



Context Aware Services in Connected Homes Using OSGi Service Infrastructure

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Outline

- Connected Home Activities in Singapore
- Market Demand for Services
- Context Aware Service Architecture Requirements
- OSGi based service Infrastructure for Context Aware Connected Homes
- Conclusions

Connected Home Activities in Singapore

- Demo Connected Homes by Companies and Housing Development Authority in 1990s
- Connected Home Initiative by Infocomm Development Authority (IDA) in 2001
- Residential Gateway for NSC, USA designed by Institute for Infocomm Research (I2R) in 2001
- OSGi based Full Service Residential Gateway (RG) by I2R in 2003 with 20 consortium members
- Connected Home trial with > 20 Homes in 2003 (one proposal is based on OSGi solution)
- Connecting the Community Initiative by IDA in 2004
- A-STAR StarHome (Real House) in 2004, Singapore Polytechnic Dream Home in 2004, powered by I2R OSGi RG

Singapore Market Demand for Services

Security Surveillance

- Intrusion
- Visitor Logging
- Loitering around user's premise
- Abandoning object around user's premise

Home Care Services

- Shout & cry detection
- Tracking population in user house
- Duration of child being alone
- Abnormal behaviours (battering, struggling, fighting)

Context Aware Service Architecture Requirements

- Develop a CSA (Core Service Architecture)
 - A set of reusable services in surveillance and homecare
- Come out device/service discovery mechanism
 - Spontaneous networks (UPnP, Jini)
- Develop context-aware services
 - Home media server with monitoring and analyzing capability
 - Intrusion, shout & cry, child staying alone detection, etc.
- Explore next-generation service delivery
 - OSGi backend system

Context Awareness: Definitions

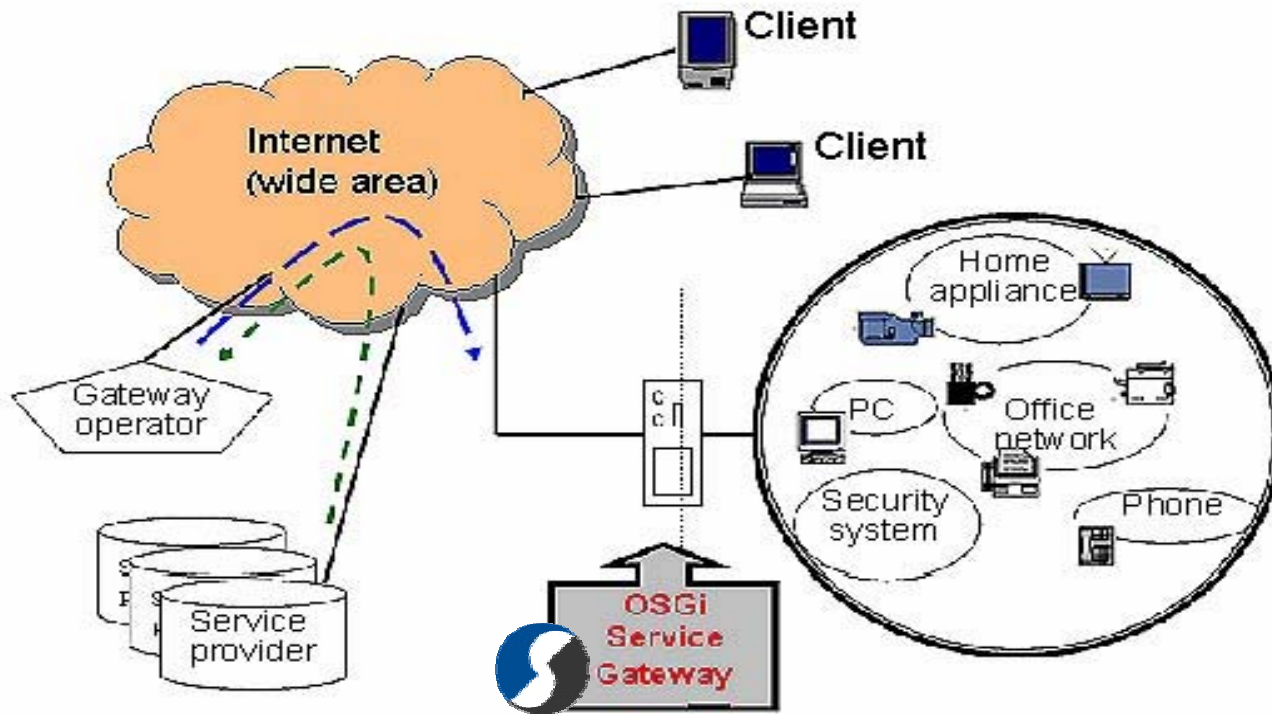
What is Context ?

