

Sensor and Context-Aware Digital Signage

Key Technologies for Future Intelligent DOOH Solutions



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NEC Europe Laboratories Overview

- ~105 staff members in Heidelberg (100), and Acton(UK) (5) (NEC E HQ)
 - NW(Heidelberg) and IT(Bonn) research merged in Heidelberg 1/1/10
- Leading researchers recruited from all over Europe
- Collaboration with network operators and vendors in EU
- Close links with leading European research institutes & universities
- **Research areas in NLE**
 - Communications Protocols
 - Network & Service Management
 - Security, Privacy & Performance
 - Internet Services and Service Platforms
 - Cloud Computing
 - (Supercomputing completed 12/09)
- **NEC Laboratories Europe**

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Overview

Key messages

1. **Context-Awareness** – Flexible middleware solutions are required for realizing future digital signage applications that leverage real-world internet services
2. **Towards Digital-Signage applications** – Future digital signage systems will execute a multitude of configurable applications

Learning from Mobile Phones

Mobile Phones

1st mobile phone



1st digital mobile



Personal Assistant



New forms of
interactivity

Socially connected

Signage



Personalization



Interactivity

Connectedness

Accessing the Real World

Interactivity

- Use a vision sensor to accurately identify and detect geometry of real-world object

Personalization

- Use a vision sensor to determine attention, age, gender



Source: metaio

Connectedness

- Provide a consistent user experience over a collection of connected displays
- Use proximity sensors to accurately and rapidly identify nearby users



Rotating compass: Arrows are shown iteratively on public display. If correct arrow is shown, mobile vibrates (Rukzio et al.)

Sensor data can be used to adapt content *in real-time* matching the situation around displays and nearby users.

Integrators Alternatives



I need **real-time** information about the **age** and the **gender** of **nearby people**. How can I integrate these sensing technologies into my system in a **cost-effective** way and deliver that to my customer **in a week** ?

The common way

- Find a technology vendor
- Integrate each technology

Digital Signage System



NLE Expertise

The cost-effective and fast way

- Find a technology vendor
- Use a common API

Digital Signage System

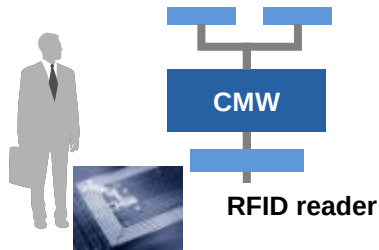
Sensor and Context Management



Contextualization

By mapping into entities, one can abstract from raw sensor measurements and provide semantic and contextualized information.

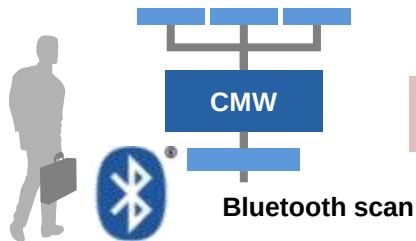
A user's presence near a display can be observed by:



Entity

- ID: Display1
- Type: Public Display
- seesNearbyPerson: John

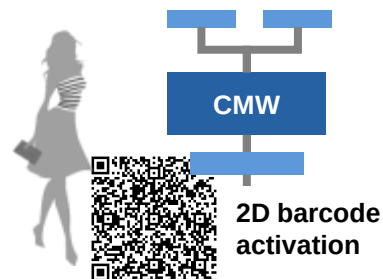
- Detecting an RFID card, e.g. putting an ID card near the display



Entity

- ID: Display2
- Type: Public Display
- seesNearbyPerson: Peter

- Scanning the user's Bluetooth device as he walks by



Entity

- ID: Display3
- Type: Public Display
- seesNearbyPerson: Mary

- A cookie in the user's browser when she visits a page indicated by a QR code (cookie provides ID and Bar code provides location, product ID, etc...)

