Future Internet Directions

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a Definition

- Is not a specific technique
- Various alternative techniques and services which will overcome the structural limits of current Internet
- Driving force is changing from network driven to service leading
- Communication, Broadcasting, Computing, Sensor Networks all integrated to provide proper service to the user based on his preference and context

Conceptual Diagram

Current Internet Trends

- Rapid Growth of SNS and Web 2.0
  - 120,000,000 users, and is growing
- Widespread of Mobile Devices
  - 4 billion users, around 1 B/ 4B will be connected to the Internet using wireless
  - Current wired connection is 1.5 B
- Traffic grows 60% per year because of multimedia contents
- Will move to the connected things world

Problems

- Openness to various terminals
- Security: built for researchers originally
- Reliability: Structure, Router
- Mobility
- Manageability
- Regulation
- personalization

5 Directions

- Seamless Internet for mobile users
- Smart Internet
- Sensitive and Realistic Internet
- Trustworthy and Safe Internet
- Green Internet

1. Seamless Internet(SI)

- Regardless of terminal type, location, mobile condition, connection type, a user should be able to enjoy service without disconnection.
  - Network seamless: among various heterogeneous networks
  - Service seamless: thru open service platform or single ID
  - Contents Seamless: free transfer and control among various devices

1. SI-Network

- Network Federation
  - 3G, wired, Wi-Fi, Wibro federation
    - User choice
    - Access network sharing (wired, wireless)
    - AP sharing
    - Best network selection based on signal status, user preference, price etc
  - Integration broadcasting service/IP network and data service/broadcasting network
- Federation of Internet of Things and Internet
  - Sensor network federation

1. SI-Network

- Integrating heterogeneous networks
  - New network concept for integrating heterogeneous networks
    - General Address system, routing, traffic and quality control
    - Standardize network services
  - Network as a Dynamically configurable Infrastructure
    - Based on user request, providing independent an d logical network to user dynamically
    - Infra as a Service (IAAS)

1. SI-Service

- Open Service Platform for creating new service easy
  - Separate service layer from network layer
  - Use standard open API for network independent open service platform
  - Under mobile condition, a user should be provided optimal service according to the user context and preferences
    - Wi-Fi, Wibro, 3G, 4G, smart phone, Netbook, tariff

1. SI-Service

- Quality Management for various network connection
  - End to End QoS for IP and Service mobility
  - Traffic classification for users and services to guarantee service quality
- Single ID for services
  - Thru CA (certified authority)
- Sharing access network among ISPs

1. SI-Contents

- One Content for all networks, services, and terminals
  - Free contents transfer and control among devices
  - One content for mobile terminal, TV, and PC screen
  - QoS guarantee thru heterogeneous networks for service continuity

2. Smart Internet

- Internet which provides personalized information and service style of the user
  - Context aware with user, surrounding things, network activities
  - Collaboration among user terminal and surrounding things, among things
- Subjects
  - Internet of Things
  - Location and context aware service
  - Intelligent web services

2.1 Internet of Things

- Intelligent Network for context aware, location detection, remote monitoring/control
  - Intelligent space: logical space which provides service proactively to user with reconfiguration of resources based on relation between user and things
  - Intelligent space based on network context
  - Intelligent space based on terminal and sensors
  - Auto recognition network and dynamic network reconfiguration based on user status such as static, walking, running etc

2.1 Internet of Things

- Intelligent communication network of things which provides intelligent space
  - Human and things, among things network
  - High efficiency energy building
  - Security
  - Environment monitoring
- Interoperability between data and systems for knowledge base service
  - Standard API
  - open platform for Context information

2.2 Intelligent Web Services

- Context information collection and transfer
  - Context information standard for storing and sharing
    - Raw data collection such as identification, location, time
    - High level information construction with combining raw data
    - From simplex sensor data transfer to duplex communication for control purposes

2.2 Intelligent Web Services

- Semantic web for large data relationship and semantic integration
  - Semantic base searching and inference techniques for distributed and informal large scale data processing
- Web Platform service for intelligent future Internet
  - Highly complex application distribution platform
  - Mobile web: not just for PC but for the mobile terminal
  - New interface for mobile web from text or image to something new
  - Web search, web TV (home shopping on TV and web shopping)

3. Sensitive, Realistic Internet

- Providing Light sense, auditory sense, tactile sense to user to enhance the presence and reality in cyberspace
- Applications
  - Realtime collaboration technique with face to face level experience
  - Realistic e-Learning
  - Sensitive remote medical diagnosis and surgery