Context is any information that can be used to characterize the situation of an entity. An entity is a person, place or object that is considered relevant to the interaction between a user and an application, including the user and application themselves. (Dey, 2000)

Most important contexts:

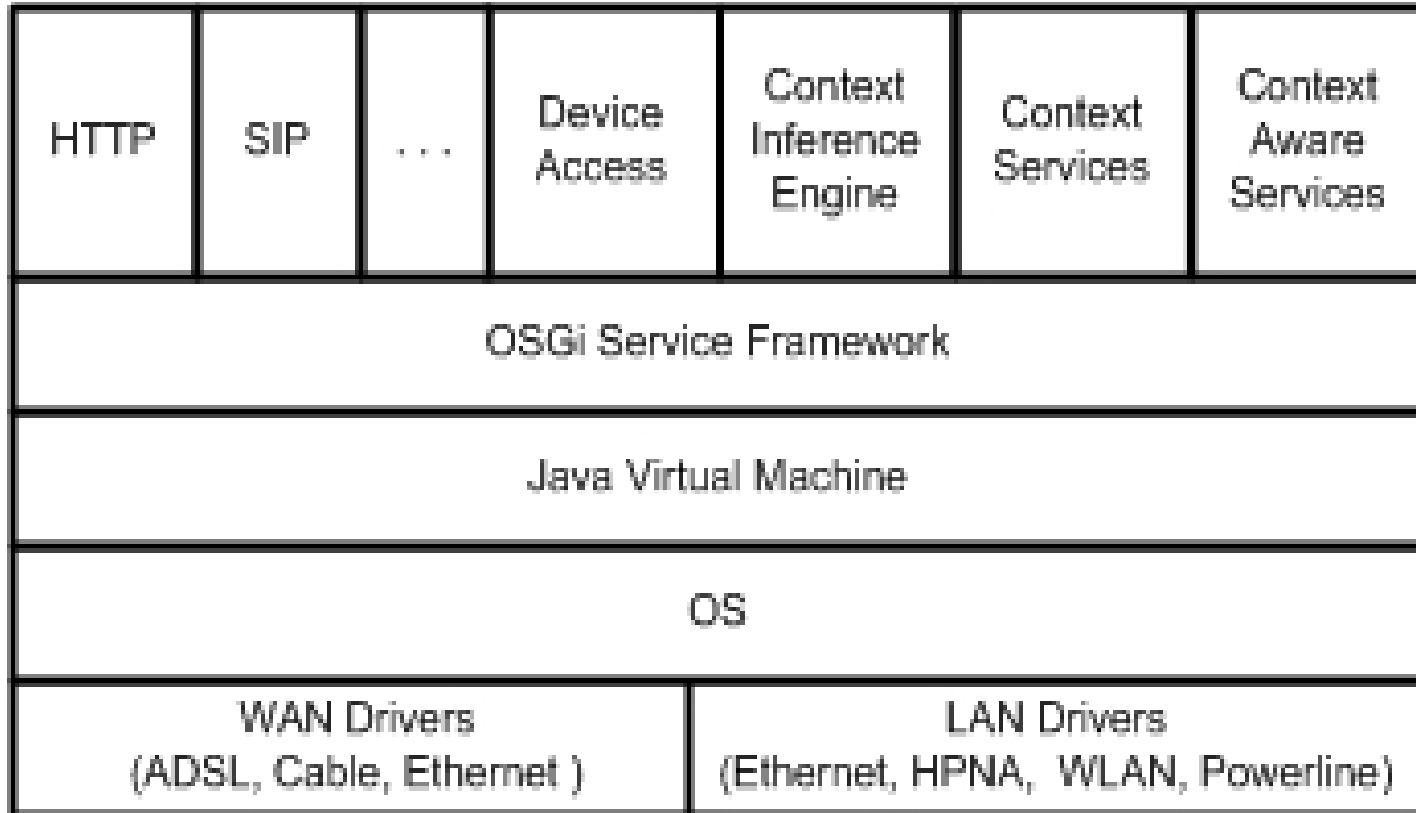
- *about people*
- *about place, time*
- *about surrounding things*