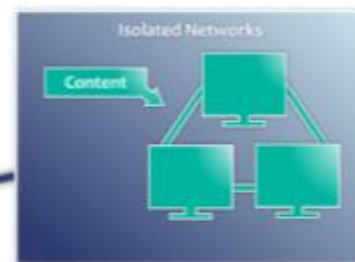
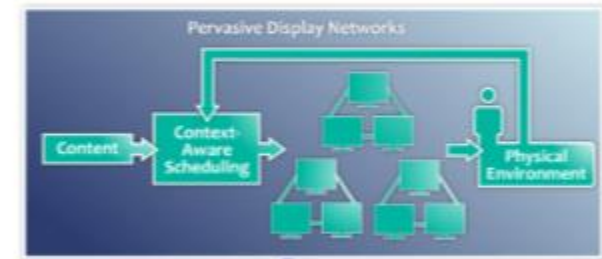
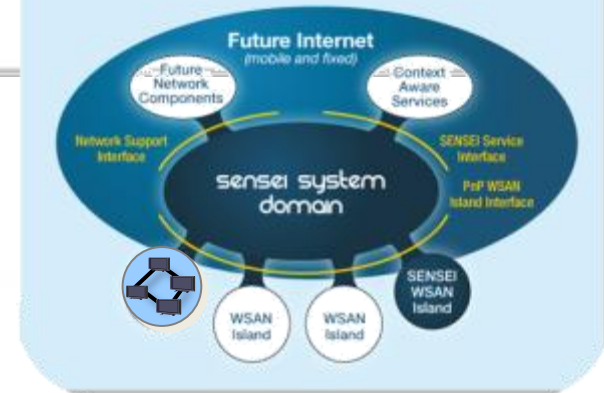
Pervasive Display Networks (PDN)

Real-world Internet Services for Public Displays

The Pervasive Display Network activity aims at

1. Developing a **context-aware display service platform** that is able to execute and manage generic and **distributed real-world internet services** on heterogeneous display networks optimally **supporting nearby users** in their current situation.
2. Leverage **local and wide area context management systems** that optimally supports real-world internet services on public displays

<http://www.sensei-project.eu/>



System
Integration

Context Management System – Desirable Features

- Semantic and Declarative Access – SQL like queries: specify what you want not how
- Extensibility – integrate new sensing technologies without changing applications
- Preserve Privacy – make sure that context stays as local as possible
- Exchangeability – exchange context with third parties, e.g. telco provider

NEC Context Management Framework (CMF)

CMF: A mature research prototype infrastructure to collect, reason and deliver context information

- Extensible: add sensors and reasoning components w/o changing applications
- Consists of Context Agents hiding distributed information sources
- Flexible distributed architecture for local area and wide area networks
- CMF provides semantic access to heterogeneous sensors using an entity based model
- Context Access LAnguage (CALA), SQL-like query language for distributed real-time information (Query, Subscribe, Insert, Update, Delete)
- Used in standardization: Open Mobile Alliance (OMA) on context management in Next Generation Service Interface (NGSI) lead by NEC
- Programming Language neutral: XML-RPC based interfaces
- Portable: Java, anywhere from mobile devices to full size servers
- Low footprint: runs on mobiles and PDAs (e.g. Windows Mobile, Android)

Large display surfaces can be used to enhance the mood of an environment and entice visitors to come nearer. On close range, a variety of sensors can be used to engage users with new forms of interaction.

CMF Integration with Instoremedia Digital Signage Platform

Applications and sensors interfaced via CMF

- Attracting Passers-by using computer vision for people tracking
- Car Configurator using
 - RFID sensors for choosing car color
 - 3D Accelerometers for animated 3D model
- Interactive Product Information using a Pickup Sensors



Scene 1 – Targeted Content

Advertisement adapts to user context

- Customize content based on proximity, preferences, shopping history, etc
- Privacy-aware proximity detection:
 - Each display pings subset of registered BT devices
 - Subset dynamically updated based on location
 - Works w BT discovery off



Scene 2 – Interactive Service Retrieval

Interactively retrieve associated services

- Augment Content to support interaction (QR code)
- Display Network Services: Product Information, Personalized Product Discounts (Barcode Coupon), Dynamic Guidance
- Feedback measurement: customer interested ?



