Adapting Mobile Systems Using Logical Mobility Primitives

Stefanos Zachariadis

Joint Work With Cecilia Mascolo and

Wolfgang Emmerich

Software Systems Engineering &

Mobile Systems Interest Groups

Department of Computer Science

University College London

http://www.cs.ucl.ac.uk/staff/s.zachariadis

Outline

- Background
- Logical Mobility
- 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:

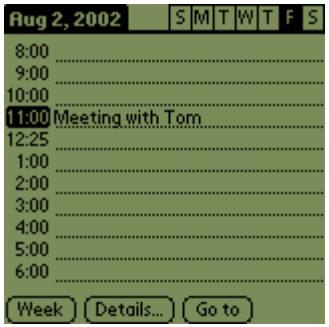
Palm Tungsten T3

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

Trends in (Mobile) Computing (Example)

1997:

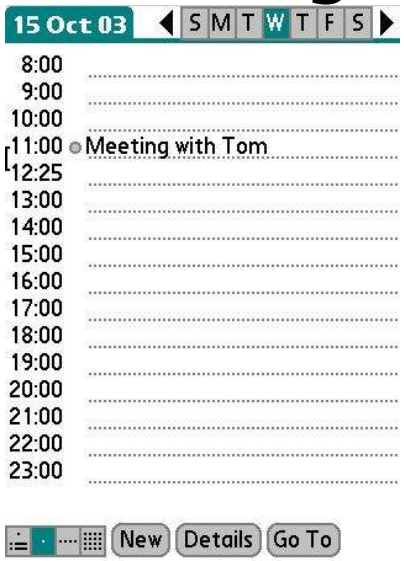
US Robotics Pilot 1000



PalmOS 1.0 (DateBook)

2003:

Palm Tungsten T3



PalmOS 5.2 (Calendar)

Black Box -> Market Saturation

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
  - People don't install 3rd party applications
  - Applications need to cater to users' needs throughout the device's lifetime
- Ubiquitous Computing -> Dynamic Environment
- The need for dynamic change

