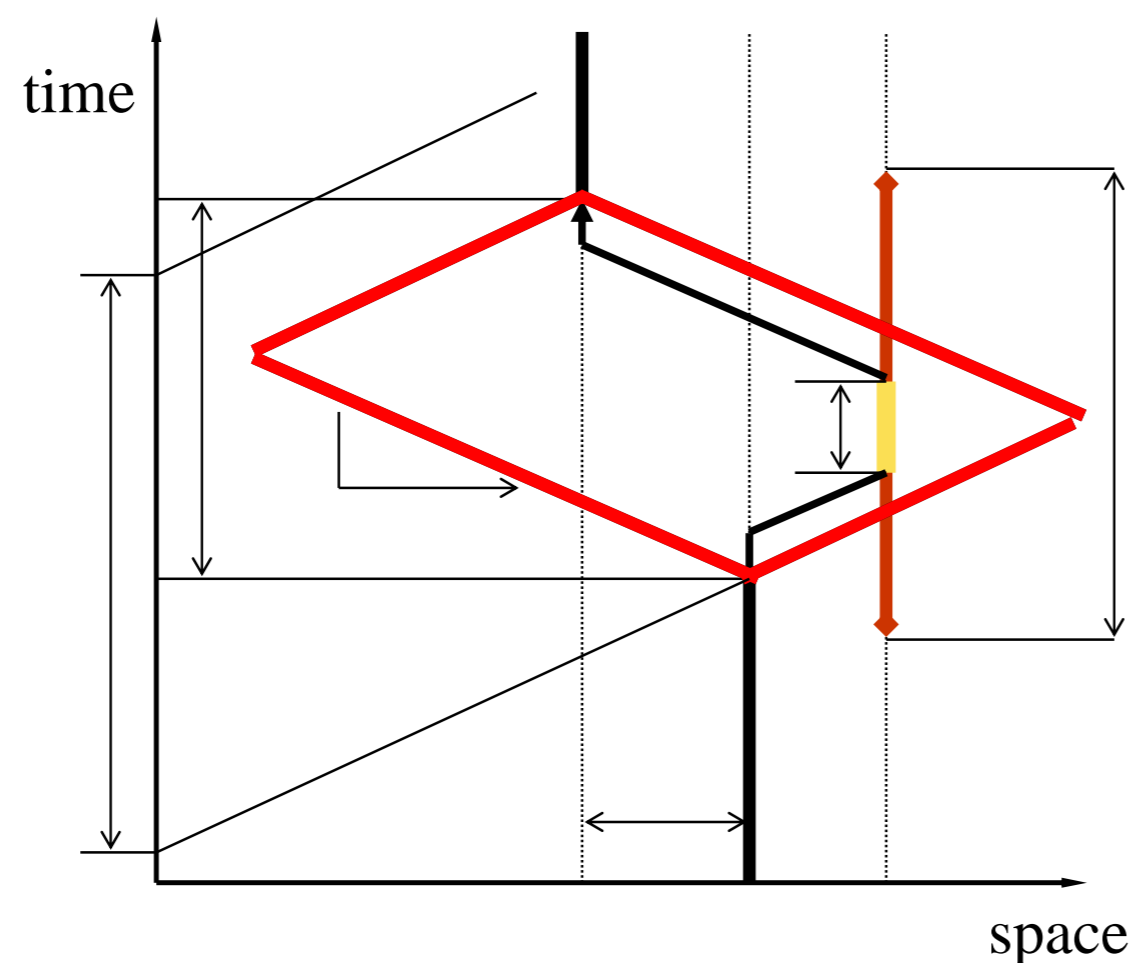
GIS-based Activity-Travel Simulator #2: SMAP for Education (SMAP-E)

SMAP-E was developed especially for the purpose of instructing students in understanding the theory of space-time prism/accessibility and travel behavior under spatio-temporal constraints. It was used in a graduate course as an educational tool.