3.1 Advanced Transport Network

- Ultra high bandwidth backbone required
  - All optical network
  - Edge/backbone: Giga/Tera, and Mesh style for robustness
  - Advanced control mechanism required for Quality of Transmission of sensitive and realistic information transfer
- Broadband Access Network required
  - Broadband Mobile and Hot Spot
  - Among ISPs, resources (Aps) sharing required
  - Broadband Home Network required

3.2 High Quality Equipment

- Super high quality broadcasting equipment required for sensitive, realistic contents transfer
- Development Interface Devices
  - From technology push to human centric
  - Touch based to non-touch based
  - Wearable computer to handle high quality realistic contents

4. Trustworthy & Safe Internet

- Under seamless, smart, realistic Internet service, to prevent negative effect, proper security function should be inherent in the Internet
- Applicable area
  - New device such as smart phone
  - Life security such as personal information
  - Infrastructure security
  - Integrated service security: IPTV, FMC, Cloud

4.1 Trustworthy Internet

- Future Internet Security Model Design
  - Reliable communication mechanism research
  - Highly available network by automatic fault and error recovery
  - Extend service continuity under attack
- Federation of Security system of heterogeneous networks
  - Auto recognition of communicating partner network's security level, and negotiating of establishing federating security system

4.2 Service Security Environment

- Security for service mobility
  - Under several networks involved, integrated or single authentication mechanism required to assure service mobility
  - Under various terminal environment, developing interoperable environment for contents and service mobility required
  - Transcoding for OSMU(One Source Multi Use) and contents protection

4.2 Service Security Environment

- Secure Internet of Things
  - Secure management system for sensor information collecting and trustworthy transmission of this sensor information
    - Blocking illegal sensor information acquisition
    - Blocking illegal modification
    - Super light encryption and authentication techniques for sensor network
  - Location information protection
    - Secure and privacy control of location information services
    - Blocking illegal location information acquisition
  - Context information management center
    - Storing, management, distribution

5. Green & Clean Internet

- Green of Internet
  - Increasing energy efficiency of Internet facilities and life cycle of Internet services
- Green by Internet
  - Using Internet technology, to increase efficiency of social systems

5.1 high Efficient Internet Policy

- High energy efficient Internet Infrastructure research required
  - High capacity, performance at the same time high energy efficiency
- Future Internet service for energy efficiency of industrial or social activities
  - SaaS (Software as a Service), Daas (Desktop as a Service) cloud computing

5.2 Clean Internet

- Healthy contents culture establishment
  - Protect copyright
  - Block access to a harmful site using traffic management techniques
- Traffic Management Platform for Clean Service
  - DPI (Deep Packet Inspection) analysis and control engine for realtime monitoring and analysis of Internet service traffic

Context Aware System

- Another expectation for future Internet service
  - Context aware service
  - Ubiquitous computing

Book Chapter

- Book: Context-Aware Mobile and Ubiquitous Computing for Enhanced Usability
- Title: Context-Aware Application in an Ecology of Application
- Author: Davy Preuveneers, Katholieke Universiteit Leuven, Belgium

Introduction

- In recent years, many researchers have interested in context-awareness to support non-intrusive *adaptability of context-aware applications.*
- Weiser(1991)
  - computing is pushed away from the traditional desktop to small embedded and networked computing devices.
- The use of context-awareness to support non-intrusive adaptability of content and applications has received a lot of attention.

Introduction

- Roles of context-awareness
  - **to meet changing user expectations**
  - **to satisfy changing device and application resource constraints**
  - **to optimize the quality of service**

Introduction

- Problem
  - to carry out application adaptation at runtime, we require a proper application design methodology that facilitates customizing the functionality during the deployment and runtime life cycle of the application.
  - the design methodology needs to be complemented with runtime support that enables applications to dynamically adapt their behavior and the content they offer to the user whenever the applications' context changes.
  - applications must take into account the characteristics of the systems.

