Categorization and Grouping of Devices in Generic Pervasive Applications

J.Madhusudanan
Research Scholar,
Pondicherry University,
Puducherry

V.Prasanna Venkatesan
Associate Professor
Pondicherry University
Puducherry.

V. Indumathy
PG Student
Department of CSE
Sri Manakula Vinayagar
Engineering College, Puducherry.

A.Kalaiselvi
PG Student
Department of CSE
Sri Manakula Vinayagar
Engineering College, Puducherry

C.Ramachandran
UG Student
Department of CSE
Sri Manakula Vinayagar
Engineering College, Puducherry

K.Preathee
UG Student
Department of CSE
Sri Manakula Vinayagar
Engineering College, Puducherry

ABSTRACT
Quick advancement of the pervasive computing era with its underlying sources of contextual data, services and applications persistently attempts to support a variety of independent devices, with different environment, requirements and capabilities. Pervasive computing equipped with many independent collaborating electronic devices like sensors, actuators and complex device capable of sensing, actuating, computing and communicates. These devices belong to different administrative domains and users. As the number of interacting devices grows, there is a need of devices to group with common interest of users. Existing research on grouping approaches dealings with domain specific application, resulting of inflexible and incompatible. In this paper, we propose Device Categorization and capable of dynamic grouping of devices based on a user request. A grouping may contain any number of devices based on the application and its functions need.

Keywords
Inflexible, Incompatible, Device category, dynamic, device grouping

1. INTRODUCTION
Pervasive computing is an emerging trend that makes computers physically available but having stricking effect of invisible to users [1]. Other names given to this trend are Ubiquitous computing and Ambient Intelligence. The concept was introduced by Weiser in 1991. When primarily concerning the objects involved, it is also called physical computing, the Internet of Things, or haptic computing [2][3][4][5]. .

An approach of clustering of devices is done with area wise based on location based system(LBS).Here nodes with different MAC and mobility are grouped under different clusters based on different location[6].

In a Ubiquitous computing environment, independent like sensors, actuators and complex device are widely spread out into action..How to effectively group the devices is a major challenge for pervasive environment.An idea of grouping of devices by providing knowledge base enclosed in each device that knowledge drawn form ontology that they need for their operation ,is discussed in[7].Panoply,a Java based middleware that assist developers in quickly developing ubiquitous computing application,the grouping of devices is performed based on location,social,task and communication group for mobile application[8].According to Harbour Research[9],Intelligent device is a global and economic phenomenon of unprecented proportions and its Intelligent device hierarchy shown in fig1.

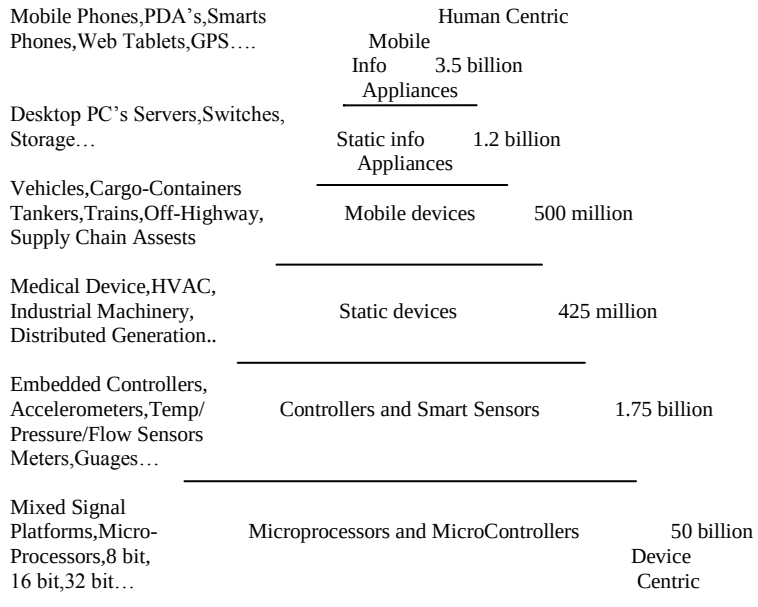

Fig 1: Intelligent Device Hierarchy (Harbor Research,2008)

2. WHAT IS A DEVICE?
Pervasive Computing Systems (PCS) devices are likely to assume many diverse forms and sizes, from handheld units (similar to mobile phones) to near-invisible devices set into 'everyday' objects (like furniture and clothing). All the objects can able to communicate with one another and act 'intelligently' according to the environment[10].

