Mobile Self Organisation through the SATIN Component Model

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Outline

- Background
- Component Model
- Middleware System
- Implementation
- Related Work
- Future Work
- Conclusion

Trends in (Mobile) Computing (Hardware)

- They are getting faster
- They are getting connected
- They are getting smaller
- They are getting everywhere

Trends in (Mobile) Computing (Software)

- Not much innovation
- Monolithic apps
- Lack of middleware
- Static apps

Trends in (Mobile) Computing (Example)

1997:

US Robotics Pilot 1000

128KB 16MHz Serial
160x160BW

2003:

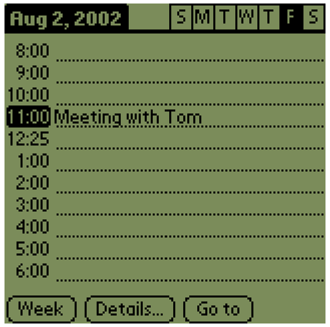
Palm Tungsten T3

64MB 400MHz
Serial/USB/Bluetooth/Infrared
320x480 24bit, Sound, Expansion

Trends in (Mobile) Computing (Example)

1997:

US Robotics Pilot 1000



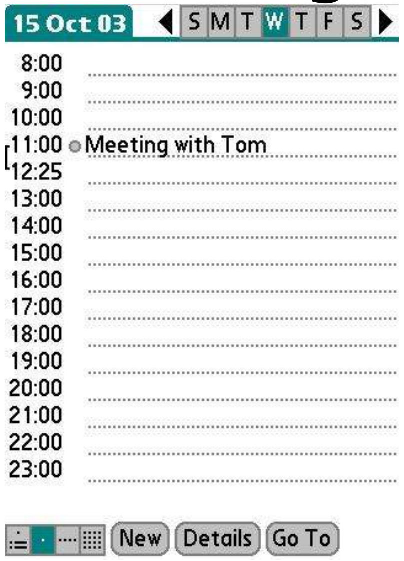
Aug 2, 2002 | S M T W T F S

8:00
9:00
10:00
11:00 Meeting with Tom
12:25
1:00
2:00
3:00
4:00
5:00
6:00

PalmOS 1.0 (DateBook)

2003:

Palm Tungsten T3



15 Oct 03 | S M T W T F S

8:00
9:00
10:00
11:00 Meeting with Tom
12:25
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00

PalmOS 5.2 (Calendar)

The Mobile Environment

- Limitations (compared to traditional computing)
  - Memory, battery power, CPU power, erratic (expensive) connectivity
  - Improving but lagging still
- Different usage paradigms
  - Input/output
  - Speed, ease of use, frequent but brief usage
    - E.g. Check schedule
  - Reports show that users rarely install applications on mobile devices
    - Applications need to cater to users' needs throughout the device's lifetime

A Dynamic Environment

- Heterogeneity!
  - Device/Hardware (Physical)
  - Software (Logical)
  - Network
- Changes to the environment
  - => Changes to application requirements.

Self - Organisation

- System adaptation to accommodate changes to its requirements
- Suitability for mobility
- Allows systems to gain new functionality
  - Reacting to changes
- Approaches
  - Expert Systems
  - Genetic Algorithms

Logical Mobility

- Ability to sent parts of an application (or migrate/clone a process) to another host
- Popularised by Java
- Classification into paradigms
  - Client/Server (CS)
  - Remote Evaluation (REV)
  - Code on Demand (COD)
  - Mobile Agents (MA)
- Various middleware (mobile & stationary) systems exploit this

Components

- Component = functionality
- Coarse-grained guide
- Monolithism vs Componentisation
- Collocation vs Distribution
  - Complexity
  - Size
  - Networking
  - Autonomy

SATIN

- System Adaptation Targeting Integrated Networks
- Component Model & Middleware
- Minimal Footprint
- Interaction & Autonomy

Component Model Outline

- Local Component Model
- Distribution Built into the Model
  - But not components
  - Using Logical Mobility
- Applications and the system itself are components