Introduction

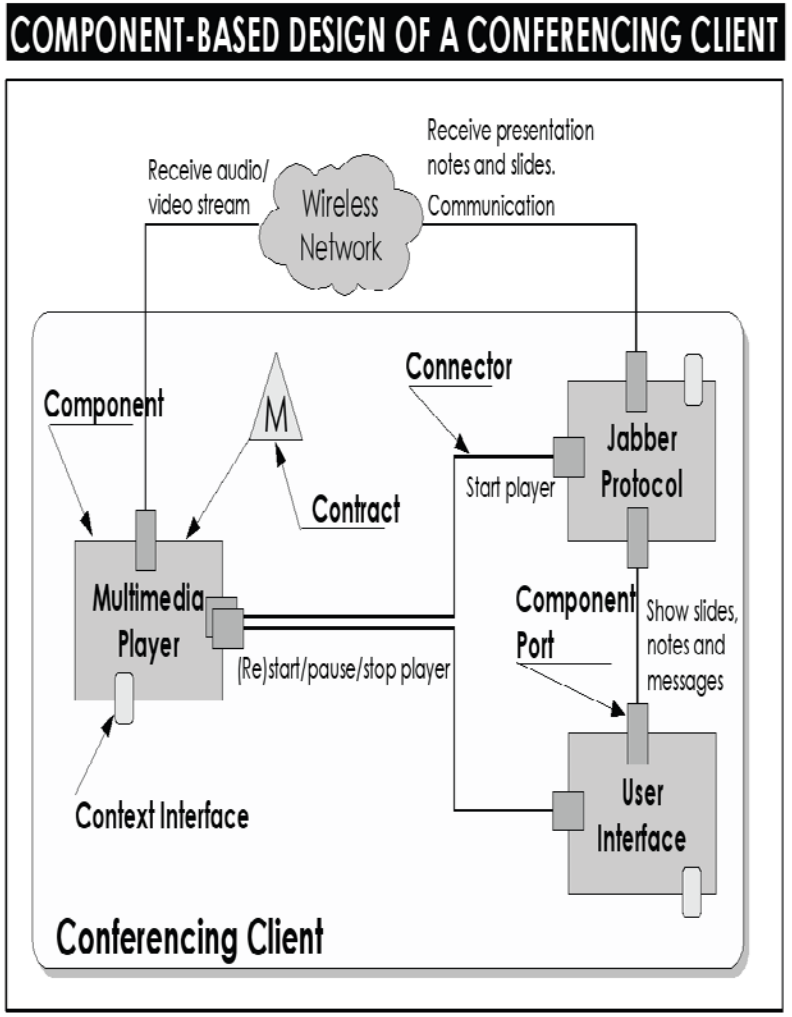
- A design methodology
  - applications are composed out of loosely coupled distributed components.
- An adaptation framework
  - Context-aware adaptation framework consists of application adaptation and content adaptation handled at different levels.

Introduction

- Components of context-aware application
  - Component
  - Component ports
  - Connectors
  - Contracts
  - Context interfaces

Introduction

- A component-based conferencing client that is composed of 3 components.
  - *Multimedia Player, Jabber Protocol, User Interface*



Motivating Scenario

① *Company Rising Sun organizes a large meeting for all its sales representatives where the results of a recent survey are presented and where the participants are discussing marketing strategies. All attendants use a display to interact with the shared whiteboard in the conference room.*

Motivating Scenario

② *One of the sales representatives, Jim, has to leave early for an urgent dentist appointment, but he will remain in touch with his colleagues to discuss the proposals.*

③ *He informs by message those managers he deals with that he is leaving. The conferencing client moves from his display in the conference room to his personal wireless handheld device.*

Motivating Scenario

④ As the capabilities of a handheld are limited, the application runs with reduced functionality. While in the dentist' s seat, Jim does not want to be disturbed and will only receive the notes and a summary of the minutes on his handheld.

⑤ Whenever devices with a larger display or more processing power show up in his vicinity for which he has permission to use, the application is again adapted and relocated to provide a better user experience.

Motivating Scenario

- In this small scenario,
  Multiple actors on different levels of the adaptation framework can initiate the adaptation process:

  • User: Jim is moving away, the framework should ensure that the application follows along.

  • Content: The video stream cannot be shown on the small screen of the handheld. Unsupported content is filtered or transformed to a different format.

Motivating Scenario

- Application: moves to the handheld device. Unused application components are disabled or removed

- Middleware: hosts the applications monitors shared resources and notifies the applications, e.g. the battery is running low.

- Network:
  - provides new context information about resources
  - triggers a relocation of the application to a new host.

Motivating Scenario

- This scenario shows
  - Many different kinds of applications surrounding the user
    - run on personal devices or on shared systems in the vicinity
    - constitute *an ecology of applications* a user can rely for his daily activities.
  - To maintain an acceptable level of user experience in pervasive computing environments
    - *Context-Aware Adaptation in an Ecology of Applications* should provide the current context at hand
    - including information about available resources and about the user's preferences.

Requirements

- In this section

  we review several non-functional concerns of context-aware adaptable applications in a mobile and pervasive computing setting.