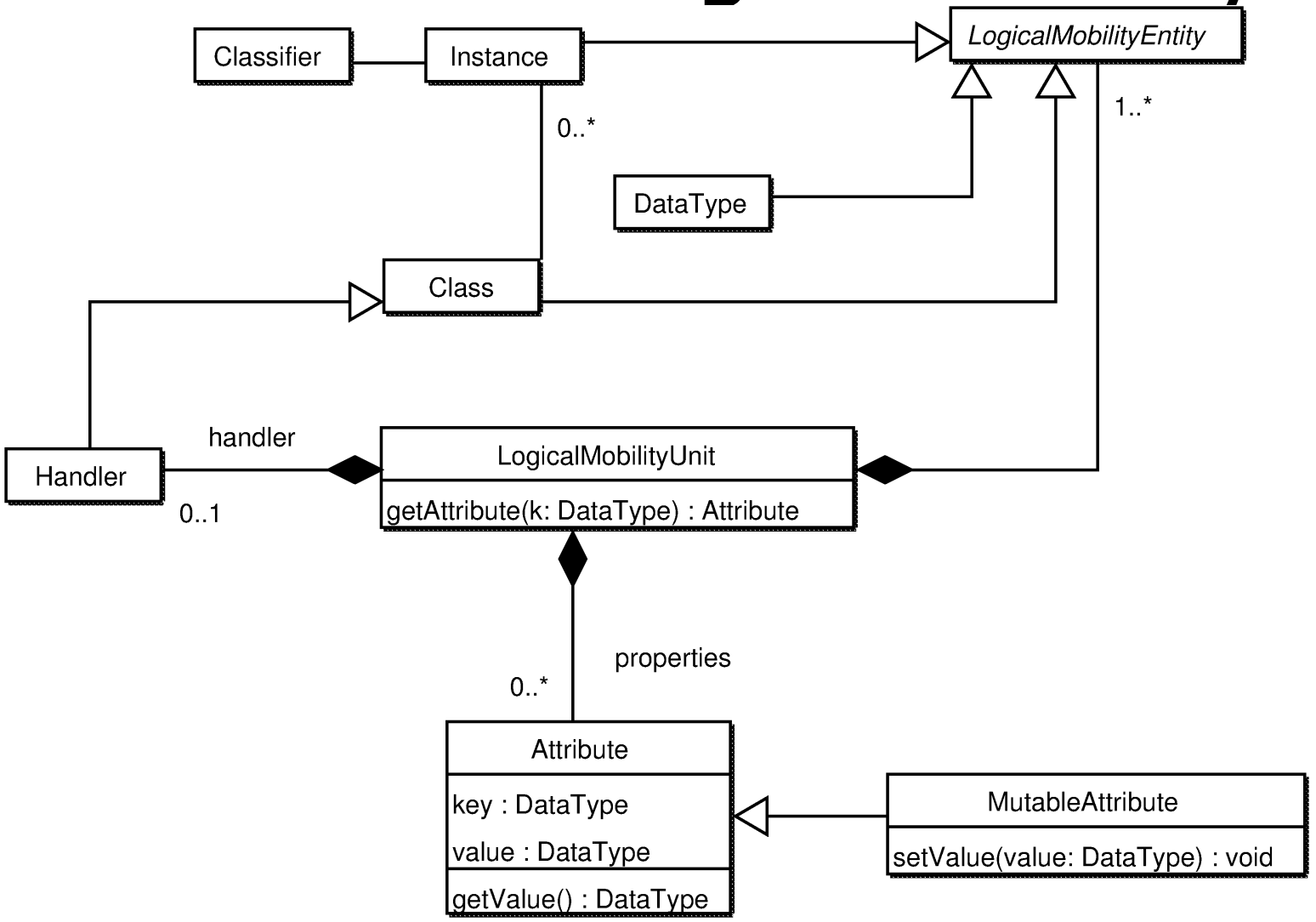
Adaptation

- Change to accommodate changes to its requirements
  - Informal: Adaptation is the process by which a system can dynamically acquire or drop functionality.
- Suitability for mobility
- Architecture & Means for Adaptation
  - Not Decision
- How to adapt?
- How to engineer an adaptable system?

Logical Mobility

