

Politecnico di Torino

Master degree in
Computer Engineering



Context Aware and Device Dependent Interaction in Smart Environments

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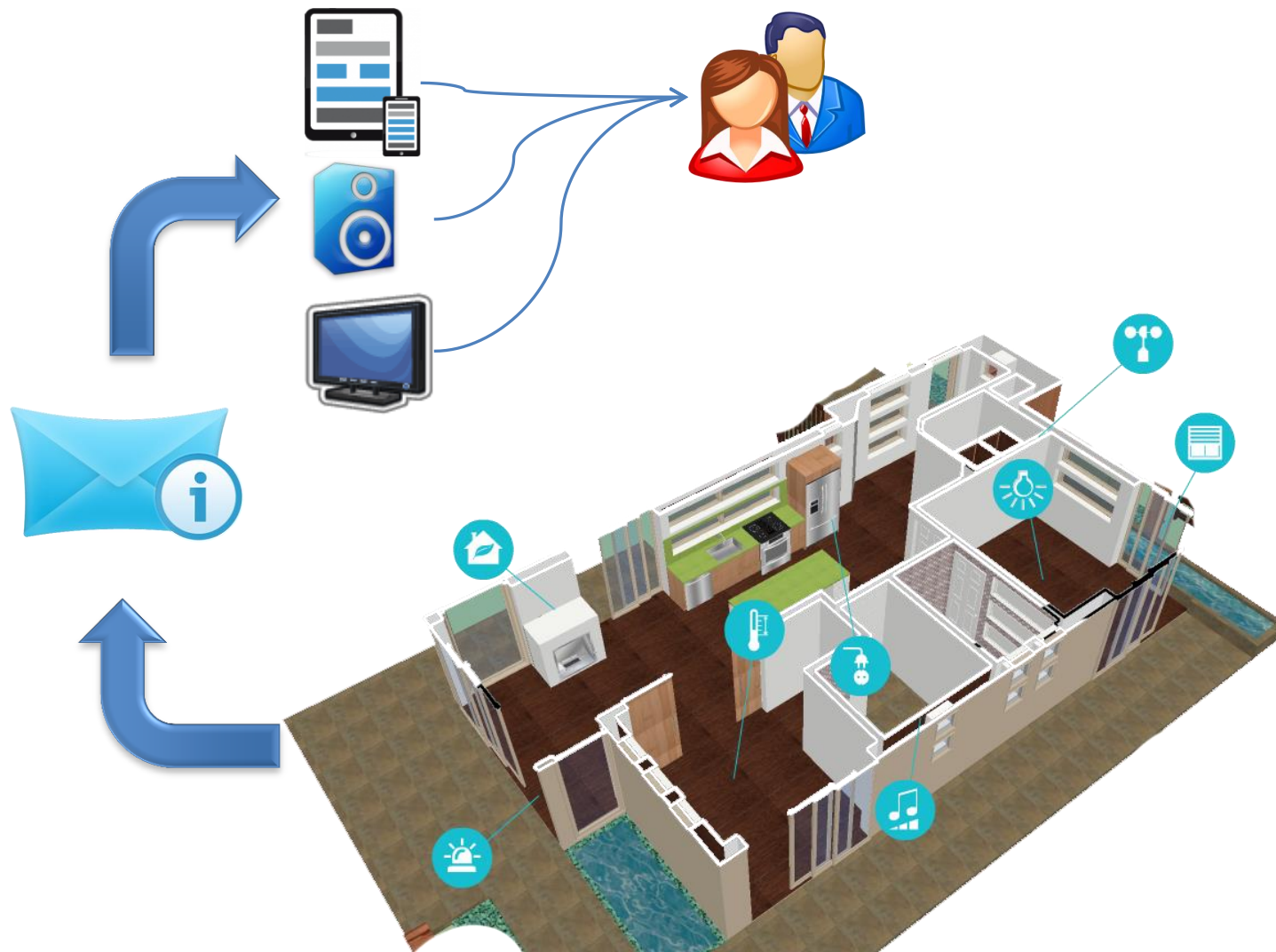
Outline

- Introduction
- Thesis work
 - Data Modelling
 - Software Development
- Scenario Test Case
- Conclusions

Goal:

- An intelligent notification system for smart homes

- Take into account the surrounding context to select end user devices and send them generated messages