  These concerns have an impact on the design and the deployment of applications and define deployment constraints in terms of the capabilities of a device as well as user preferences with respect to the application.

Requirements

- Context and User Personalization

  Requirements or preferences for the applications should be taken into account to meet user expectations.

  - For example,

  Jim may wish to preserve the battery power of his handheld device

  - The highly power-consuming wireless communication should be disabled.

  - Context constraints determine which applications are selected, how they are adapted and composed and how they behave at runtime.

Requirements

- Resource- and Context-Aware Deployment

  While on the move Jim will mainly interact with mobile and embedded systems.

  - This means

    - Resource constraints, including limited memory, processing power, network bandwidth and, battery life time for applications

    - Determine whether a application can execute properly on a given device after deployment or further adaptations are needed.

Requirements

- User Mobility and Application Relocation

  The amount of environmental resources the mobile device can address to extend its capabilities may fluctuate accordingly.

  - For example,

    - an application remotely deployed, a decreasing network bandwidth or network disruptions may reduce the QoS to an unacceptable level.

    - when on the move Jim may choose to run an application locally, but when stationary Jim may free up some local system resources by relocating and running one or more applications remotely on a more powerful device in the neighborhood.

Requirements

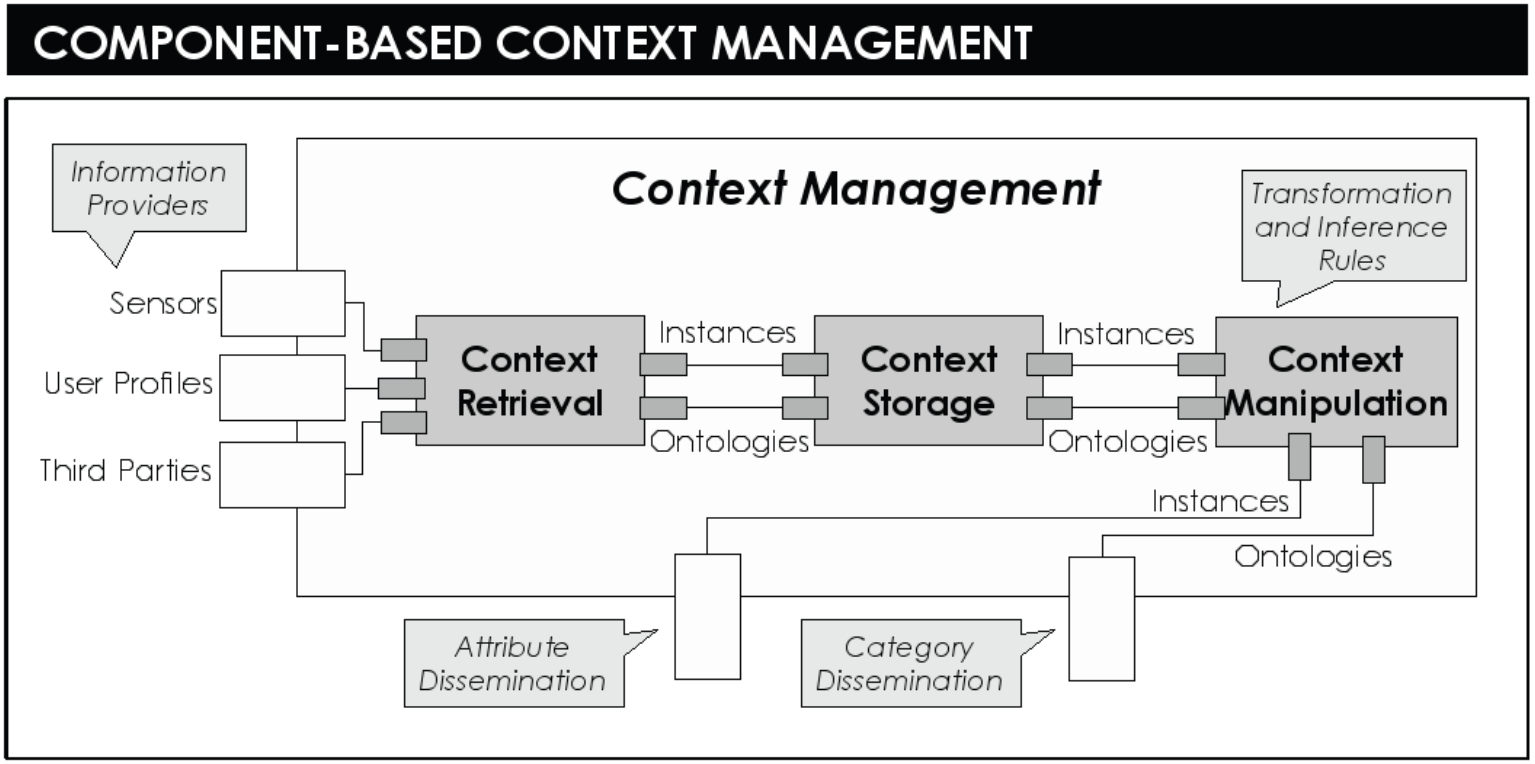
- Application and Content Adaptation
  - Sales representative is cruising through highly dynamic pervasive computing environments, applications need to adapt to conditions.
  - To offer personalized applications on devices with versatile resource characteristics, the application must be adapted to the capabilities of the device.
  - Applications with a modular structure replace parts of the application without changing the overall intended functionality requested by the user.
  - *Context-Aware Adaptation in an Ecology of Applications* environments impact the user's interests and the relevance of the content.
  - Content is selected and presented to the user