The participants simulated the volume of prism and the feasibility of engaging in a discretionary activity in the prism, using their own one-week activity diary data, before and after changing important variables in activity schedule, transport system and activity opportunities affecting space-time accessibility.

From the analysis of students' reports, it was found that a series of simulation using SMAP-E had contributed to help the students to better understand the theory of space-time prism and human activity-travel patterns under spatio-temporal constraints in the urban area, as demonstrated in HATS.

- time budget
- distance between fixed activity locations
- speed
- railway service hours
- the volume of the prism
- activity duration
- location of the opportunity
- opening hours of the opportunity



Operational Variables in the Simulation Exercise in SMAP-E

Ohmori, N., N. Harata and K. Ohta (2003) Development and Application of GIS-based System for Simulating Activity-Travel Patterns under Spatio-Temporal Constraints, Proc. of the 8th International Conference on Computers in Urban Planning and Urban Management, CD-ROM.

Representation of Activity-Travel Pattern and Available Opportunities within a Space-Time Prism

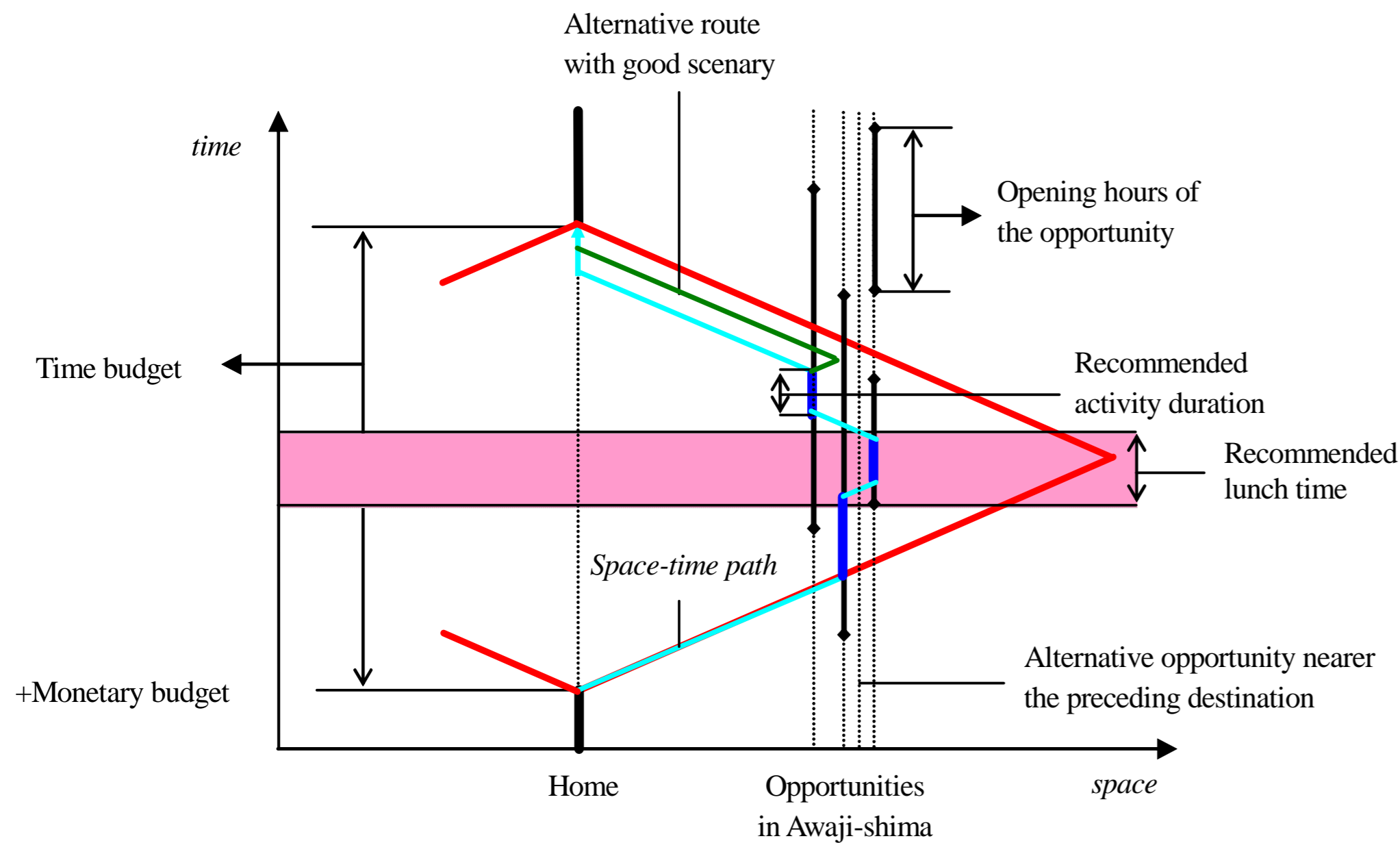
GIS-based Activity-Travel Simulator #3: SMAP for Leisure (SMAP-L)