Components

- Encapsulation of functionality
- Facets
- Properties & Attributes
  - Extensible
  - Heterogeneity (Debian)
  - Identifier, Versioning, Dependencies
    - <ID, "identifier">
    - <VER, version number>
    - <DEP, dependencies>

Container

- Component Specialisation
- Registry/host of components
  - References to all components
- One on each instance
- Dynamic Registration/Removal (delegated)
  - Registrars can have different policies
- Listeners/Custom Notification

Distribution

- Logical Mobility Entity (LME)
  - Generalisation of class, object, data, component
- Logical Mobility Unit (LMU)
  - Composition of LMEs
  - Attributes & Properties
  - Handler
  - Fine grained mobility

Reflective Components

- Component Specialisation
- Components that can be changed
  - LMU Recipients
  - The Container is Reflective
  - Inspect LMUs
    - Acceptance
    - Rejection
    - Partial Acceptance
    - Handler Instantiation

Deployer

- Component Specialisation
- At least one in each instance
  - Advertised
- Abstracting sending/receiving/requesting LMUs
- Uses attributes for matching
- Synchronous and Asynchronous primitives
  - Operation Formalised using Mobile Unity

Middleware

- Fully componentised
- Advertising & Discovery
  - Advertisable Components
    - Advertising message
  - Advertiser Components
    - Register Advertisable Components
  - Discovery Components
    - Listeners / Notification

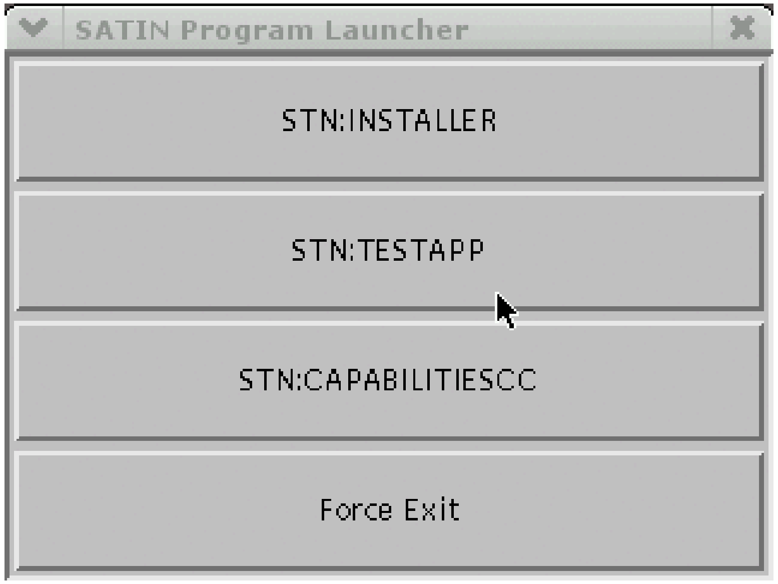
Logical Mobility

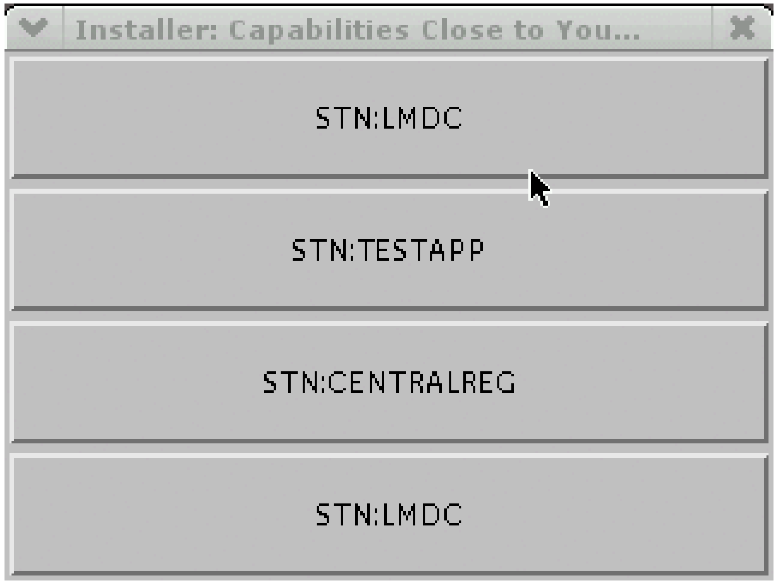
- Finer Grained
- Not only Components, but Classes/Objects
  - Patching
- Logical Mobility as a computational paradigm