Context-aware adaptation in an ecology of applications

- Identity: The user himself, a person he is dealing with, user profiles and preferences
- Activity: Appointments, scheduled tasks in agenda, shopping, leisure pastime
- Spatial information: Location, direction, speed, presence, nearby items
- Temporal information: Date, time of the day
- Environmental information: Temperature, light, noise, weather
- Social situation: People nearby or with whom the user is interacting
- Resources and services: Devices, resources, services and applications on the network

Context-aware adaptation in an ecology of applications

- Context management from an application perspective involves the following functional building blocks (see Figure 2), no matter whether the context information is used locally or has to be sent out to a remote entity somewhere on the network.



Context Addressing and Distribution

- Considering the features of context-aware applications and the target network, a context addressing scheme should offer the following features:
  - (1) description of the data that is sent or requested,
  - (2) specification of the environment in which the context data is relevant,
  - (3) additional meta information about the context data or environment
- The context addressing should not make assumptions about the physical network (IP-addressing) or refer to services on the network.
- A context address can be adapted while routing the context request or the context information in the network.

Context Addressing and Distribution

- We take the reasoning process one step further by not only letting the input and outputs types select the operators, but also the semantic meaning of them.
- In our example, the query expressed as '*Find all dentists close to me*' can be translated to '*Find all dentists within a range of 500m from myself* in case that I am on foot, and to '*Find all dentists within a range 20km from myself* when by car.
- Thus, one can specify queries that align with human questions asked in real world.

Deployment and Application Adaptation

- An context aware application that provides a certain level of quality of service typically needs sufficient system resources.
- Since resources are spread across the many nodes that comprise a pervasive environment, they create a challenge for optimizing application deployment scenario's that still meet the quality of service requirements.
- Thus, "where" and "when" to deploy component are important
- By allocating components only shortly before they are expected to support the user of the system, resources are freed-up for components that are needed more urgently at the time.

Resource-Driven Adaptation

- Applications that run on mobile embedded devices are often limited in the functionality they can offer because of resource constraints that characterize such devices.
- We believe that good mechanisms for deploying an application in a pervasive computing environment need to be able to:
  - 1. *Optimize the deployment configuration to a stable state*,
  - 2. *Exhibit self-organizing deployment behavior to perform redeployment*,
  - 3. *Deal with disconnected operation.*
- Pervasive computing exploits remote resources
- Thus, a distributed deployment mechanism aware of the resource requirements of the application components on the other node.

Activity-Driven Adaptation

- Activity-driven software adaptation relies on the input from an activity model representing the user's activities and the relation between those.
- An activity model is transformed into a STN(State Transition Network)
- The STN knows which components need to be available to support the user's ongoing activities.

Content Adaptation

- Content adaptation involves the transformation of an original content into another version according the user's context and preferences, or the selection of the most appropriate version of a content item.
- Besides the capabilities of the client device, other elements of the user's context can also be considered for adaptation purposes.
- Yang & Shao (2007) adopt a broader vision of what is context, enlarging this notion with concepts such as network bandwidth, user accessibility and situation.
- The context in which the users interact with the application may affect the relevance of a given content.