Steps:

- create a data modelling infrastructure able to represent information about the context (domain of interest)
- develop a software to elaborate data model information and deliver house related messages to the appropriate end users device

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Data Modelling

Data Modelling

- Definition of the Domain of Interest
 - Users
 - User Devices
 - Smart Home
 - Message Categories
- Ontology-Based Modelling
- Exploration of existing ontology for context modelling

Notont the Notification Ontology

- 4 directly imported ontologies
 - Locont
 - Device
 - DogOnt
 - Core
- 27 overall imported ontologies
- 1385 classes

Notont – User Modelling

- Activity (e.g. eating, sleeping)
- Accessibility (e.g. freeable_hands)
- Location (e.g. livingroom, kitchen)
- Obtrusiveness (e.g. mobile_only, no_audio)
- End-User-Devices (e.g. smartphone, tablet)
- Message Categories (e.g. AppliancesAlert)

Notont – Device Modelling

- Physical Features (e.g. screen size, camera)
- Capabilities (e.g. audio and video reproduction)

Notont – House Modelling

- Architectural aspects (e.g. wall, window)
- Appliances (e.g. oven, HVAC system)
- Devices (e.g. smart tv, HiFi system)
- Furniture (e.g. couch, table)

Notont – Message Category Modelling

- Priority (e.g. lower_level, highest_level)
- Attributes (e.g. min_temperature_value)

Notont – Information modelling

- Information as Class instance
- Instance data properties
- Connections by means of object properties
 - A single .owl file as data model

Scenario Test Case

- 2 users (Luca, Giulia)
- 3 devices (LG Nexus 4, Samsung Galaxy Nexus, Samsung Galaxy Tab 10”)
- 1 smart home (temperature and humidity sensors, smart plugs, door sensors, Hifi system)
- 6 message category (EnvironmentalComfort, PowerOverThreshold, EnergyManagement, AppliancesUsage, AppliancesAlert, SecurityAlert)

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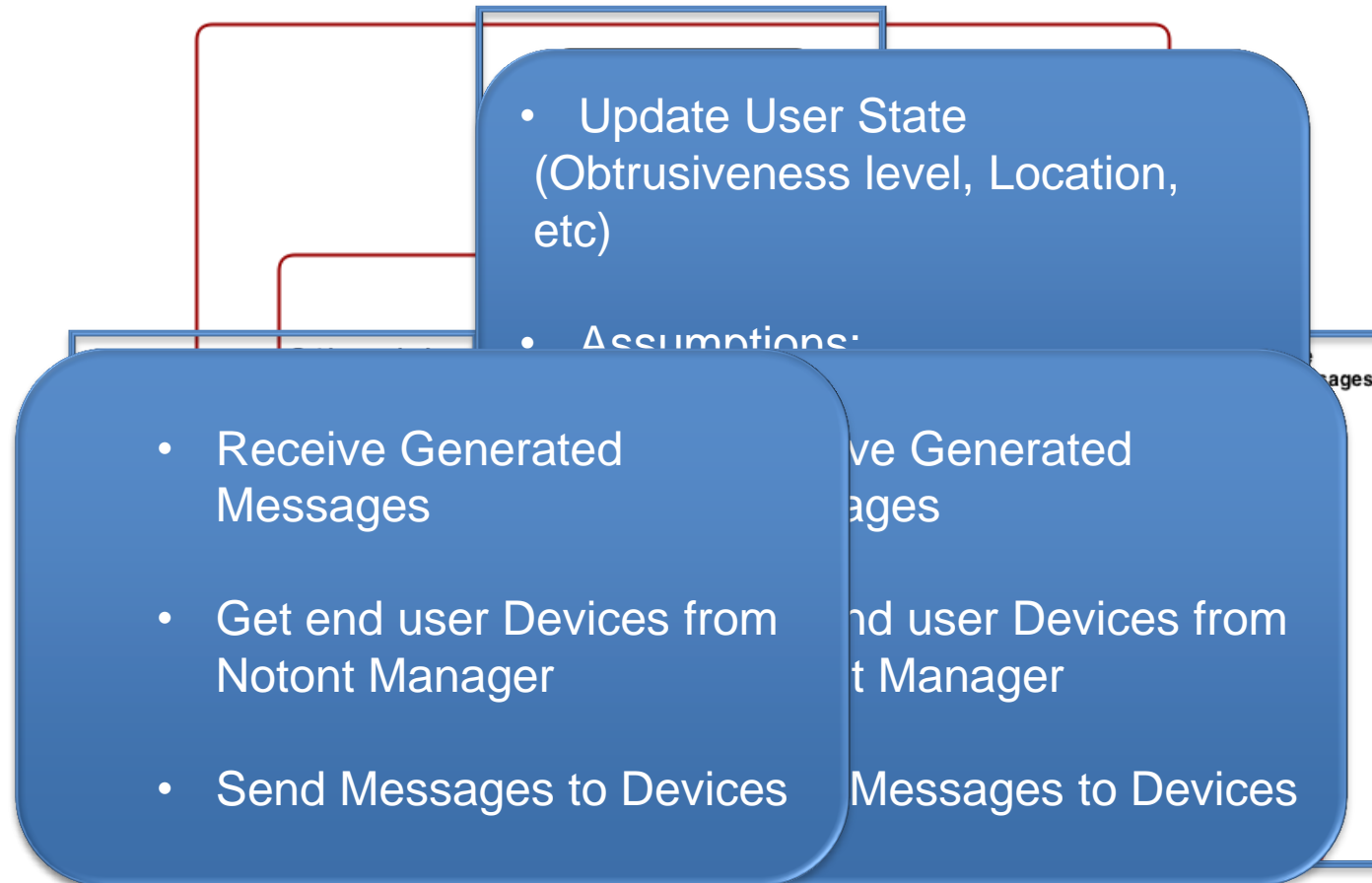