Example Application: Dynamic Launcher

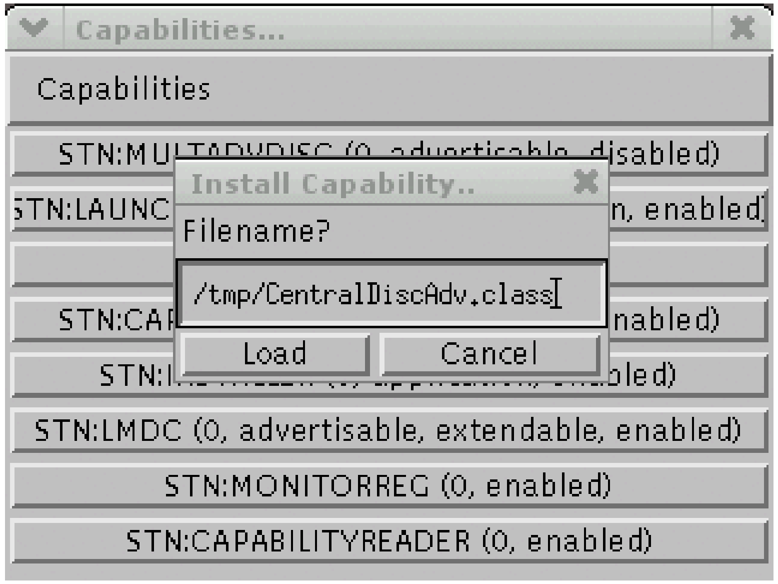
- Similar in Functionality to PDA Launchers
- Installs Components from multiple sources
  - Centralised Source, p2p...
  - Uses any discovery components installed to find components available
  - Uses Deployer to request and receive components
- Transparent update
  - Using any Discovery components installed and Deployer to find and install updates

Dynamic Launcher [2]





Dynamic Launcher [3]



Capabilities...

Capabilities

STN:MU ... disabled)

STN:LAUNC ... n, enabled)

STN:CAP ... nabled)

STN:I ... bled)

STN:LMDC (0, advertisable, extendable, enabled)

STN:MONITORREG (0, enabled)

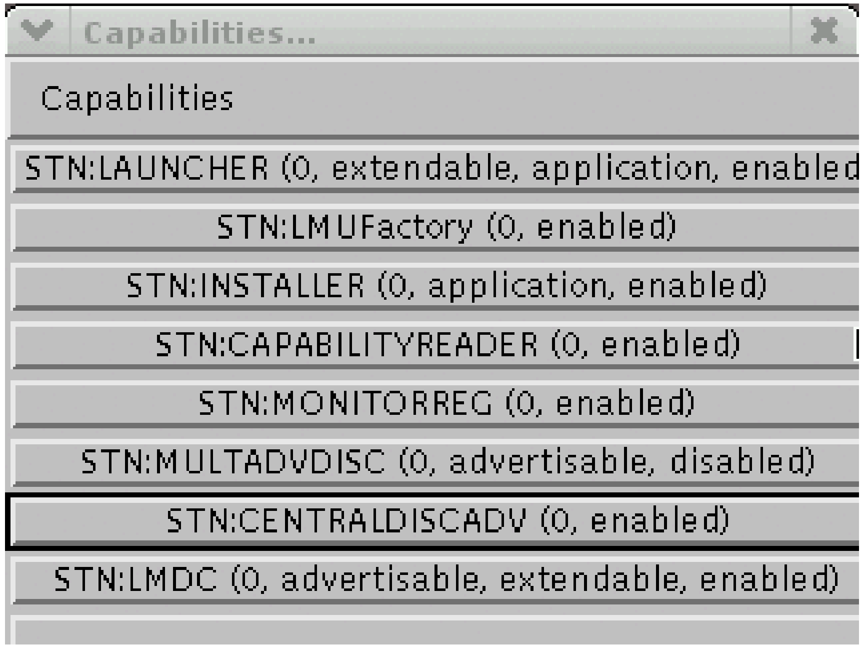
STN:CAPABILITYREADER (0, enabled)

Install Capability..