An Integrated Approach to Context-Aware Adaptation

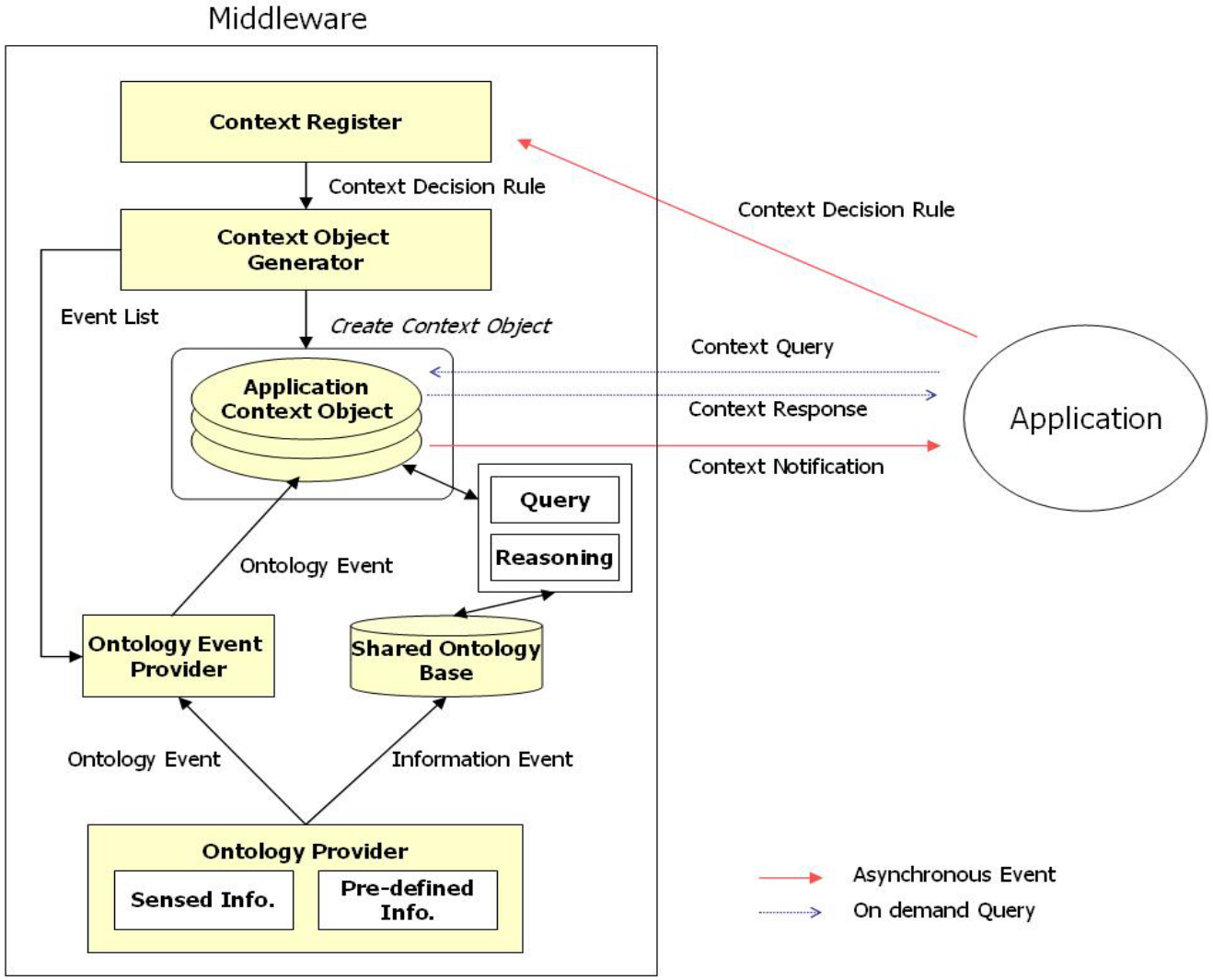
- The whole adaptation process is entirely based on the processing of context information
- The adaptation algorithm consists of the following high-level consecutive steps :
  - 1. Hardware : Process the hardware of the device to discover processing power, network capabilities, and other input providers, such as a GPS module.
  - 2. Resource-awareness : Request the current available resources on the device. (CPU load, memory, bandwidth usage and battery status.)
  - 3. Context dependencies : Check which context information is required by the active applications for personalized content and optimal component behavior.
  - 4. Context component selection : Determine for each context concept the minimum resource requirements, and select the most appropriate component.

UTOPIA

- **U**biqui**TO**us com**P**ut**I**ng **A**rchitecture (UTOPIA)
  - middleware to support middleware-dependent application development
  - ontology based context model
  - context communication protocol to deliver context
  - explicit and formal context decision rule to describe application context

UTOPIA

- architecture



UTOPIA

- Context Register
  - To register applications' context decision rule into middleware.
  - Firstly an application finds context register of middleware and starts authentication process (implemented with simple ID/PW)
  - Then an application registers its context decision rule to the context register
- Context Object Generator
  - To generate the application context object and make the event list
  - Application context object makes a context decision.
  - Event list is to notify the dynamic change of the environment to the application context object.