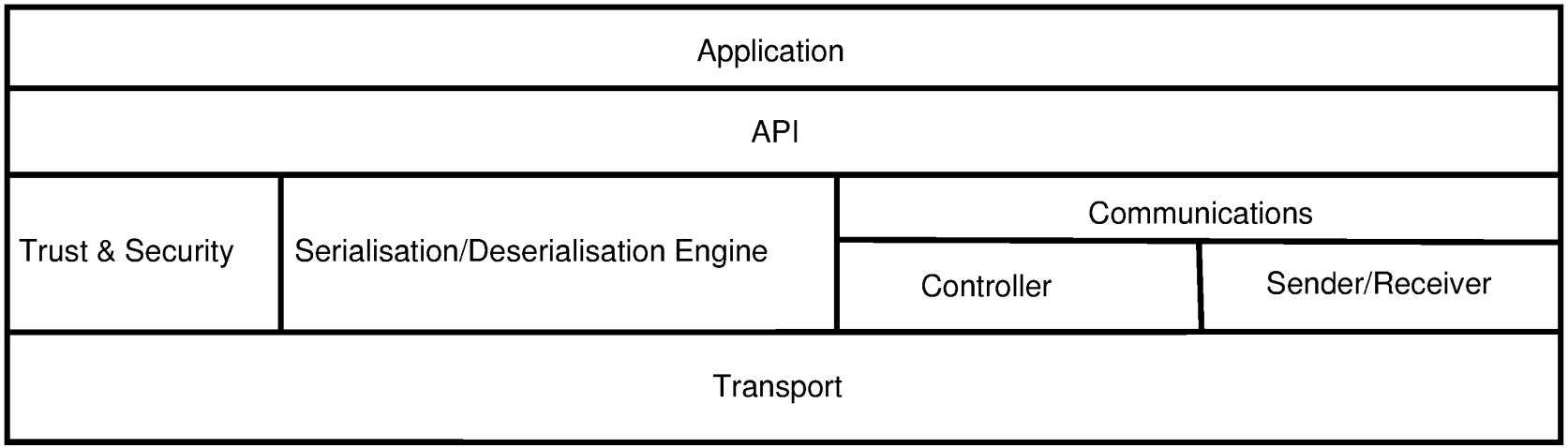
- Ability to sent parts of an application (or migrate/clone a process) to another host
- Popularised by Java
- Classification into paradigms
- Encapsulate Functionality
- Numerous examples
  - Active networking, resource exploitation...
  - Need for systematic and flexible use of all paradigms
  - Send & receive

