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Location, Context and Device aware Framework (LCDF): A unified Framework for Mobile Data Management

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ABSTRACT

The objective is to propose an unified framework to manage and optimize the data being generated by the mobile devices we regularly use, specially the smart cell phones, tablet pc, wearable devices after studying the current practiced frameworks. This study proposes a top-level framework for data consuming and sharing between mobile devices as well as the data collection and data management methods. This study has addressed some issues with the current data management frameworks and proposed the way how those issues can be avoided in future.

CCS CONCEPTS

Hardware → Communication hardware, interfaces and storage → wireless devices

KEYWORDS

mobile computing; hybrid data management framework; pervasive computing; middleware computing

1 INTRODUCTION

The growing trend of implanting computational skill in anytime, anywhere, any device or any network is the concept of pervasive computing. Now-a-days computing is being implemented almost on everything & as a result they produce a large amount of data [1]. A precise and simple system to manage such voluminous amount of data is a necessity now. Pervasive computing is an effective way which performs useful tasks in less interaction. The idea behind this process is to make devices "smart,".

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These devices are network-connected and frequently accessible. With the involvement of wireless communication and networking technologies, mobile devices, embedded systems, wearable computers, RFID tags, middleware and software agents, data inconsistency will occur [2-3]. To adapt the activity from surrounding a sensor is placed in the network which can collect, processing and sending data [4].

A defined, performance worthy and a vast system, possibly a distributed database management system implementation can be a solution to process these amount of records. This paper is based on the practiced data management system and integrating them in a hybrid system.

2 PRACTICED DATA MANAGEMENT STANDARD AND ISSUES

The movement towards the ubiquitous computing realm will integrate the advances from both mobile and pervasive computing which considered a great idea in the era of computing evaluation [5-8].

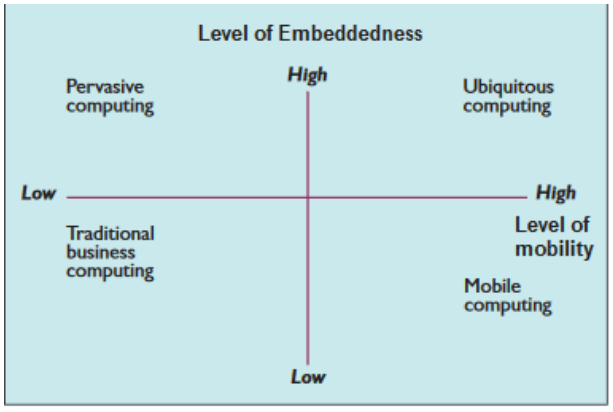

Fig 1: Level of Embeddedness [12]

Weiser put forth a revelation of people and environments augmented with computational assets that deliver information and services when and where desired [11]. For the past decade, researchers have tried this augmentation with the implicit goal of

supporting ordinary life and not overpowering it. Weiser's vision defined a construction of devices from hand-held "inch-scale" personal devices to "yard-scale" shared devices. This proliferation of devices has undeniably occurred, with commonly used devices such as hand-held personal digital assistants (PDAs), digital tablets, laptops, and wall-sized electronic white-boards. The arrangement of required infrastructure to support continuous mobile computation is arriving.

The Forget-me-not was designed to use with a wearable system [2]. It logs and finds the context of the user along with time. The saved context contains the information of physical and virtual world of the user. This system does not directly save the data to its own storage, but it allows the data to be saved and searched that are stored elsewhere.

Sulawesi is a spatial reminder service, that uses GPSand infrared to imprecise a person's location and conveys reminders accordingly.[13]

The ParcTab allows access to the linked files that were stored in a particular location [3] [4]. With the change of user's location with the movement of the user, the file browser displays relevant changed data from the changed location. They only considered location context in their file system, to establish the relevance of context in data access it was important.

MemoClip saves event-location paired small database in a hardware device and generates notification according to the user's location.[5].

CyberMinder is almost same of the MemoClip but it supports a wide range of context including reminder function for time, location, weather etc [6]. The target of this project was to build a generic framework to support wide range of application.

The Stick-e document framework is based on data and context information, which is described in SGML format. If any specified context matches with the pre stored document it triggers to make that data available to user [7]. This approach does not use the proactive retrieval method for the change in context but use the interactive retrieval method for user interaction [8].

The Gaia CFS focuses in to simplifying the process of locating data for automatically launched applications in active space [9]. It emphasized on the data acquirement on the device and store the data in a device in organized way. In this system data is organized based on different context and a user access right is managed accordingly. In addition of supporting context-aware applications for data management, this system also provides data management for different multimedia applications built on the Capnet architecture [10].