SMAP-L was developed as an decision-making support system for activity planning using interactive surveys to collect information on the activity scheduling process of tourists' leisure tour.

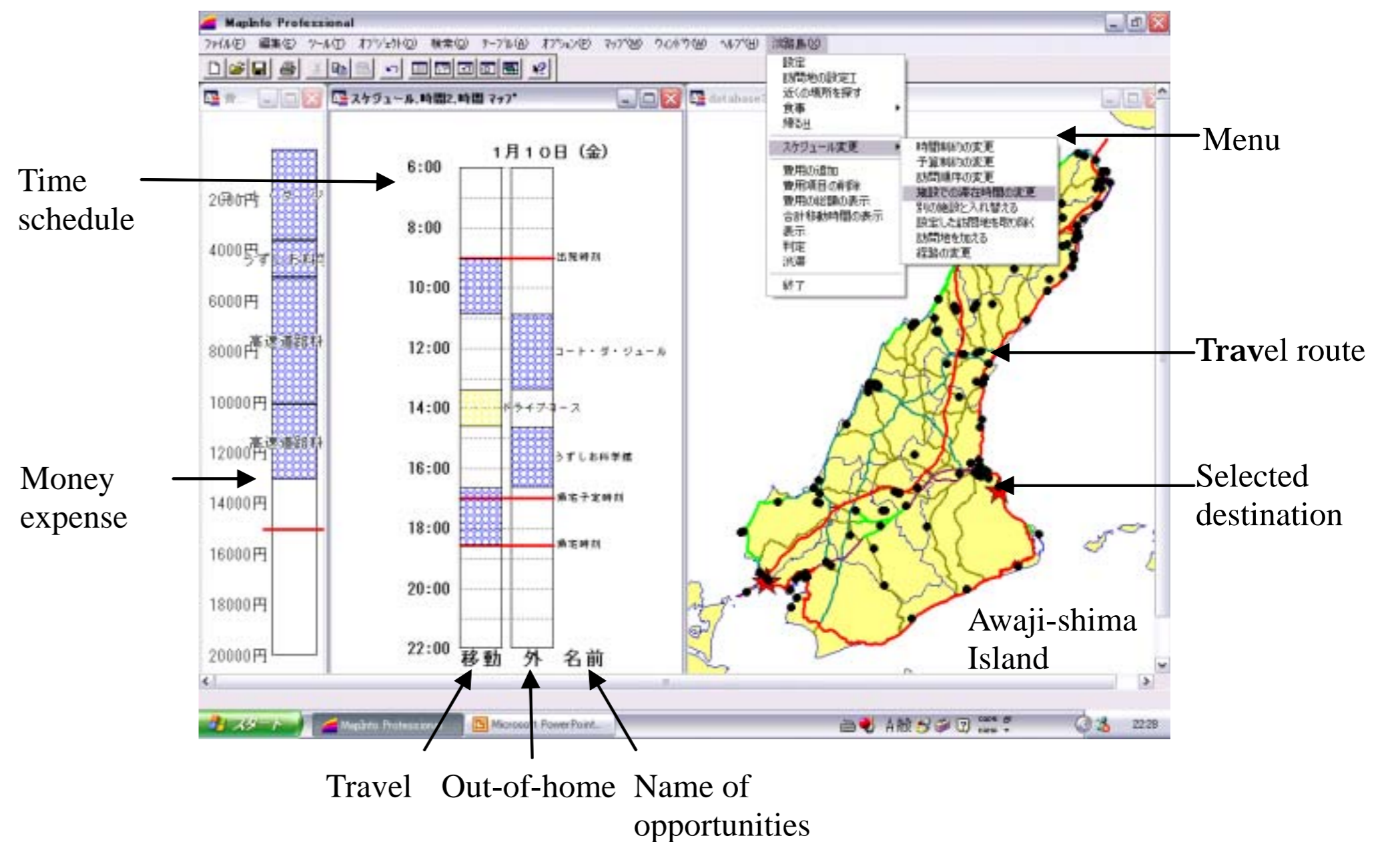
Face-to-face interview surveys were conducted with SMAP-L to simulate pre-planned activity schedule of one-day leisure tour.