Scene 3 – Dynamic Guidance

Service provided by display network

- Navigation Service: show navigation when user approaches display
- Provided collectively by intelligently networked displays using CMF



Scene 4 – Context-Aware Checkout

Legacy application as context sources

- Buy Product: scan product and coupon, and redeem personal discount
- Barcode Scanned Context: scan events are used to infer location information
- Stop Dynamic Guidance Service: location as trigger to stop service
- Sensor Abstraction: App uses *location* (not BT/barcode events)
- Feedback measurement: product bought and discount used ?



The Killer App

Mobile phones: the AppStore, Market Place, etc.

What is the iPhone Killer Application ?

Would you use the iPhone w/o being able to phone ?

iPhone differentiators

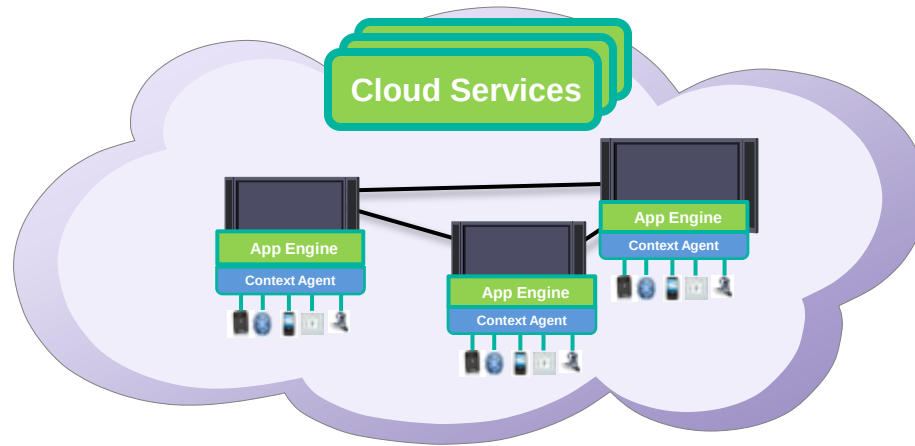
- sensor and integration and huge number of (affordable) apps, many free
- There is no single killer app. The device lives from the multitude of apps and personalization

Killer app for Digital Signage ?

- Place-based, situated displays: depends on the location
- But hot apps are: (place-based) advertising, safety, navigation
- There is no single killer app