OSGi Service Provisioning Architecture

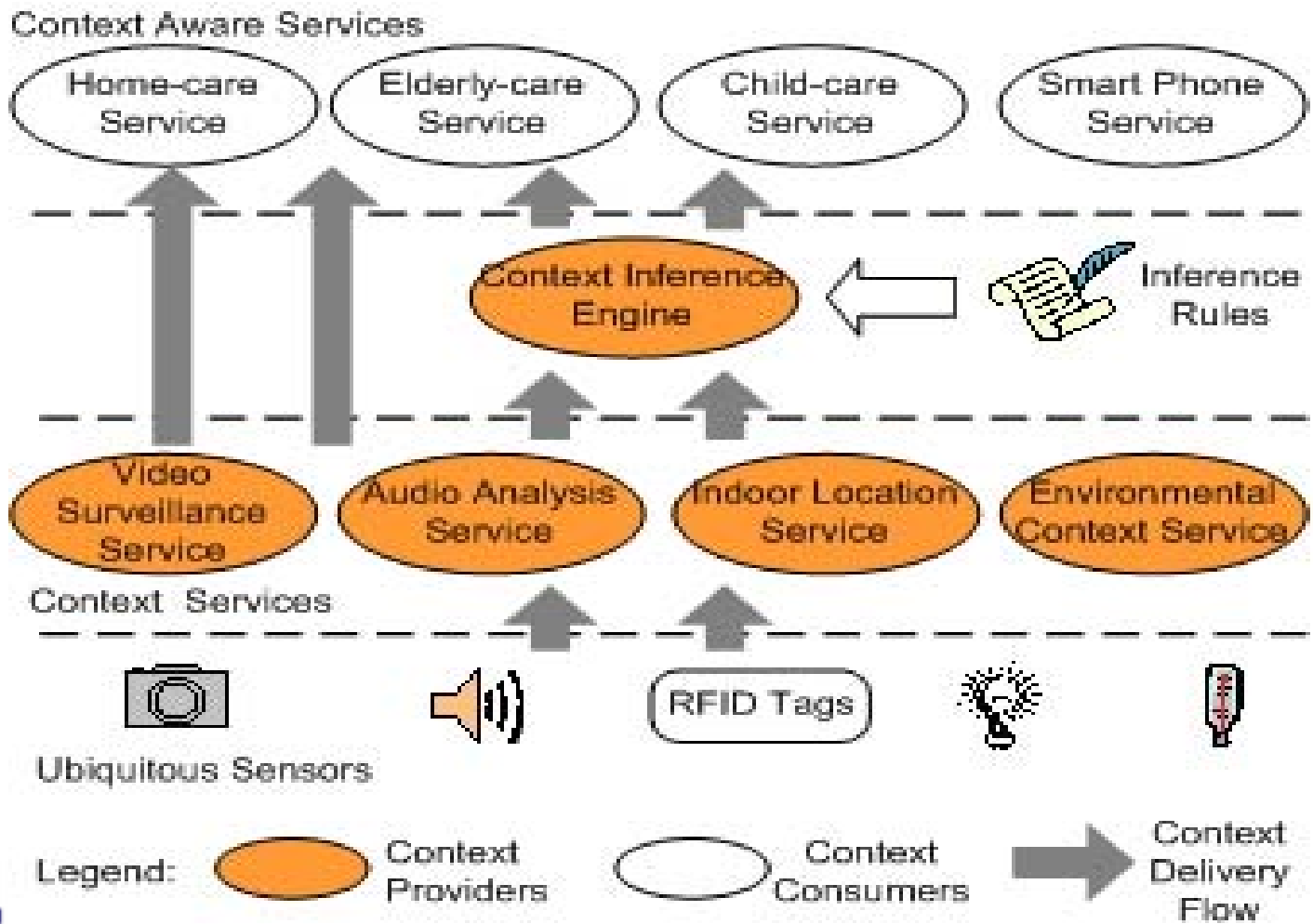


OSGi Service Gateway in the Big Picture

OSGi Service Infrastructure: Gateway Stack



Context Aware Architecture



Contextual Events: Definitions

Table 1. Video/Audio Contextual Events

Video	E1 -Stranger in house
	E2 -Restricted zone violation
	E3 -Child is left alone with duration exceeding threshold
	E4 -The elderly is motionless with duration exceeding threshold
	E5 -The elderly falls
	E6 -The elderly stays in specific room (e.g., bathroom) with duration exceeding threshold
Audio	E7 -Scream
	E8 -Explosion
	E9 -Crying

Context Inference Rules

- $\text{locatedIn}(\text{User}, \text{Bedroom}) \wedge \text{lightLevel}(\text{Bedroom}, \text{LOW}) \Rightarrow \text{status}(\text{User}, \text{Sleeping})$
- $\text{locatedIn}(\text{Elderly}, \text{Bathroom}) \wedge \text{status}(\text{WaterHeater}, \text{ON}) \Rightarrow \text{status}(\text{Elderly}, \text{Shower})$
- $\text{locatedNear}(\text{Child}, \text{TV}) \wedge \text{status}(\text{TV}, \text{ON}) \Rightarrow \text{status}(\text{Child}, \text{WatchingTV})$
- $\neg(\exists (\text{Adult})X \text{ locatedIn}(X, \text{Home}) \wedge \text{locatedIn}(\text{Child}, \text{Home})) \Rightarrow \text{status}(\text{Child}, \text{Alone})$

Event-Condition-Action Rules