ComMotion is a context-aware reminder system which consider location as contextual information. Using GPS technology for location-sensing, people could set reminders around certain locations, with given time limits. If the person was nearby that location and the timing constraints were fulfilled, they would be notified with an audio alert.[14] PlaceIts is a location-based reminder application that runs on mobile phones. It is used for "placing" a reminder message at a physical location. Reminders are created with a message, They chose to use the location technique employed GSM cell towers. [15]

To provide the informations to the tour guide with the help of u user's current location as well as a history of past locations Cyberguide is served visitors with services concerning location and information through mobile. It offers a detail info such as, map of the physical environments; a structured repository of information relating to objects and people of interest in the physical world; information on tourist location and orientation; and a messaging service. Location sensing is built on the top of infra-red technology for indoor and GPS for outdoor.[16]

Based on both the user's interests and his current context, COMPASS is used as a mobile tourist application that adapts its services to the user's needs. A recommender system has been integrated with this application platform [18].

SPETA is act like a real tour guide with the help of user's current location, weather forecast, time, user preferences, friend's recommendation, social networks, as well as a history of past locations A GIS system is used here[17]

In cities m-LOMA [19] used as a mobile portal to provide location-based information. The user can perform textual searches to location-based content, navigate using 3D maps supported by a GPS, and leave messages. Its primary focus is on 3D rendering techniques in mobile client which is more acceptable in today's era.

Another process is available there to manage the data from pervasive computing that is server centric method. In this method there is a single server available for all the data generation enabled devices and they synchronize all the data with the server and the distribution and processing is done on that server.

Another process is profile based data management [1]. It is an extension of context based data management. The extension is the introduction of Information Manager (InforMa), Information Provider and Information Consumer. There is a domain of data, which describe the data, and there is another function named Utility, which represents the relation with other data. InforMa manages the data management functions as well as the network communication. In respect to the data management actions InforMa discovers available sources, build dynamic indexes and catalogs, queries and caches the data sources and data itself. At the networking procedures, InforMa discovers devices, interact with them, and route messages. Every InforMa maintains information about Providers and Consumers. This information contains the lifetime of each Provider and its service model, process models, and query restrictions. And it also maintains the information that contains the ID and context of the about peers in its area.

ContextContacts [20] allows for presence and context cues to be shared between users who already know each other over the network. Information such as location, state of the phone (ringer, vibrator), and number of friends or strangers nearby is shared through servers. This application acts very much like instant messaging applications, and is aimed to reduce the communication gap between friends across distances.

A. Issues in Data Management for Mobile Devices [1]

Context-aware computing is not a new computing paradigm but every time researchers faced lots while building distributed applications, either mobile or stationary, on top of the network layer which was extremely tedious and error-prone. Application developers would have to deal explicitly with all the non-functional requirements such as heterogeneity and fault-tolerance which could be slow down considerably the development and maintenance of an application. According to Lei[21], requirements for frameworks support context-awareness areas follows. Due to lightweight restrictions of limited processing power it is not possible for a single device to sense all context information. Then come Robustness: The architecture has to be robust against

disconnections of remote sensors also the model needs to contain meta-information; On the other hand, Context-Sharing is also needed to share the sensed context with other devices. Because of resource limitations, to run heavy-weight middleware systems on these devices is not feasible, It is therefore necessary to elect the right trade-off between computational load and non-functional requirements accomplished by the middleware. Mobile devices connect to the network speculatively for small periods of time, mainly to access some data or to request a service.

- Unlike fixed distributed systems, mobile systems execute in an extremely dynamic context where Bandwidth may not be stable because of the short period of time.
- Spatiotemporal variation of data and data source availability: As devices move, their area or locality changes accordingly, which changes and affects data and data source availability.
- Lack of a global catalog and schema: As the mobile devices moves from one place to another the neighborhood changes along with the movement and as there is no fixed location mapped with the devices it loses the data catalog or context. That is why a global catalog or index is needed for a full functional framework.
- No guarantee of reconnection: If a device moves from one neighborhood to another while in perusing state of a communication both the devices will lose the communication and their last state. In the current scenario this connection cannot be reinstated if the devices again comes to the same neighborhood.
- No guarantee of collaboration: This issue is focused on privacy and trustworthiness. When random devices exchange data in random vicinity there will be a question of trust, which data should be, trusted which is not as well as the shared data and their modification access. Current frameworks do not have this problems solution and still it is a big issue in mobile data exchange.

3 LCDF: THE PROPOSED FRAMEWORK

Location, Context and Device aware Framework contains some modules, which will serve different purpose. This framework actually is a middleware that will provide some service and manage all the necessary operations of managing data like data consuming, storing and sharing.

The term middleware is a buzzword which depends on the computing field it is used for & the possibility of the person referring to it. Middleware provides a generic interface between the physician & the real world transforming physical qualities into measurements that can be attached for a wide ranging field of applications.

Primary focus of this framework is on Location and device mapping and next is the Context and device mapping. It is based on peer-to-peer device communication and it has got a middleware to keep the framework running.