A device is characterized as an objects or entity consisting of a set of properties, some internal mechanism, and an interface. The properties provide information about a device such as its purpose, its capabilities, vendor and operating requirements. These are critical information for both system integrators and service programmers. The internal mechanisms are responsible for the operation of the device and unknown to the external world. The gap between the internal mechanism and the external world is bridged by the interface of the device.
It specifies device IO and provides guidance to applications and other services to interact with the device. For example, the digital blood pressure monitor interface is responsible for parsing the byte streams to meaningful data and it is passed to the serial port of the monitor. From a service-oriented perspective, the properties of a device which are existent to its utilization by an external user are its properties and interface.

The properties gives information about a device such as its purpose, its capabilities, vendor and operating requirements. The interface defines how a device interacts with its external users and provides ways to access the device either to get information from it and/or to control it[11].

3. CATEGORIES OF DEVICE

Devices can be classified into three categories namely:

- **Sensors:** input devices that discover some changes in the environmnet, user actions, human commands etc;
- **Actuators:** output devices that response to process the information by changing the environment via electronic or mechanical means. For example, air temperature control is often done with actuators. However the term refers to devices which deliver information, rather than changing the environment physically.
- **Complex Device:** A complex device which can both accept output from the external user and provide input to the external user.

There are many goal for the future development of PCS devices. Many research groups are endeavouring to produce networks of devices that could be small as a grain of sand. The idea is that each one would function independently, with its own power supply, and could also communicate wirelessly with the others. These could be distributed throughout the environment to form dense, but almost invisible, pervasive computing networks, thus eliminating the need for overt devices.
At the other outermost point, augmented reality would involve overlaying the real world with digital information. This approach emphasizes the use of mobile technologies, geographical positioning systems and internet-linked databases to distribute information via personal digital companions. Such devices could come in many forms: children might have them integrated into school bags, whereas adults might use devices more closely resembling personal digital assistants (PDAs).
Ultimately a spectrum of devices may become available. These will range from miniaturized (potentially embedded in surrounding objects) to a variety of mobile (including handheld and wearable) devices. While these could exist as standalone systems, it is likely that many will be interlinked to form more comprehensive systems.

4. GENERIC DEVICE FRAMEWORK

A generic device framework(Fig 2) introduces a general framework for all devices in pervasive computing.A devices which has the common properties can be categorized(eg.mobile device,handheld devices etc., each can be one category).Each category can have a ‘n; number of device type(eg.for mobile device category PDA,cellphones,setupboxes etc., are device type).A device type have a ‘n’ number of device representation