Platform for Logical Mobility



Platform for Logical Mobility (2)

- Modeled as Concurrent Processes (FSP)



- Can be used to implement any paradigm

Components

- Component = functionality
- Coarse-grained adaptation guide
- Monolithism vs Componentisation

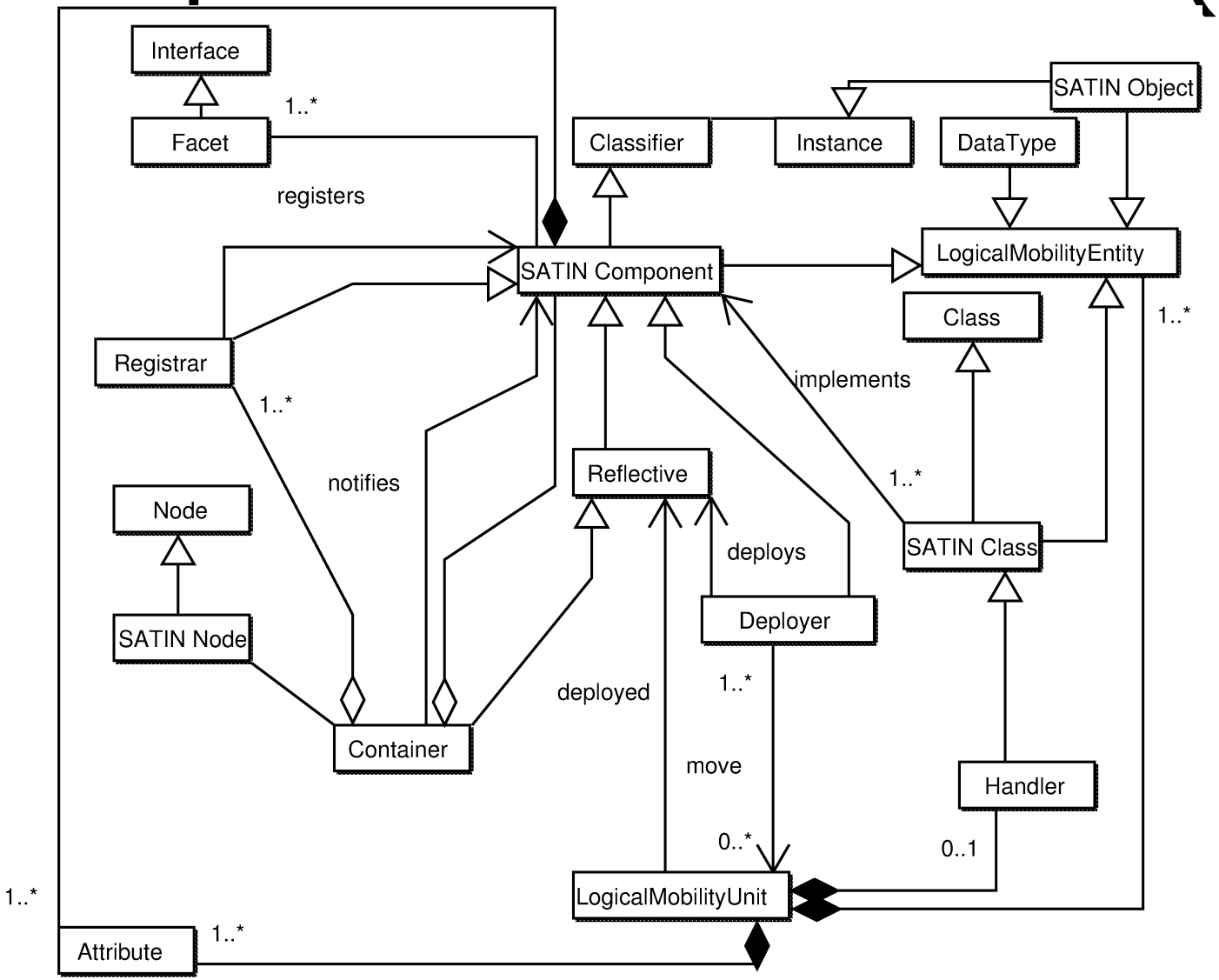
SATIN

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

Component Model Outline

- Local Component Model
- Late - Binding
- Logical Mobility as a first class citizen
  - by encapsulating and offering the platform
- Everything is a component