Software Development

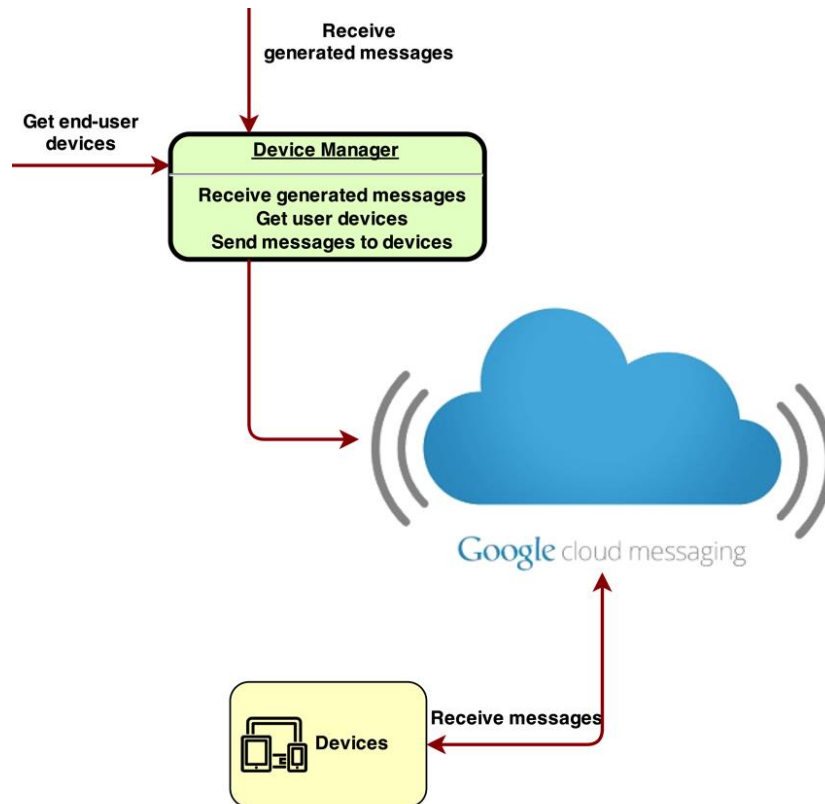
Software Development

- Data Model Management
 - Notont Manager
- User Interfacing
 - UserManager
- House Interfacing and Message Generation
 - House Message Manager
- Device Message Delivery
 - Device Manager

NINS: Notont-based Intelligent Notification System



NINS – Device Manager



- Android – Based Devices
- Gcm Service
- Mobile application on Devices

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Scenario Test Case

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Video



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Conclusions

Conclusions

- Notont – Notification Ontology
 - Formal representation of context information in Smart Environments
 - Inferring of the most suitable end user device
- NINS – Notont-based Intelligent Notification System
 - Data model Management
 - House and User interfacing
 - Sending messages to devices