Towards a Digital Signage *Applications* Platform

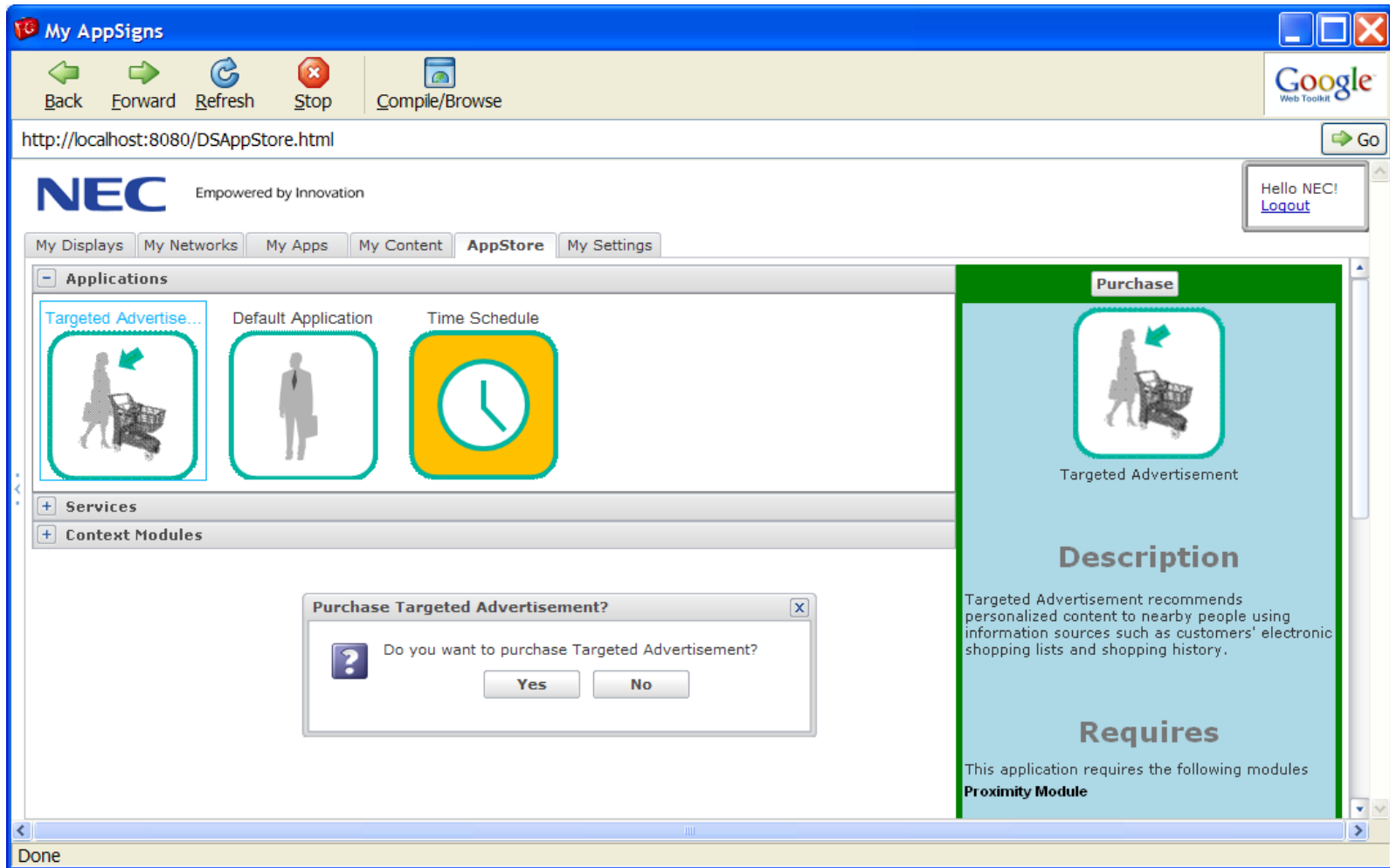
Consider displays as cloud-connected computing resources able to execute any context-aware application that shows situated content.



- Cloud offers services that can easily be mashed-up to develop a multitude of *configurable* applications for public displays
- New applications will increasingly use sensors and various interaction modalities

Requires new infrastructure approaches and technologies to manage context-aware applications on public display.

Digital Signage Application Store



Summary

The full power of digital displays will be leveraged by:

- Integrating knowledge about the physical world - Context-awareness is a key technology for adaptive digital signage solutions. Gartner describes context-aware computing as “*disruptive technology*” that will provide significant competitive advantage
- Flexible middleware solutions will provide competitive advantages (cheaper, faster, better applications) for realizing future digital signage applications
- Future digital signage systems will execute a multitude of configurable applications

NEC is developing highly flexible Context Technologies for Digital Signage Systems that adapt to changes in the real world.

Find us at ISE



Pervasive Display Networks

A project of NEC Display Solutions and
NEC Laboratories Europe

Empowered by Innovation

The logo consists of the letters 'NEC' in a bold, blue, sans-serif font. The letters are closely spaced and have a slight shadow effect.

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ADDITIONAL MATERIAL

CMF Sensors and Retrievers

A range of CMF retrievers have been developed that provide the following information:

Developed by NEC

- GPS Position
- RFID events and information
- **Barcode events**
- **Calendar information (Microsoft Outlook)**
- Bluetooth Proximity/Device Information
- Nearby WLAN networks
- IMS Presence
- Gesture events (SUN SPOT)
- **Brightness**
- **Acceleration**
- Temperature
- Inclination
- Siafu Context Simulator
- **Serial Port Retriever**
- **Ultrasonic 3D position**



SUN SPOT
sensor node



SIAFU simulation of
Glasgow

Developed by partners

- Pressure Mat events (Novay)
- Weight (EU MAGNET Project)
- MAC Layer Network Info (EU MAGNET project)
- Computer vision: Number of nearby people (Novay)



Note: Many more sensors can be used if needed