Component Model Outline (2)



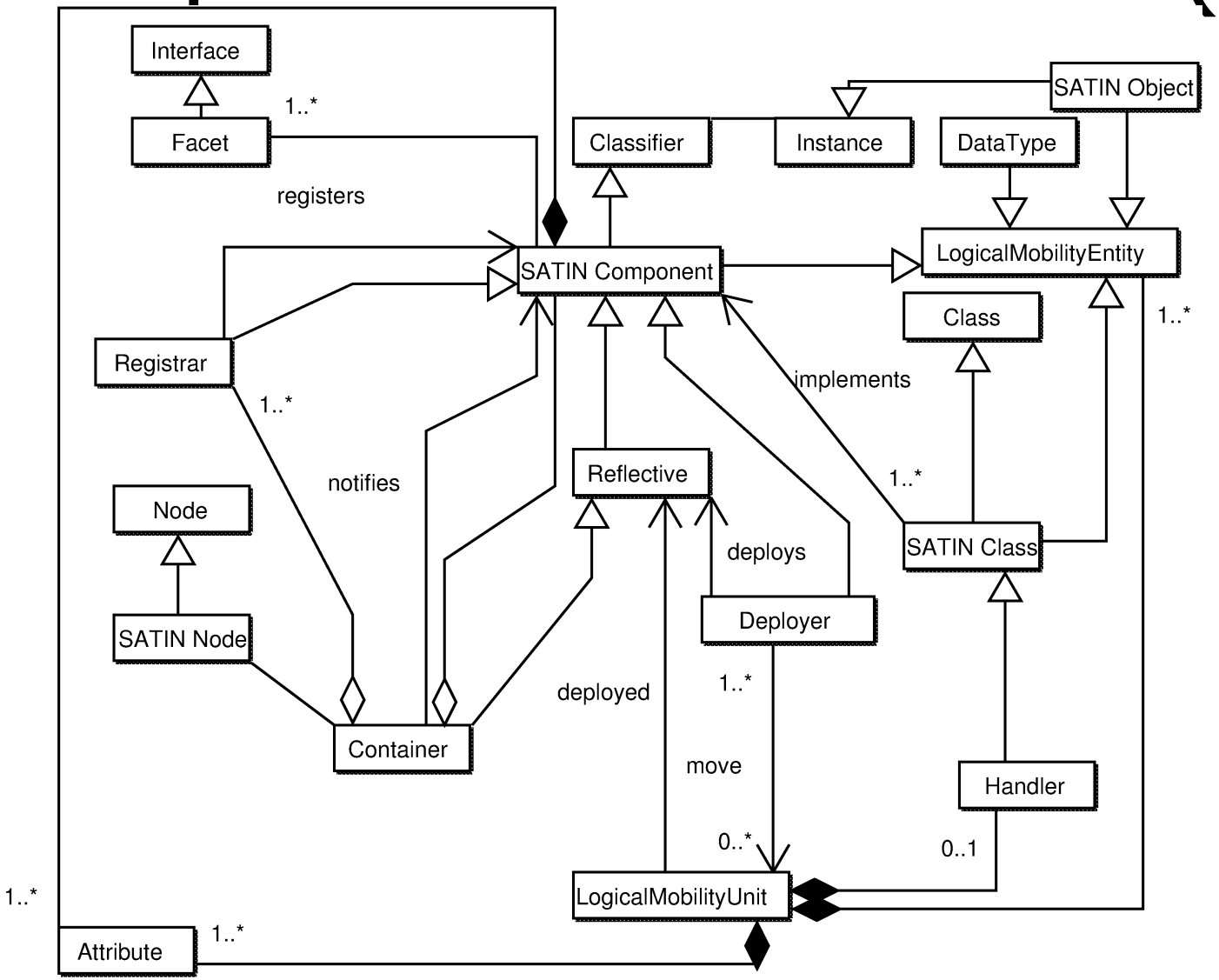
Components

- Encapsulation of functionality
- Facets
- Properties & Attributes
  - Extensible
  - Heterogeneity (Debian)
  - Request template
  - Identifier, Versioning, 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