Future Works

- Test in a real home setting
- Usage of the context to infer “how” send a message to end users devices
- Increase supported devices

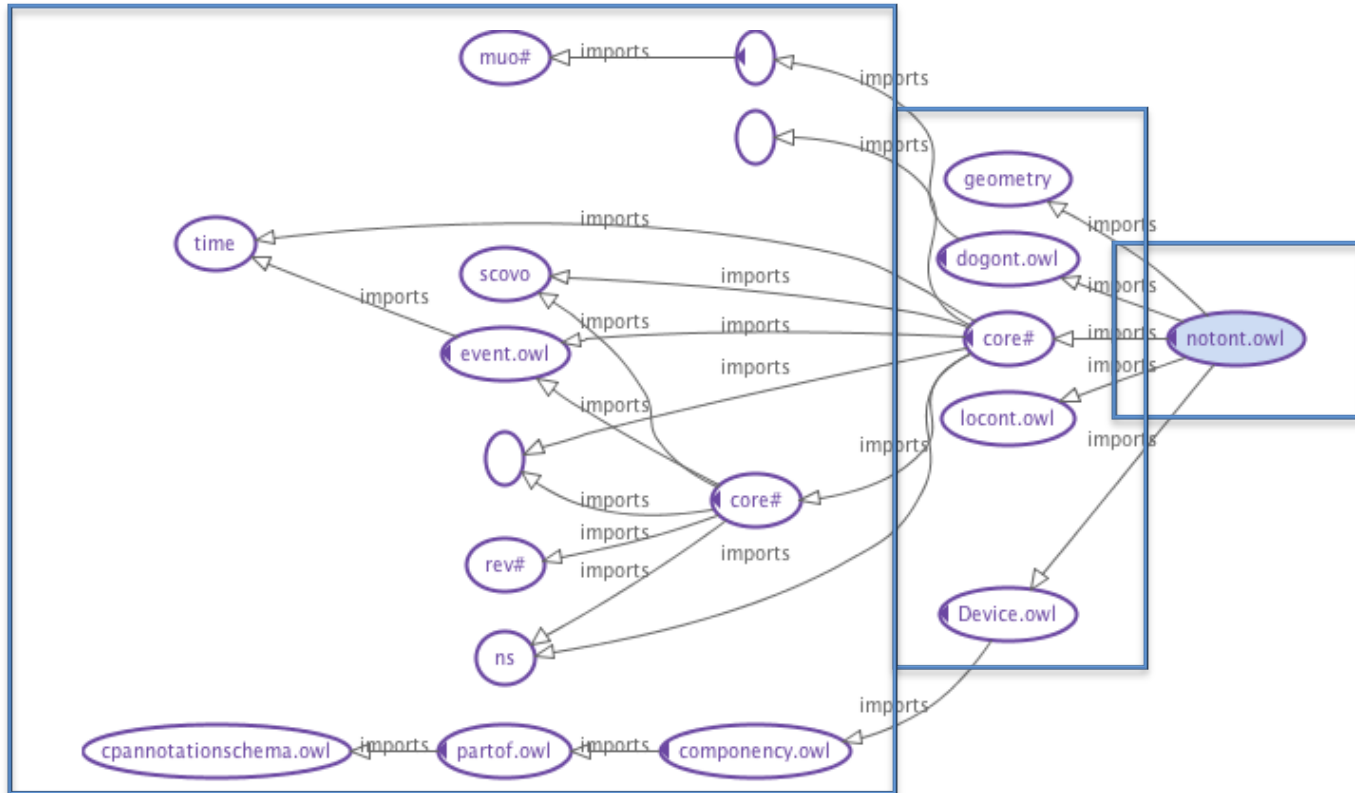
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Thank You!