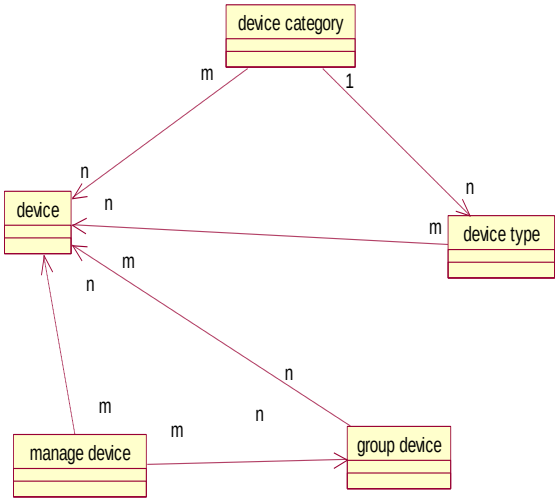

Fig 2: Generic Device Framework

request.Finally,the devices has to be managed by device manager**.**

5. GENERIC APPLICATION DEVICE

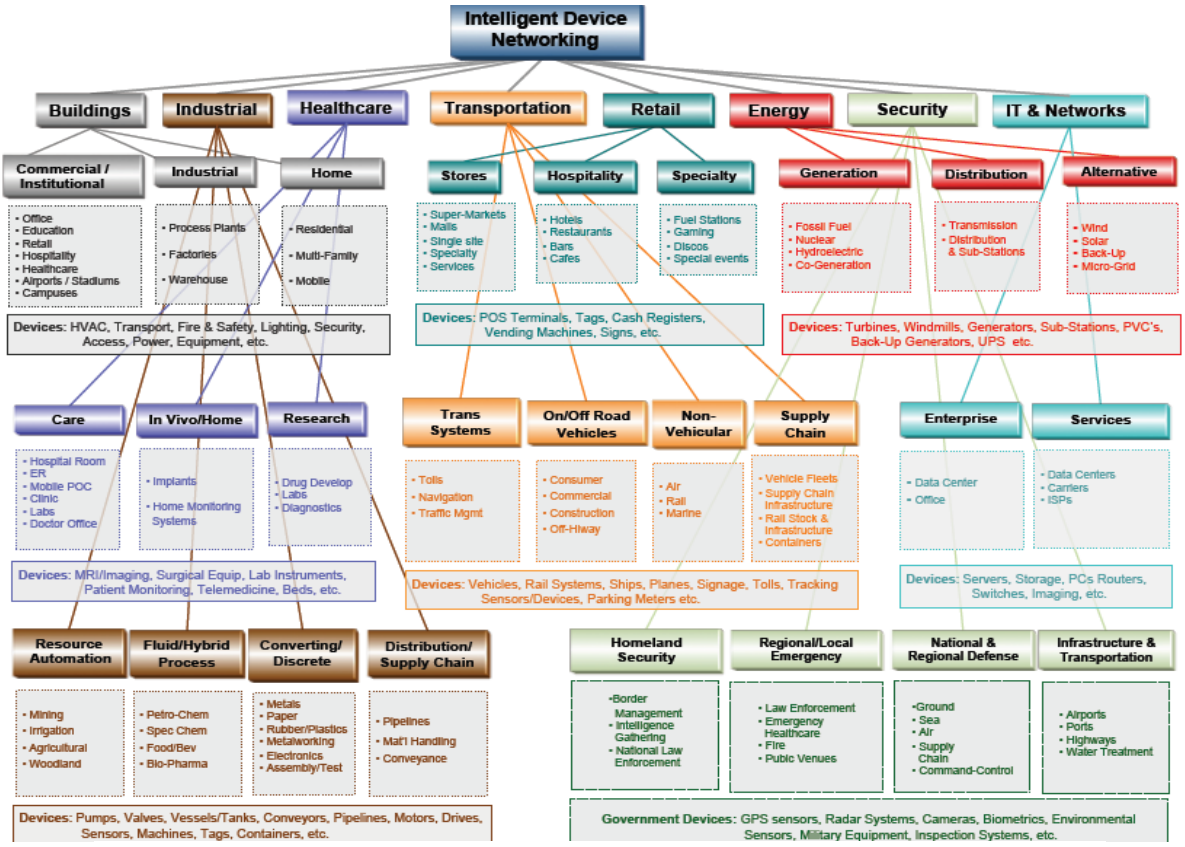

Fig 3: Generic Device Category based on application(Harbor Research,2008)

For a Pervasive computing system, variety of smart devices are dispersed in a real World. For a Generic Device Category,the devices can be categorized based on pervasive application (eg. Building, industrial etc.,)(Fig 3).

6. GENERIC DEVICE GROUPING

A pervasive system is equipped as collection of available devices that are scattered physically in the pervasive environment. In response to a user request, each device can perform one or more sub functions.Accordin to that particular function, the devices in the physical world arrange themselves such that they work with each other in order to perform overall function.We define set of devices called grouping of devices,based on application requirement(Fig4).