Component Model Outline (2)



Distribution

- Use LM platform defined before
- Logical Mobility Entity (LME)
  - Generalisation of class, object, data and component
- Application is a Reflective Component

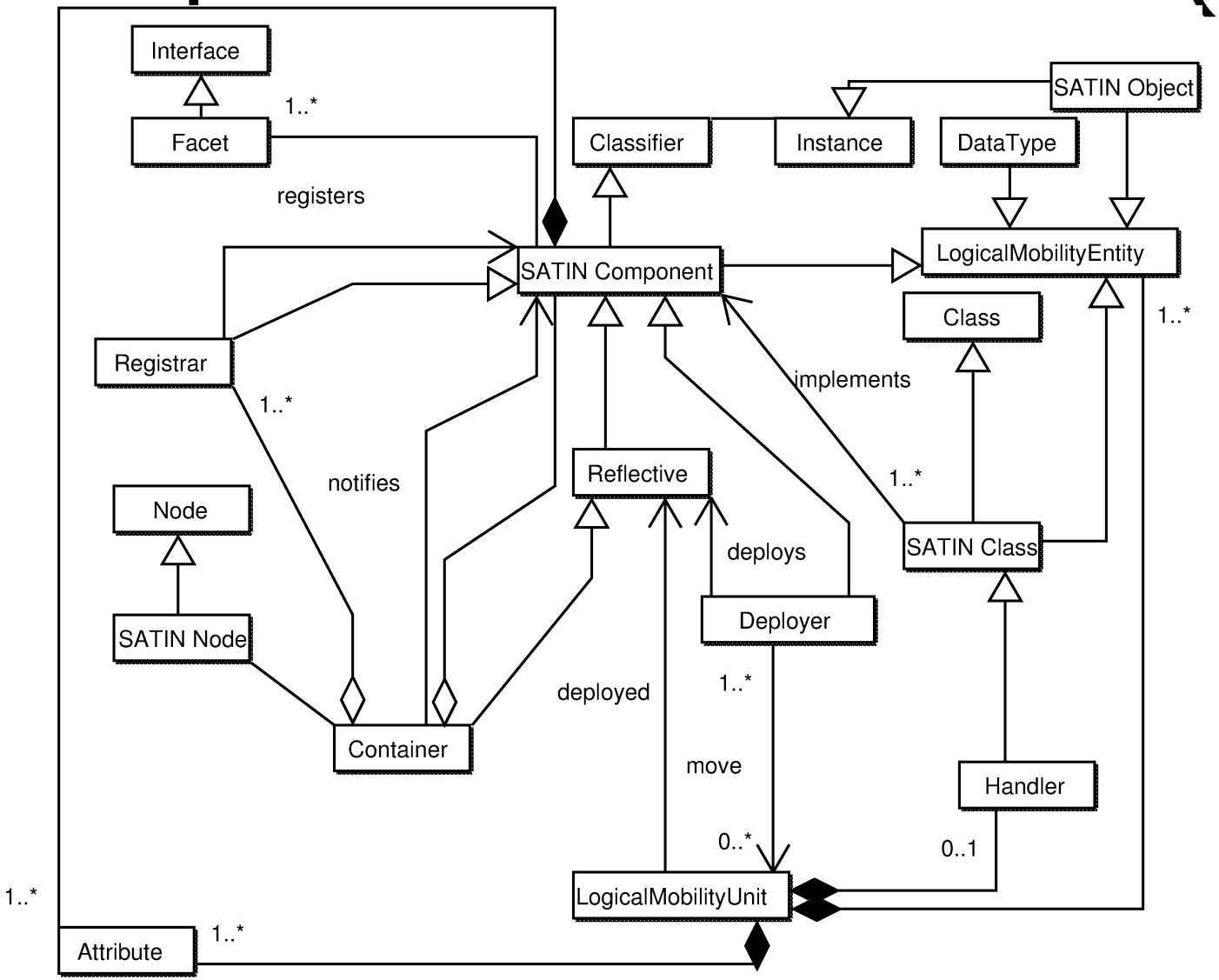
Reflective Components

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

Deployer

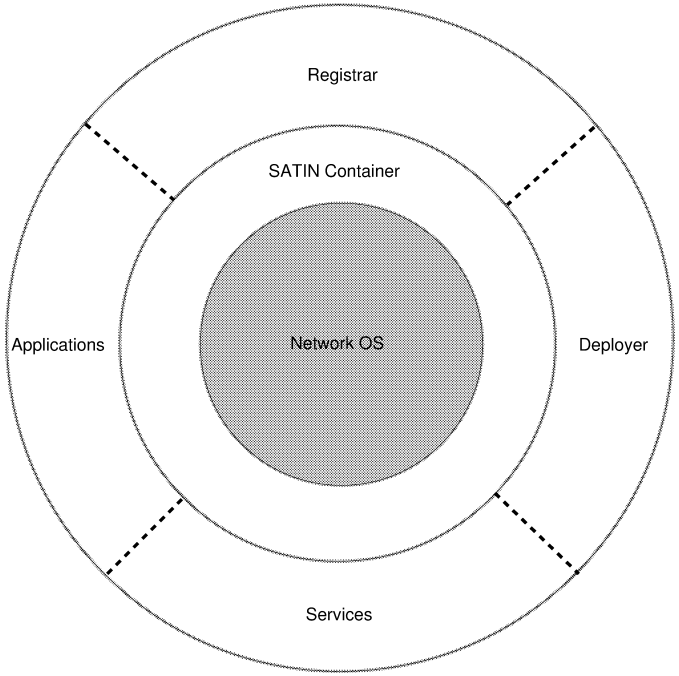
- Component Specialisation
- At least one in each instance
- Abstracting sending/receiving/requesting LMUs
- Uses attributes for matching
- Synchronous and Asynchronous primitives
- Can be used to implement all paradigms

Component Model Outline (2)