Filename?

```
/tmp/CentralDiscAdv.class
```

Load | Cancel



Capabilities...

Capabilities

STN:LAUNCHER (0, extendable, application, enabled

STN:LMUFactory (0, enabled)

STN:INSTALLER (0, application, enabled)

STN:CAPABILITYREADER (0, enabled)

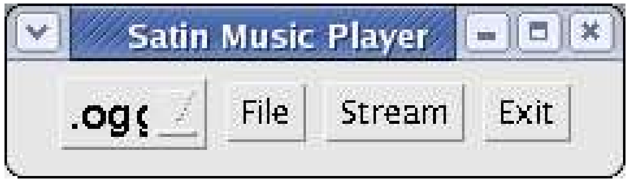
STN:MONITORREG (0, enabled)

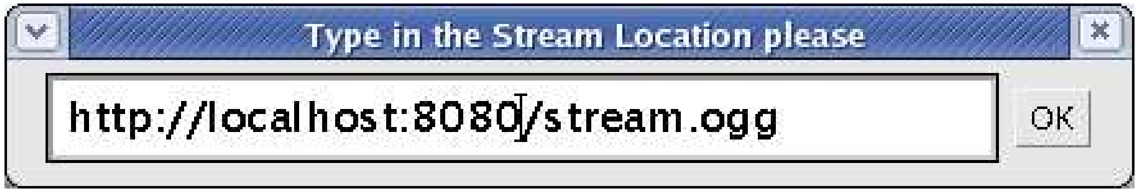
STN:MULTADVDISC (0, advertisable, disabled)

STN:CENTRALDISCADV (0, enabled)

STN:LMDC (0, advertisable, extendable, enabled)

Example Application: Music Player





http://localhost:8080/stream.ogg

Example Application: Scripting Framework

```
-=Initialising the Container=-
-=Container (ID=STN:CONTAINER,FACETS=Discovery,VER=1)
  initialised=-
-=Creating Self=-
-=Registering Self (ID=STN:SHELL)=-
-=This is SATIN version 0.8=-
-=Running on Linux 2.6.5-1.358 / i386=-
-=Hostname: hamsalad.cs.ucl.ac.uk=-
-=Java 1.4.2_04 / Sun Microsystems Inc.=-
-=A reference to the container will be made available via the
  object reference container=-
-=Starting the beanshell...=-
BeanShell 2.0b1.1 - by Pat Niemeyer (pat@pat.net)
bsh % Component c=container.getComponent(``STN:SHELL'');
```

Some Numbers

- J2ME cdc personal profile
- 84KB jar
- Dynamic Launcher
  - 22KB jar
  - Startup Time on PDA: 21 seconds
  - Memory Usage on PDA: 1155KB
  - Update to PDA from peer: 2063 ms
- Music Player
  - 3.6KB jar application
  - 105KB jar codec
- SATIN Scripting Framework
  - 280.6KB jar

Related Work

- Logical Mobility Middleware
  - Limited Use of LM
    - System Reconfiguration (UIC, ReMMoC)
    - Too Specific (Lime, PeerWare, Jini, XMIDDLE)
  - Not geared for mobility
    - Disconnections pre-announced (Fargo-DA)
    - Fixed advertising and discovery (one.world)

Related Work (2)

- Component Model Systems
  - Distributed ones unsuitable
    - Large
    - No autonomy (P2PComp, PCOM)
  - Local Component Models
    - Heterogeneity
    - Some make a distinction between Component providers and consumers (Beanome/OSGi)

Future Work

- Applications
- Integration with CARISMA
- PhD Thesis ?

Conclusion

- The SATIN Component model
  - Distribution as a service
  - Attributes for heterogeneity
  - Applications & System: interconnected local components
  - Reconfiguration of Local Components
- The SATIN Middleware System
  - Componentised Middleware (Advertising and Discovery)
  - Logical Mobility as a Computational Primitive
- Security?