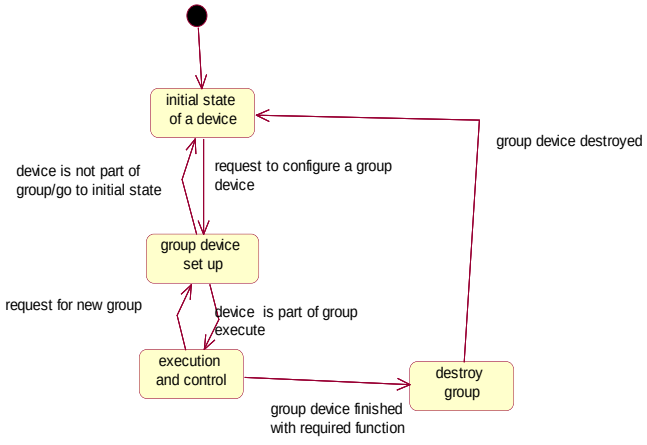

Fig 4: State chart diagram for Grouping of device

Steps for grouping of devices:

Step1:All devices are in initial state.

Step2:A device changes to group device setup when it receives the request from user to perform the sub-function. In this state, a device checks if it knows the sub function. If the request matches with its function the device joins to the group device setup. the process continues until all other sub function of request satisfies.

Step3:When a device becomes a part of group device, it goes to the execution state and execute the controller of the device.

Step4:After the execution of the grouping device with the the required function it moves to the destroy group state and destroy the group.

Step5:After destroyed the group it goes to the initial state and again process continues for next grouping.

7. SAMPLE APPLICATION

For our Generic Device framework we have taken a Smart Home as a sample application.

7.1 Device Category For Home Devices

The devices can be categorized by,devices which having common characteristics falls in each category.For Smart Home application,home devices are characterized as smart objects,cooling device,mobile device,sensors,electrical and electronic devices.The Smart Object Category includes door,window,curtain as device type(Fig 5).