UTOPIA

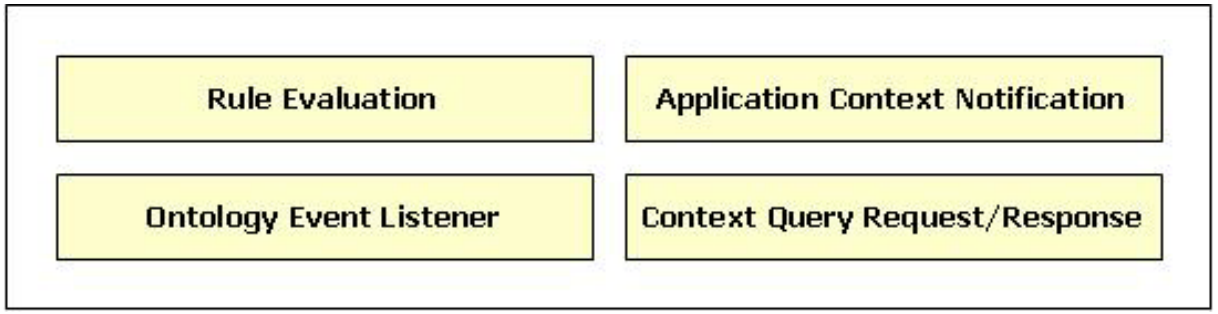
- Ontology Provider
  - To store sensed or pre-defined information into the shared ontology base.
  - To generate and notify the ontology event to the ontology event provider.
  - The ontology event means that current environment changes.
- Shared Ontology Base
  - Context knowledge base to store instances' values into a file
  - We created a OWL file by using Protégé ontology editor , and update values in file by using Jena and Protégé OWL plugin API
- Ontology Event Provider
  - To receive ontology events from the ontology provider and to deliver it to related context object.

UTOPIA

- Application Context Object
  - To perform context decision-making and respond to a context query from an application.
  - All applications have one context object which is responsible for their context decision and query
  - stores a set of rules describing application context, and listens to environment's change and context query.
  - can recognize environment's change through events issued from ontology event provider.
  - The context object evaluates the rule set whenever an environment changes so that makes a decision about a relevant application is interested in current context or not.