SMAP-L was very useful for supporting decision-making on activity scheduling, providing information on travel times, routes and opportunities, examining time and monetary budget constraints.

Data on scheduling process collected with SMAP-L were used to analyze respondents' scheduling process in activity planning. The analysis revealed the inter-personal difference of scheduling patterns and responses when travelers found that the schedule was infeasible under time and monetary constraints.



Activity Scheduling in SMAP-L



Snapshot of SMAP-L

Ohmori, N., N. Harata and K. Ohta (2004) Two Applications of GIS-Based Activity-Travel Simulators, Presented at EIRASS Workshop on Progress in Activity-Based Analysis, in Maastricht, The Netherlands, May 28-31, 2004.

Future Research

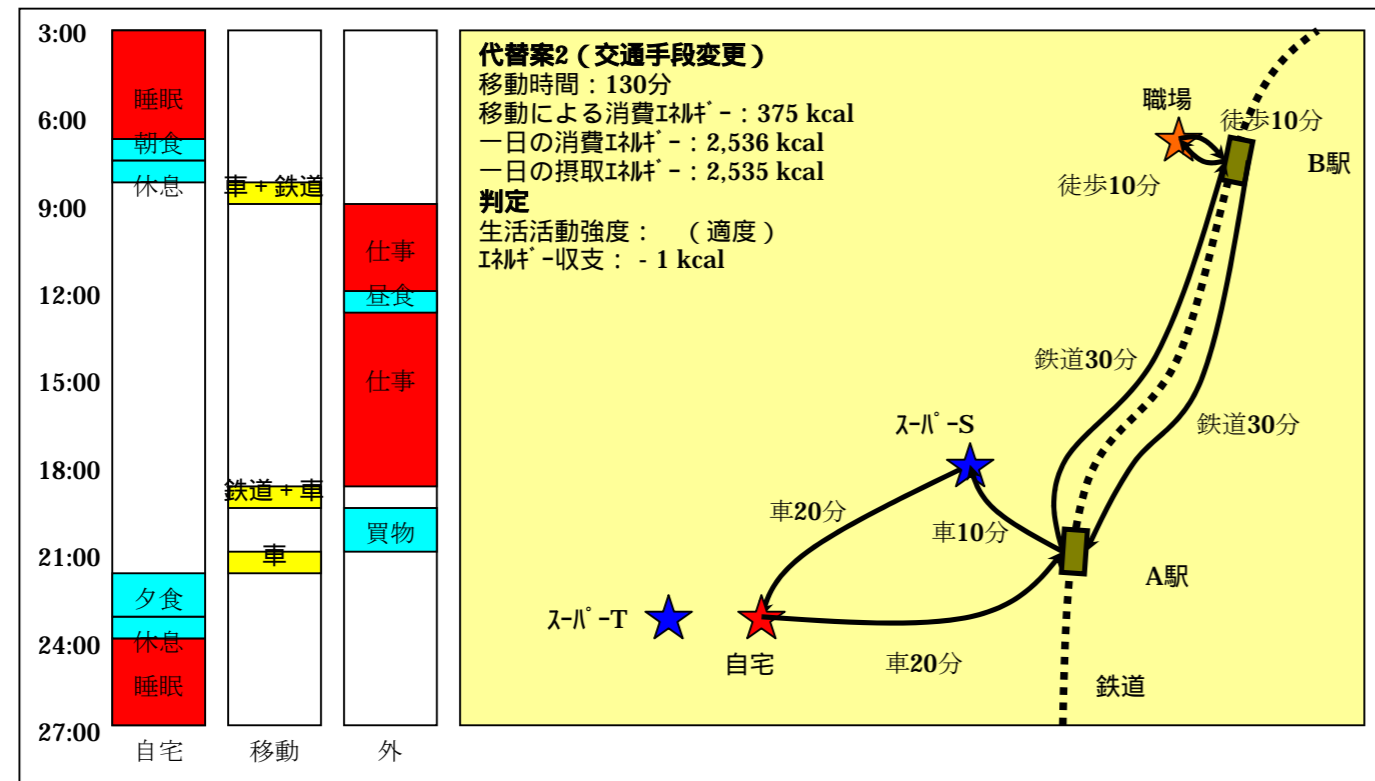
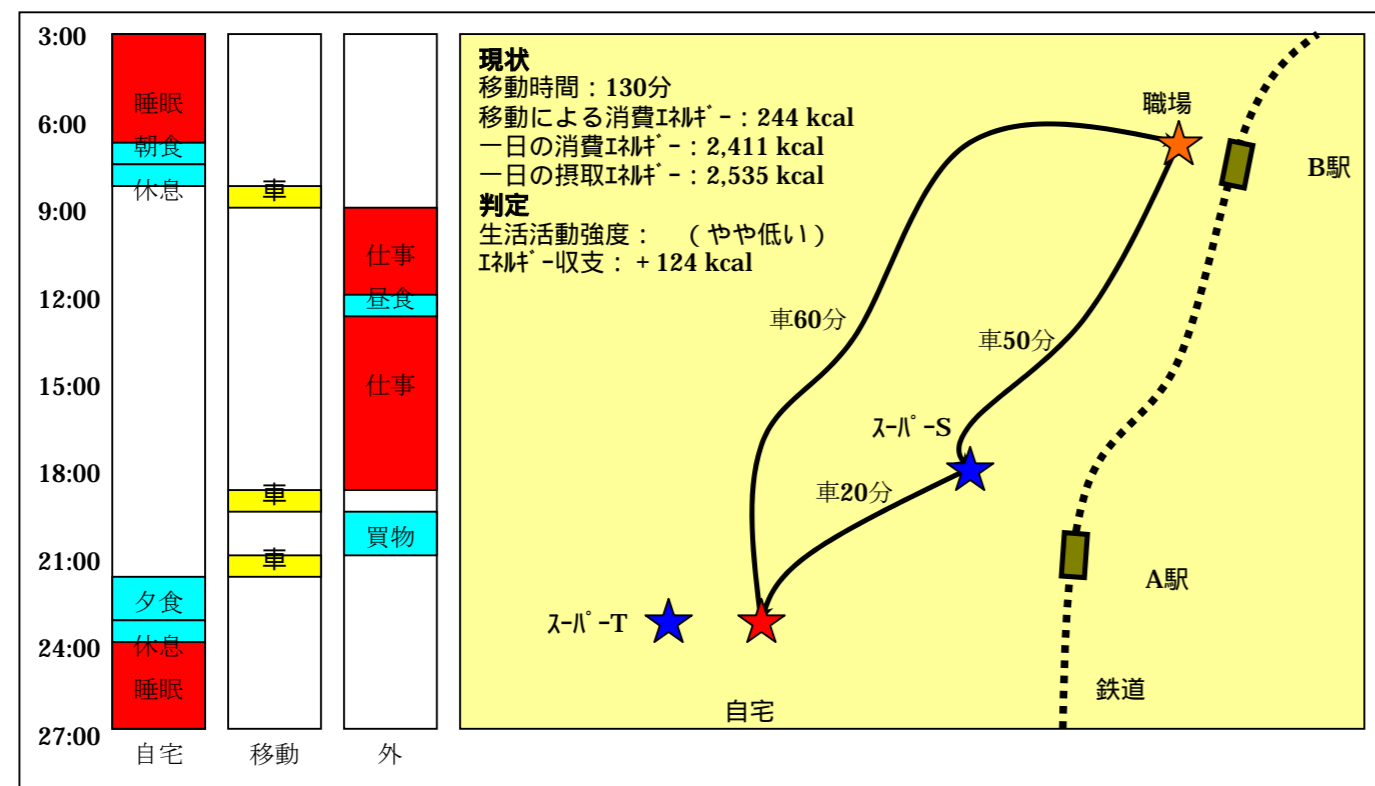
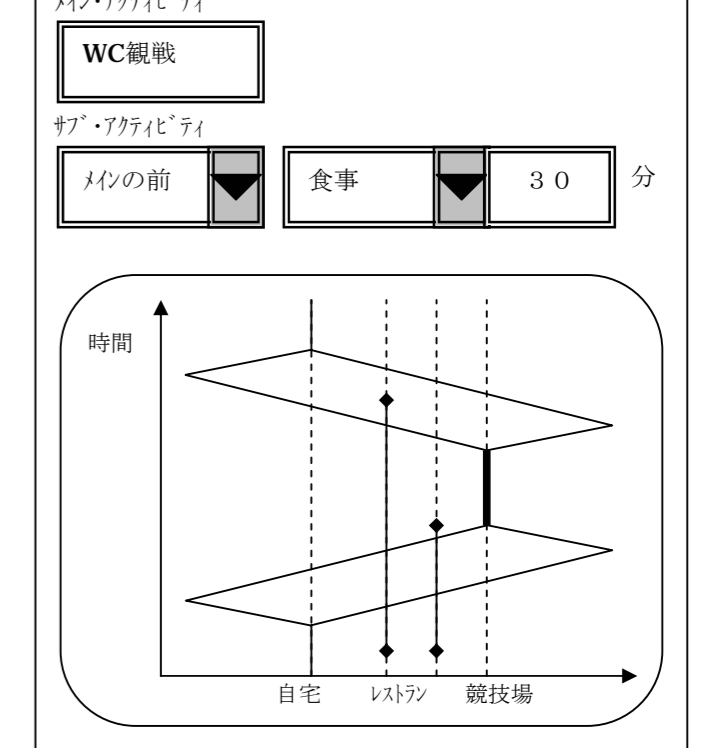
- Future research concerns the following subjects:
- Self-diagnosing system for evaluating activity-travel patterns with a variety of indicators (travel time, travel distance, travel cost, fuel consumption, environmental damage, energy balance, etc.)
 - Enhanced personal navigation system with a real-time scheduling function by getting real-time information on travel and activities
 - Activity-travel scheduling/pattern including activities engaged in “cyberspace” by the use of telecommunications