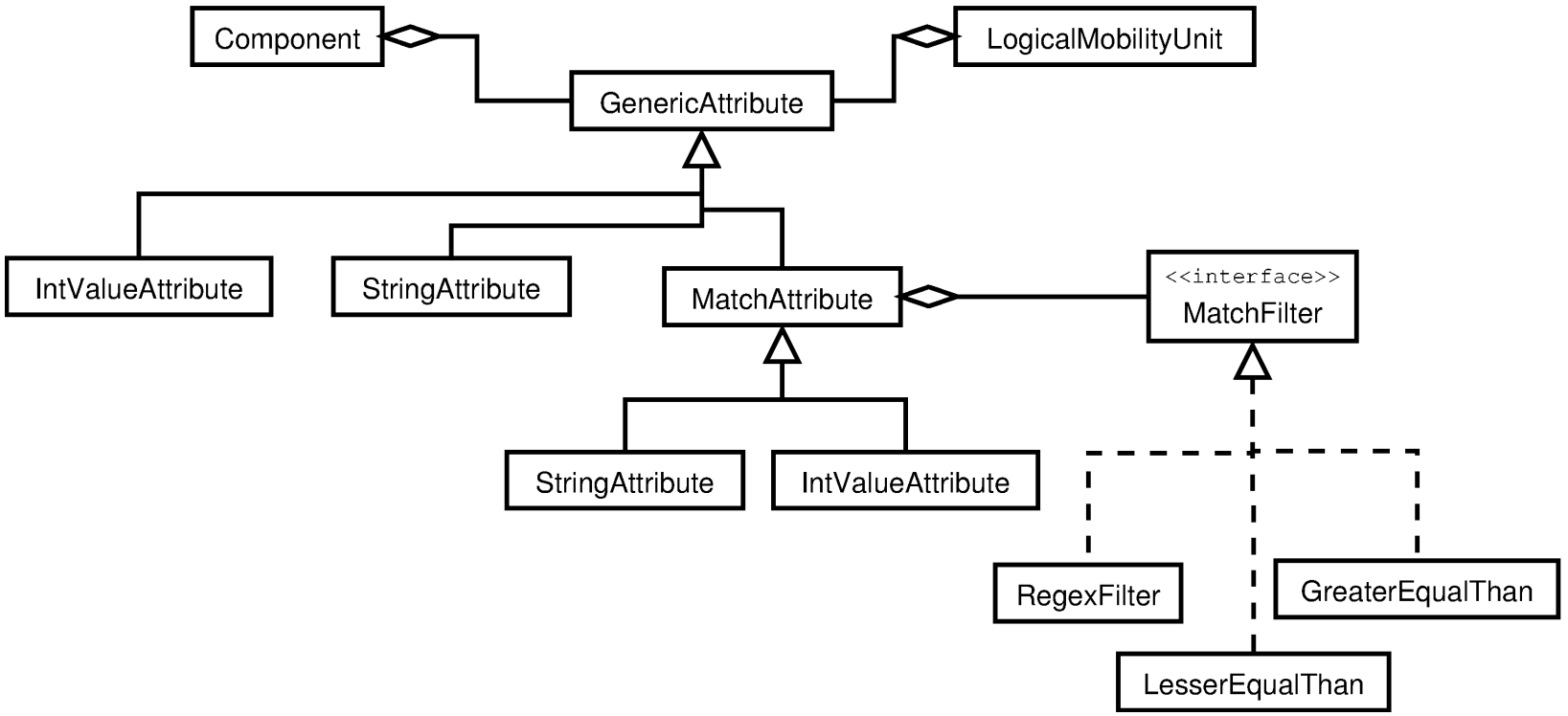


Middleware

- Component Based
  - "Equal" Components
- Advertising & Discovery
  - Advertisable Components
    - Advertising message
  - Advertiser Components
    - Register Advertisable Components
  - Discovery Components
    - Listeners / Notification



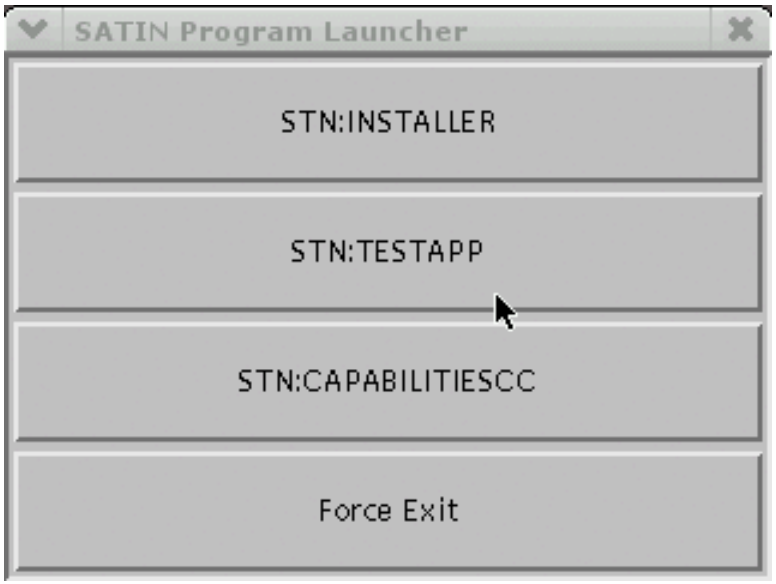
Middleware (2)