7.2 Sample Device Representation For Tubelight

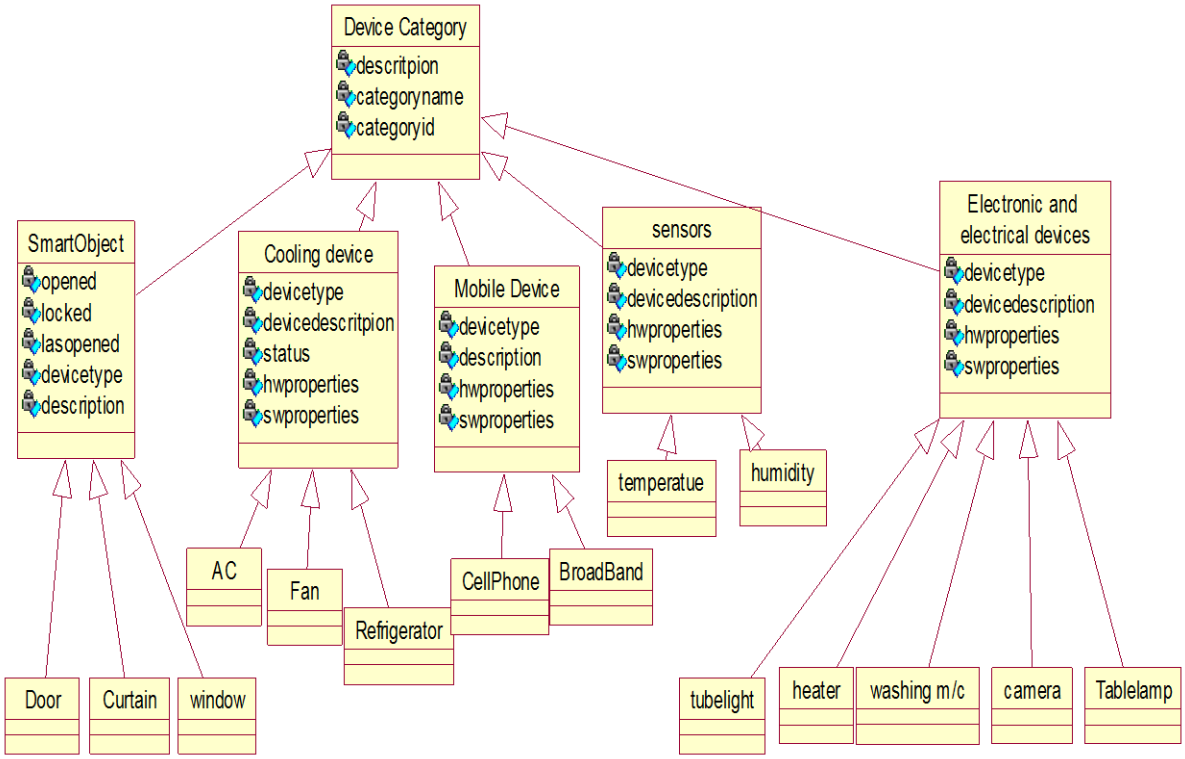

Fig 5: Device Category for Smart Home Devices

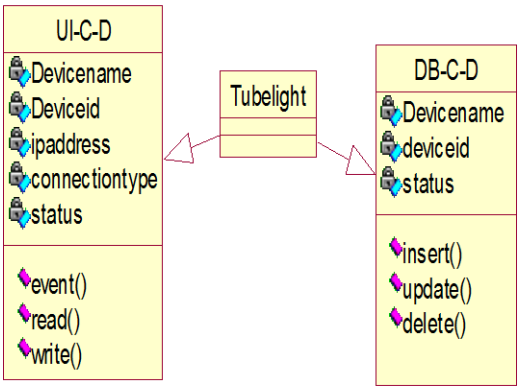

Fig 6: Device representation of Tubelight

In a Smart Home application each device includes user interface class(includes device name,device id etc.,)which defines configuration,characteristics and whether the device in read or write mode.It also includes database class for insertion,deletion and updation of each devices. Fig 6 shows an example for Tubelight.

7.3 Dynamic Device Grouping For Smart Home

7.3.1 Scenario 1

When User walk into the kitchen and turn on Stove,turn on television with volume low.

Devices: Stove,Television.

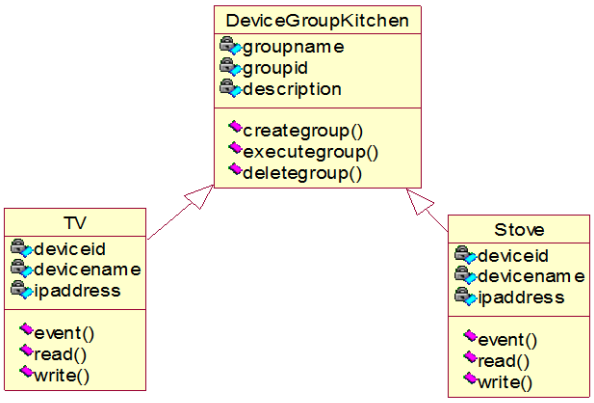

Fig 7: Device Grouping for Scenario1

class includes TV and Stove devices as one group to perform the subfunction of the request.The Device group kitchen includes groupname,groupid as attributes and creategroup,executegroup and delelegroup are methods.

7.3.2 Scenario 2

If User in the living room after 10pm,close the door and dim the living room lights.

Devices:Door,Lights

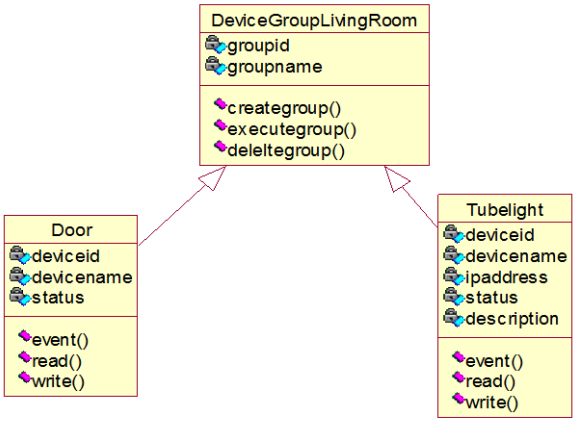

Fig 8: Device Grouping for Scenario2

Thus the device grouping can be dynamically performed for smart home application for two sample scenario.

8. CONCLUSION

In this paper, we have proposed a generic device category based on application and capable of supporting dynamic grouping of devices based on user request. We have shown sample Smart Home application, how device category and grouping of devices can be performed in home devices.In the future, we plan to implement a smart home simulator tool for device category and dynamic grouping of devices and it should be a generic one.

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