Alternative Patterns	
P&R 移動時間64分 ガソリン100円 運賃240円×2人 駐車300円/h	自動車 移動時間85分 ガソリン300円 駐車600円/h
11:50 自宅	11:25 自宅
12:19 古淵	
12:46 新横浜	12:45 駐車場
12:50 〇〇館で30分	12:50 〇〇館で30分
13:30 競技場	13:30 競技場

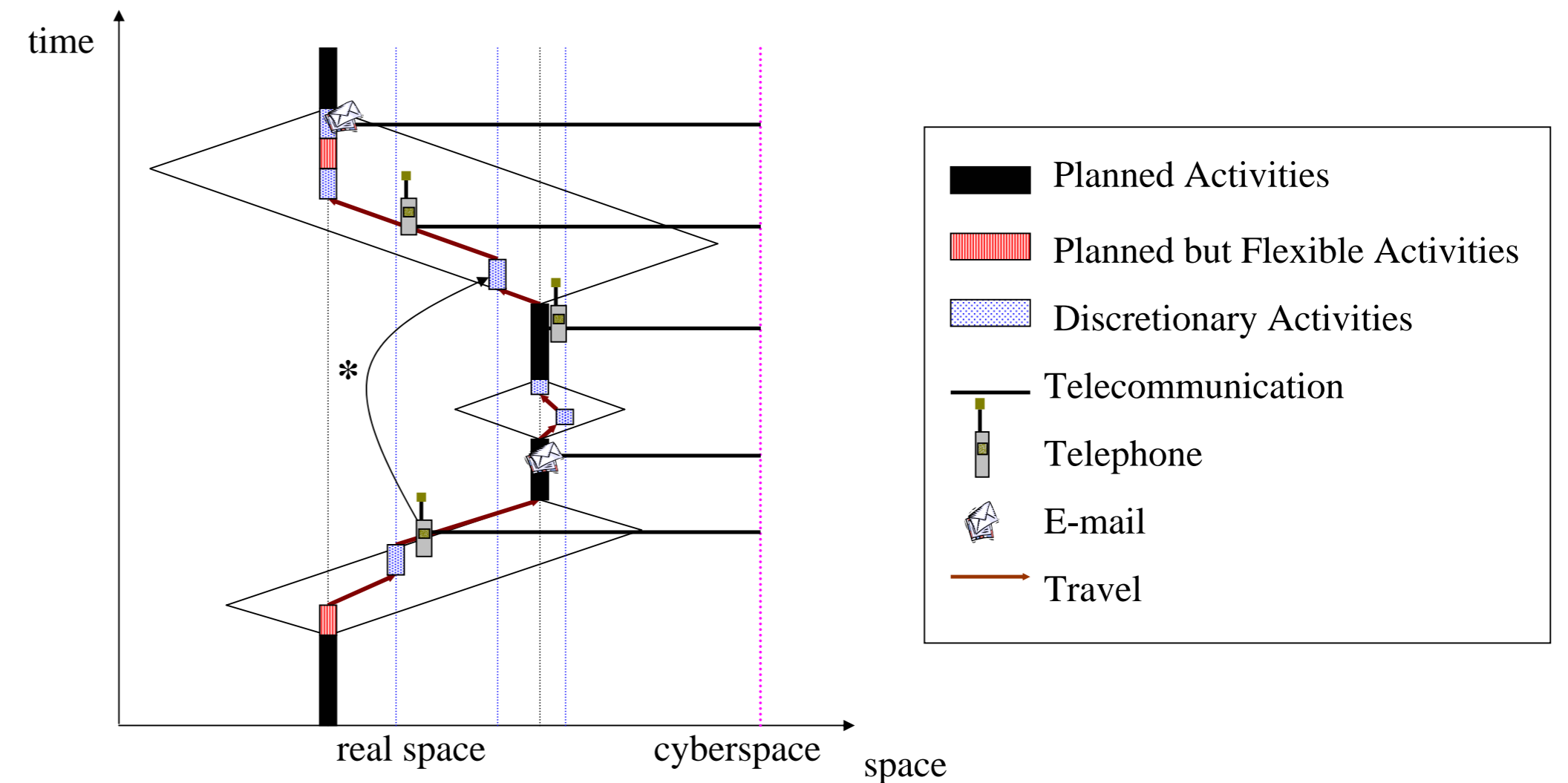
Dynamic P&R Parking Information



Activity Scheduling



Personal Navigation System with a Real-Time Scheduling Function



* The use of telecommunications affects some elements of the activity

Activity-Travel Scheduling/Pattern Including the Use of Telecommunications

Evaluation of Activity-Travel Patterns: Energy Balance