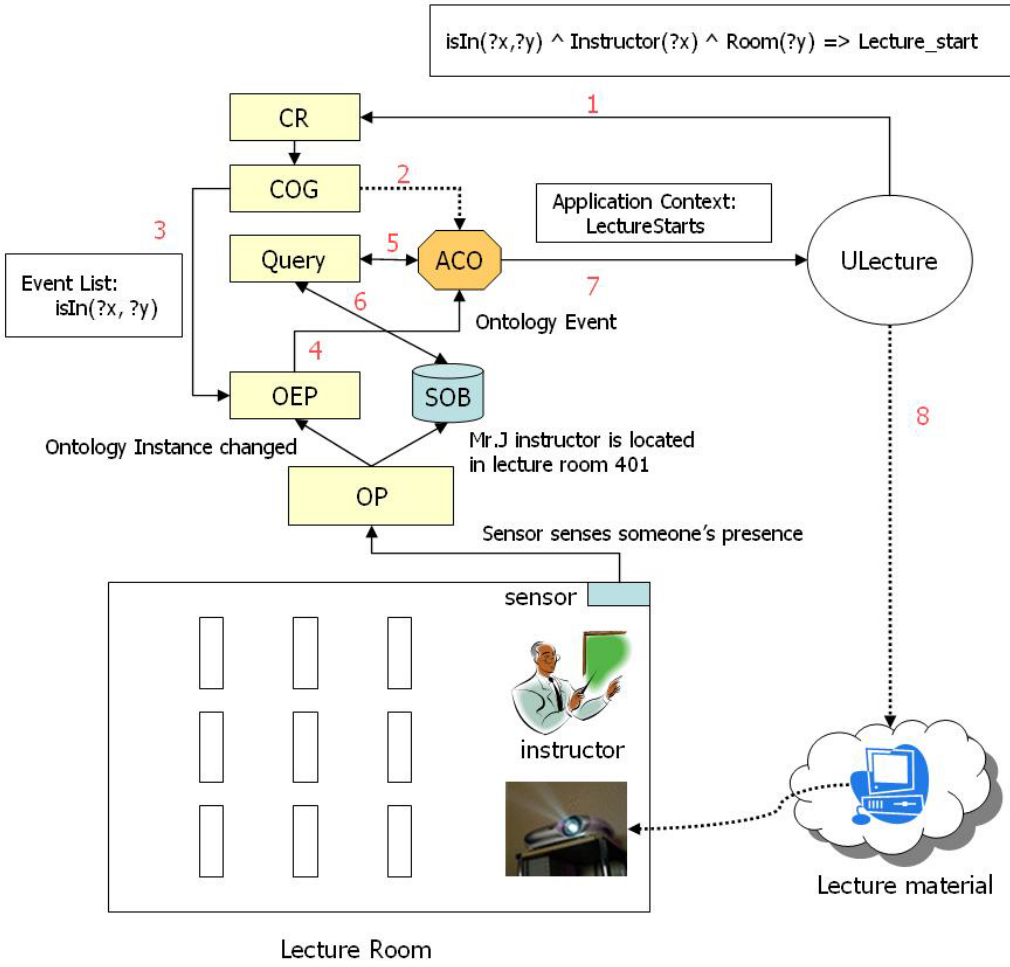
UTOPIA

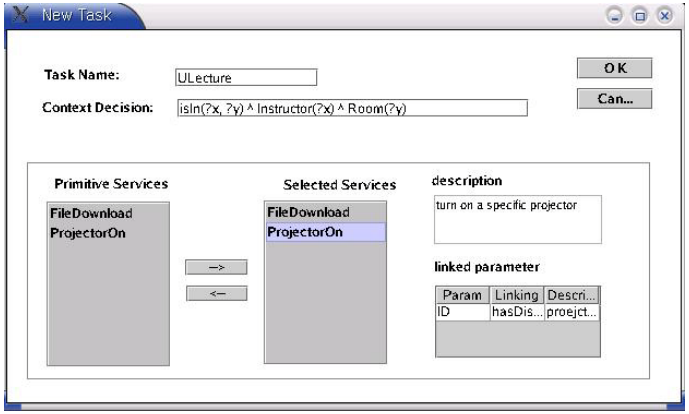
- Application Context Object
  - Functional architecture

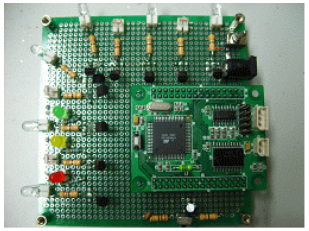


  - Implementation
    - The antecedent part is converted into a query statement of Bossam
    - E.g, *query q is isIn(?x, ?y) and Instructor(?x) and Room(?y);*
    - To make a context decision, the context object performs the converted query using Bossam engine.
    - If the result of query execution is *false*, not interesting. If the result includes instance lists then current context is application context.

Application Example







Projector control
by using ATmega128 [27]

Application Example

- Ulecture's simple source

```
//CR discovery, Authentication using CRDP

crdp.startBroadcast();
crdp.setID("UTOPIA");
crdp.setPW("UTOPIA2006");
boolean auth_result = crdp.requestAuthentication();
```

```
//Rule Registration using CCP

String CDR = new String("isIn(?x, ?y) ^ Instructor(?x) ^ LectureRoom(?y) => Lecture_start");
CCP ccp = new CCP();
ccp.setCRInfo(crdp.getAddr(), crdp.getPort());
boolean reg_result = ccp.registerCDR(CDR);
```

Application Example

- Ulecture's simple source

```
//wait for context notification using CCP

while(true) {
msg = ccp.waitMessagesFromACO();
if(ccp.isACOstared(msg)) ;
if(ccp.isNotification(msg)) {
   ContextInfoList cil = new ContextInfoList();
   while(cil.moreInfo()) {
         String var = cil.getNextVariable();
         String val = cil.getNextValue();
         // now do something with variable and value
   }
}
```

```
//fsc discovery, Authentication using FSCP

FSC fsc = new FSC();
fsc.startBroadcast();
ContextInfoList query1 = ccp.requestQuery("hasObject(" + val + ", ?x)) ^ Projector(?x)");
 String var2 = query1.getNextVariable();
 String val2 = query1.getNextValue();
 fsc.callFSC("TurnOnProject", val2);
```

We discussed

1. Another perspective on future Internet from service viewpoint inside Korea
2. Context Aware approach is required.
3. 2 papers are discussed on context aware system

Thank You