Ubiquitous Computing Using SIP

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1. Introduction
Ubiquitous Computing

“Enhance computer use by making many computers available throughout the physical environment, but making them effectively invisible to the user”

◆ 電腦無所不在
◆ 但你不會感覺到
Global-scale

- 安全性
- 多管理者，且互相獨立
- 使用現成的硬體、軟體
相關的Issues

- Multimedia
- Device integration
- Event-based
- Location-aware
- Privacy-conscious
- Invisible to user
2. Related Work
Similar Project

- Intelligent Room (MIT)
- Interactive Workspaces Project (Stanford University)
- Aura Project (CMU)
The limit

Although they (similar projects) were built successfully, they are primarily based on non-standard protocols and are generally limited to a signal organization or building.
Open protocol standard

- SIP (Session Initiation Protocol)
- SLP (Service Location Protocol)
- Bluetooth
- On-going efforts in the IETF
Incorporated work

- Active badge location system
- Location based service
- Push-based application
- Local Location Assistant
- Position techniques
- Relay location information
3. System Architecture
System Architecture

Three core components:
- Location sensing
- Service discovery
- Call control
System Architecture Outline

1. Determining User Location
2. Location Information
3. Publishing Location Information
4. Service Discovery using SIP
5. Event-Triggered Action
6. Access Control
7. Privacy
Determining User Location

1. Mobile devices determine its own location (ex: GPS-based, 802.11-based)
2. Location beacons announce their current location (ex: Bluetooth “beacons”, IR/RF programmable badges, DHCP extended)

The advantage: They require little user interaction, but they require that the user carry a PDA, laptop or our programmable badge.
Location beacons

- Bluetooth
  - Using the SDP of Bluetooth
- IR/RF programmable badge
  - Sending a unique identifier to an access point
- DHCP extended
  - MAC address
Location Information

- Not geographic coordinates or civil location information
- Place-types: home, office, driving, public
- Classification: public, private, quiet
Publishing Location Information

- SIP devices upload their location information via SIP REGISTER, PUBLISH mechanism
- Watcher: Entities subscribe to this information such as friends, colleagues, and software application
Software agent control mode

- User-centric: Each user maintains a service script that listens for location presence updates for itself.
- Device-centric: Devices subscribe to user presence and store user preferences.
Service Discovery—SLP

- SLP—Service Location Protocol
- Open standard
- Special Comparing ability:
  - $\geq$, $\leq$, conjunctions, disjunctions
- Components:
  - User Agents, Service Agents, Directory Agent
SLP framework allows the User Agent to directly issue requests to Service Agents.

In larger networks, use one or more Directory Agents -- cache.
Service Discovery — SLP

- The ways User and Service Agents discover DAs:

  - User or Service Agent
    - Multicast SrvRqst
    - Unicast DAAdvert
  - Directory Agent
    - Multicast DAAvert
A User Agent is normally assigned a scope string

The User Agent will only be able to discover that particular grouping of services
Service Discovery—SLP

◆ Other materials:
  • DNS SRV 結合 SLP (RFC 3832)
  • DNS SRV (RFC 2782)
Event-Triggered Actions

- Location Sensing
- Service Discovery
- Other
- Call Control Module
  - CPL scripts
  - SIP servlets
  - SIP CGI scripts
EX:

Access point read the serial number from the badge.

Detection message (CPL, SIP servlet, SIP CGI scripts)

server
Control Message

- 執行的 scripts 或 servlets，透過送出 Control message 的機制，來控制其它的 device
- SIP、HTTP、SOAP

Call control module  →  Control message  →  執行 device

SIP 位址： sip:lamp@r102.csie.ntu.edu.tw
HTTP 位址： http://r102.csie.ntu.edu.tw/light?op=on
Access control

- 远端控制的危险性
- 解决方案:
  1. 使用AAA server (Authentication, Authorization, and Accounting) —— 双方有有「漫游」的协议，透过AAA进行身分确认
  2. 近水楼台先得月 —— 「遥控」你已经摸的东西
Privacy

- 限制系統能取得的 **location information**
- 範例規則：
  1. 地點
  2. 資訊內容
  3. 時間

- 然而， **watcher** 是否能被信任？
4. Service Example
在PDA连接上时，提供其目前所在位置的资讯（如：台湾、台北、台大校总区、资讯系系馆、R102）
Service Discovery

- PDA利用SLP（Service Location Protocol），向系館的SLP Server查詢R102可用的資源
- 發現一台Web cam和一台單槍投影機，並且了解這些資源的能力
Register

- PDA向Home SIP Server註冊（SIP REGISTER）
- 註冊內容，包含了自己的所在位置，以及手邊有的資源（投影機和 web cam）
- 利用這些資源，PDA可以達成視訊通話的能力

Register
向Home SIP Server发出INVITE，同时指明要视讯

- PDA透过系馆SIP Server，送出INVITE给web cam，此时INVITE的内容是乡民的SDP（Session Description Protocol）资讯
Complete!

Home

SIP Server
AAA Server

Video
Audio

SIP Server
SLP Server
我的PDA
sip: artoo@home.org

R102 Bluetooth Server

系館 SLP Server

系館 SIP Server

R102 Web cam

Home SIP Server AAA Server

鄉民

Query

R102

SLP Query

sip: webcam102@csie...

REGISTER(允許video)

200(for REGISTER)

INVITE

INVITE

AAA request

OK

INVITE m=video
我的PDA
sip: artoo@home.org

R102
Bluetooth
Server

系館
SLP
Server

系館
SIP
Server

R102
Web cam

Home
SIP Server
AAA Server

鄉民

INVITE

200

200

200

200

200

200

ACK

ACK

ACK

ACK

Video

Audio
What have we done?

- Multimedia
- Device Integration
- Location-aware
- Invisible to user

還有呢？
- Event-based
- Privacy-conscious
Stefan Berger, Henning Schulzrinne, Stylianos Sidiroglou, and Xiaotao Wu, “Ubiquitous computing using SIP”