A. Outline of LCDF:

- Each mobile device is mapped with 2 or more location such as Home, work and guest Location.
- All the data from various sensors are updated and stored in the device on need basis as if the device itself needs it or any other device request to get that data.
- Each device is provided with location and device id. Same location id's device will work as a collection that means they can share data among themselves.
- When the device enters into new location it will be mapped with the guest location and it can pull data from any device mapped with that location, which contain recent data.
- Each device will have an update marker by which it will indicate that it has the most recent data with itself.
- It is to be defined that how much time any data will be considered as updated or recent data.
- It can be defined like the last device enters into its mapped areas
  - If many device enters into area at the same time then any device can be chosen based on the device status (battery level, processor and ram capacity)
  - If no device enters or leaves within a certain amount of time then any device can update itself.
  - Certain amount of time can be determined on the basis of which data is being contained or served by the device.
- Each device can store and share any specific data or the mixture of all the data based on the context or interest. This is the device and context mapping.

B. Modules of LCDF:

- The heart of LCDF is the Data Manager Module (DMM).
- This DMM is the middleware or the application that will run inside the mobile devices.
- DMM is responsible for consuming, sharing and storing the data.
- DMM contains (Fig 3.1):
  - Data Consumer Module. This module consumes or pulls data from various devices or servers through appropriate communication interfaces (e.g. Bluetooth, Wi-Fi).
  - Data Sharing Module. This module shares or pushes data to other devices or servers thorough any appropriate communication interfaces.
  - Data Storage Module. This module is responsible for storing the data that is being consumed or shared.
  - Network Manager. This module handles all the necessary operations for communicating between the devices and sharing as well as consuming data. It is also liable for holding the known device lists.
  - Time Sync Marker. This module is used for tracking the status of the data whether it is updated or not.
  - Device Information. This module stores the device information, locations mapping and other status related to the device.
  - Data Types. With this module it can be set which types of data can be stored, shared and consumed.
  - Configuration manager. It will be used for configuring all the parameters of the middleware.

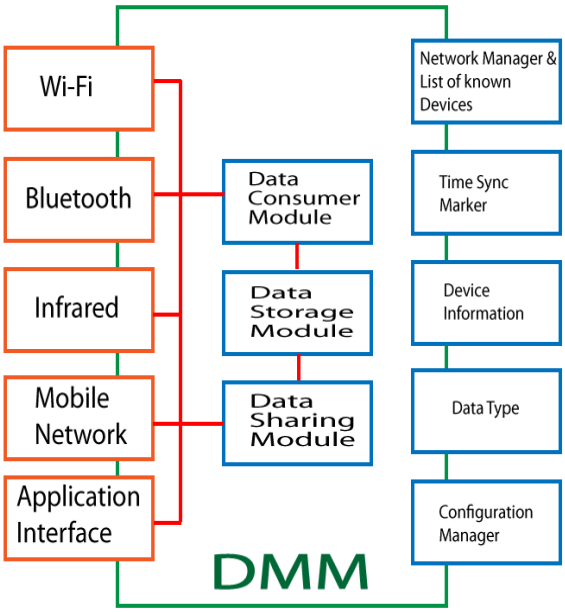

Fig 2: Data Manager Module

C. Advantages of LCDF

There are several advantages of LCDF. The most significant advantages are it has removed the issues in Data Management for mobile devices named as follows [1]

- Spatiotemporal variation of data and data source availability. This issue can be removed by the location and device mapping and with the known device list functionalities.
- Lack of a global catalog and schema. Mapping the devices with the location and listing the entire known devices can remove this issue.
- No guarantee of reconnection. The LCDF manages it with the known devices list and their last interactions state.
- Context Sharing can always be done through data sharing module.
- No guarantee of collaboration. This issue has been addressed by introducing the configuration manager. With the configuration manager user can define which data or context to be shared or exchanged, which devices can interact with user's device and where this access can be happened.

As it is based on peer-to-peer architecture it is easy to maintain the network configuration and there is no central dependency, whenever any device consumes any data it is ready to share that data. And users can control their shared resources via the configuration manager hence they can control their privacy and security concerns.

4 CONCLUSION

Now-a-days computing capabilities are growing quickly, while their size is shrinking. So, while moving, if any computing device can build incrementally dynamic models from its surrounding and configure its services accordingly then our goal can be achieved. Furthermore, all the devices need to remember past environments they functioned in, thus helping us to work efficiently when we reenter, or proactively build up services in new environments whenever we enter them. Studying pervasive computing from a data-centric point of view raises some similarity with current database research like data streams, data and services integration, or distributed databases. The whole proposal may resolve the issues related to distributes system centric data management systems. Basically this paper will help those communities who are interested in developing pervasive computing data management system. "Context is what surrounds" and in pervasive systems this word is used to indicate the physical and virtual world explanations that surround us in our everyday lives. While there are a vast number of challenges in developing context aware framework for pervasive environments our model can be a solution to increase the reusability of the system architecture.

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