Smart Phone	<i>IF</i> status(User, Shower) \vee status(User, Sleeping) <i>THEN</i> forward the incoming call to voice message box
	<i>IF</i> status(User, WatchingTV) \vee status(User, LisentingMusic) <i>THEN</i> turn up the volume of the phone and lower the volume of TV
	<i>IF</i> status(User, Dinner) <i>THEN</i> set phone to vibrate mode
Security	<i>IF</i> E1 \vee E2 <i>THEN</i> <i>IF</i> \exists (Adult)X locatedIn(X, Home) <i>THEN</i> alarm via loadspeaker <i>ELSE</i> alert owners via MMS
Child-care	<i>IF</i> ($\neg \exists$ (Adult)X locatedIn(X, Home)) \wedge (E3 \vee E7 \vee E9) <i>THEN</i> notify parents via MMS
Elderly-care	<i>IF</i> ($\neg \exists$ (Adult)X locatedIn(X, Home)) \wedge (E4 \vee E5 \vee E6) <i>THEN</i> alert the care giver via cell phone

Experimental Set-up and Results



a) Prototype system set-up



b) event of falling child



c) Home monitoring

Conclusions

- Based on the market demand, a OSGi based service Infrastructure for Context Aware Connected Homes has been proposed.
- Rich context is supported. Rich context information can be extracted through motion analysis and voice recognition. Context acquisition, processing and context aware service development are separated.
- The OSGi based solution will be experimented in the demo smart home in Singapore



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Questions?