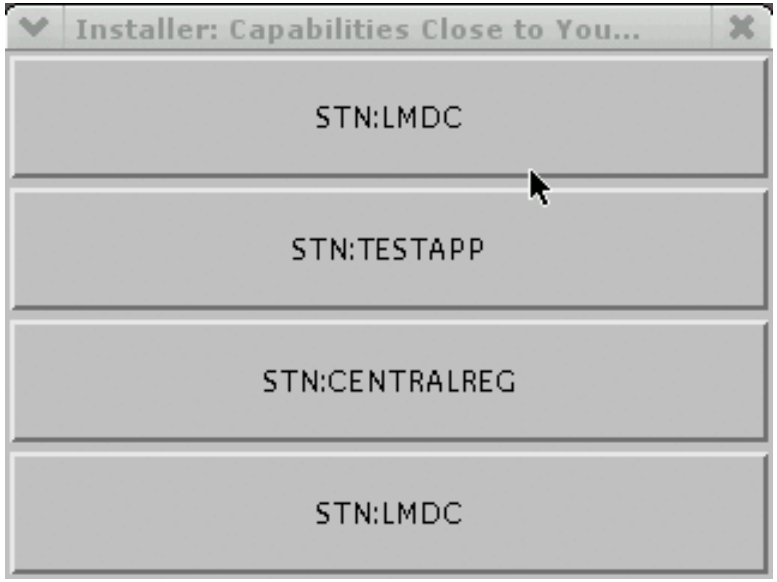


Example Application: Dynamic Launcher

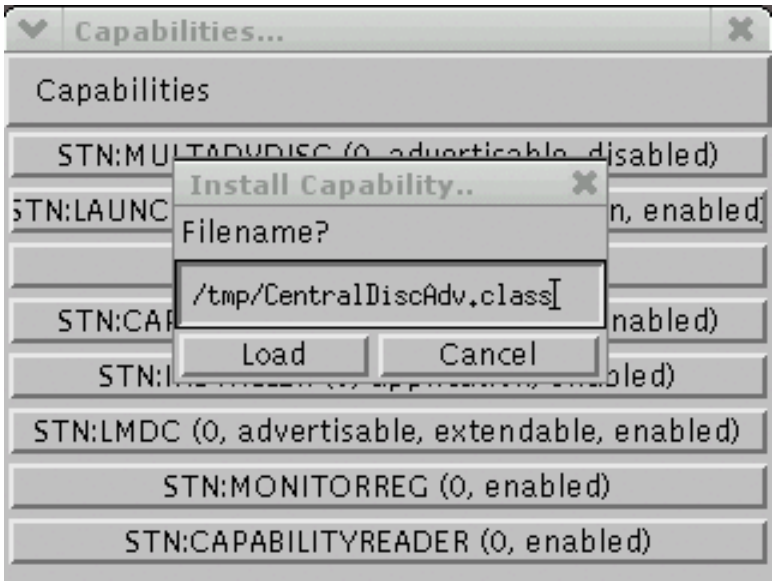
- Similar in Functionality to PDA Launchers
- Installs Components from multiple sources
  - Centralised Source, p2p...
  - Uses any discovery components installed to find components available
  - Uses Deployer to request and receive components
- Transparent update
  - Using any Discovery components installed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

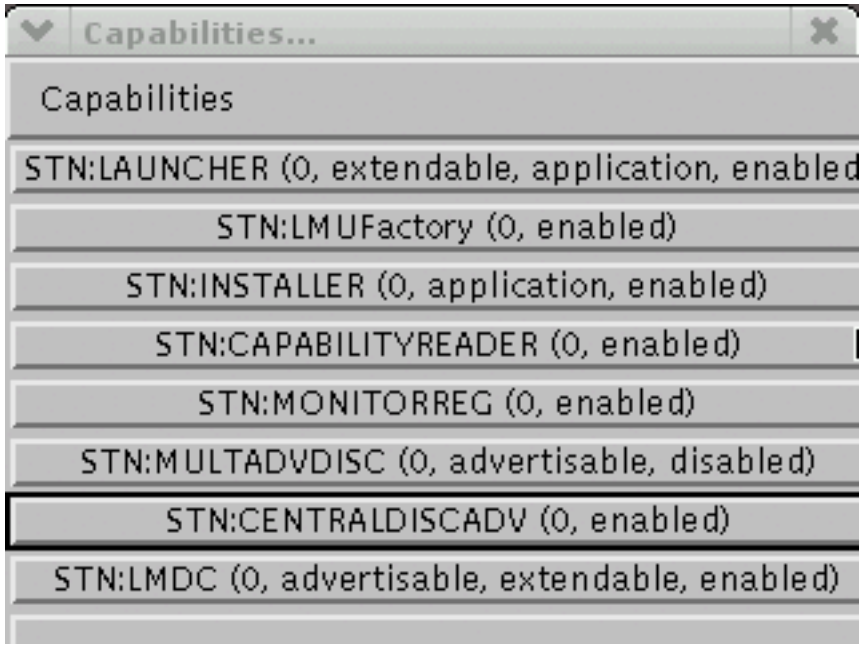
Dynamic Launcher [2]





Dynamic Launcher [3]





Example Application: Music Player

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
    - 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

- SEINIT, http://www.seinit.org/
  - EU Project for pervasive computing security
  - Demo @ IST 2004
- RUNES, http://www.ist-runes.org/
  - EU Project for middleware for ubiquitous computing
- Q-CAD
  - QoS-aware resource discovery framework
  - Joint work with Licia Capra
- Open source!

Conclusion

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

Any Questions?

Publications and more information at

http://www.cs.ucl.ac.uk/staff/s.zachariadis

Thank you!