Notont the Notification Ontology



Notont & scenario modelling

The screenshot displays the Protégé OWL editor interface for the 'scenario' ontology. The browser address bar shows the URL: `scenario (http://elite.polito.it/ontologies/notont/scenario.owl)`. The main interface is divided into several panes:

- Class hierarchy (left):** Shows a tree view of classes. The 'locont:Person' class is expanded, showing subclasses like 'locont:Employee', 'locont:AssistantProfessor', 'locont:Clerk', 'locont:Lecturer', 'locont:Manager', 'locont:Professor', 'locont:Stockholder', 'locont:Student', 'locont:Posture', 'locont:SymbolicLocation', 'locont:TimeGranularity', 'msg0:License', 'msg0:Work', 'notont:Accessibility', 'notont:Obtrusiveness', 'rdfs:Class', 'rdfs:Resource', 'rev:Comment', 'rev:Feedback', 'rev:Review', 'schema:CreativeWork', and 'schema:ImageObject'.
- Individuals: notont:accessibility_free (center):** Lists various individuals, including 'nexus_5_display', 'nexus_5_flashmem', 'nexus_5_front_camera', 'nexus_5_mic', 'nexus_5_ram', 'nexus_5_rear_camera', 'nexus_5_speakers', 'NotMovingStateValue_dog_bathroom_presen', 'NotMovingStateValue_dog_bedroom_presenc', 'NotMovingStateValue_dog_livingroom_prese', 'notont:accessibility_free', 'notont:accessibility_freeableHands', 'notont:accessibility_freeableWrist', 'notont:accessibility_notFree', 'notont:obtrusiveness_audioOnly', 'notont:obtrusiveness_available', 'notont:obtrusiveness_houseOnly', 'notont:obtrusiveness_mobileOnly', 'notont:obtrusiveness_noAudio', 'notont:obtrusiveness_noAvailable', 'notont:obtrusiveness_noVideo', 'notont:obtrusiveness_videoOnly', 'NotPresentNotification_dog_bathroom_prese', 'NotPresentNotification_dog_bedroom_presen', 'NotPresentNotification_dog_livingroom_pres', 'NotPresentState_dog_bathroom_presence_s', 'NotPresentState_dog_bedroom_presence_se', and 'NotPresentState_dog_livingroom_presence_'.
- Annotations: notont:accessibility_free (top right):** Shows a list of annotations for the selected individual.
- Description: notont:accessibility_free (bottom left):** Shows the description of the selected individual, including types and same/different individuals.
- Property assertions: notont:accessibility_free (bottom right):** Shows a list of property assertions for the selected individual.

Scenario: Giulia modelling

```
<!-- http://elite.polito.it/ontologies/notont/scenario.owl#giulia -->
<owl:NamedIndividual rdf:about="&scenario;giulia">
  <rdf:type rdf:resource="&locont;Employee"/>
  <foaf:birthday rdf:datatype="&xsd;date">1987-02-26</foaf:birthday>
  <foaf:familyName rdf:datatype="&xsd;string">Brambilla</foaf:familyName>
  <foaf:firstName rdf:datatype="&xsd;string">Giulia</foaf:firstName>
  <foaf:nick rdf:datatype="&xsd;string">Giuly</foaf:nick>
  <notont:hasObtrusivenessLevel rdf:resource="&notont;obtrusiveness_available"/>
  <core:preference rdf:resource="&scenario;AppliancesAlert"/>
  <core:preference rdf:resource="&scenario;AppliancesUsage"/>
  <core:preference rdf:resource="&scenario;EnvironmentalComfort"/>
  <core:preference rdf:resource="&scenario;SecurityAlert"/>
  <locont:hasCurrentActivity rdf:resource="&scenario;activity_giulia"/>
  <locont:hasCurrentSymbolicLocation rdf:resource="&scenario;kitchen"/>
  <locont:usingArtifact rdf:resource="&scenario;galaxyTab"/>
  <locont:usingArtifact rdf:resource="&scenario;nexus4"/>
</owl:NamedIndividual>

<!-- http://elite.polito.it/ontologies/notont/scenario.owl#activity_giulia -->
<owl:NamedIndividual rdf:about="&scenario;activity_giulia">
  <rdf:type rdf:resource="&locont;Eating"/>
</owl:NamedIndividual>
```

Query the model – Giulia's activity

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
PREFIX locont: <http://webmind.dico.unimi.it/CARE/locont.owl#>

SELECT ?activity ?activityType WHERE {

?person foaf:firstName "Giulia"^^xsd:string.
?person locont:hasCurrentActivity ?Activity.

?activity rdf:type ?activityType.
?activityType rdfs:subClassOf* locont:Activity.
}
```

Android user application

