Collaborative Computing: Application to Information Services

Subrata Bose

Department of Computer Science and Engineering, Neotia Institute of Technology, Management and Science
Jhinga, Diamond Harbour Road, South 24 Parganas, WB, India – 743368

***Abstract*— Collaborative computing has set a new technology trend in recent years. It involves a large number of entities and shared resources, which are distributed, dynamic and heterogeneous. The range of collaborative computing is wide and expanding. Through collaboration number of services can be offered such as hospitality, tour and travel, health care etc. to name a few. In this work we have proposed a multi-party *collaborative information retrieval service* (CIRS). CIRS supports a long-range of queries involving text and multimedia data. The idea of CIRS is extended to a more generalized information service called *collaborative information service* (CIS). In CIS the collaborators share their data for serving complex and critical information need of organization or individuals. CIS provides consolidated information to the user collecting data from different data owners. In addition, different data owners are allowed to access as well as update other data owners' data in a collaborative scenario such as online stores like Amazon and Flipkart who connect different manufactures, vendors, transporter, and courier services etc. We have classified CIS in three different categories - basic, application and business. CIS can be considered to model any collaborative computing system where different partners collaborate for any joint activity by exchanging information among them.**

***Keywords*— Collaborative Computing, Information Service, Information Retrieval, Classification of Information Services, IT business**

I. INTRODUCTION

A. Collaborative Computing

"*In the long history of humankind (and animal kind, too) those who learned to collaborate and improvise most effectively have prevailed*." – Charles Darwin.

Collaboration is a natural phenomenon. Collaboration enables individuals or organizations to work together to achieve a defined and common *goal* [42]. Organizations have started realizing that even their best individual effort may not be sufficient in today's complex and interconnected business. Collaboration across organizational and national boundaries is common in today's organizational life. Collaboration is the new competition. Even seemingly unsolvable problems are resolved in collaboration [35]. The partners of collaboration share responsibilities of the collaborative work for their collective interest and shared objectives. Strategic alliance with organizations across the globe or different end of the supply chain is a fact of life in business today. Collaboration driven by society may be inter organizational or across a diverse group of organizations or even among competitors. In his award-winning book "The Collaboration Challenge" Austin showed how nonprofit organizations and businesses can succeed through strategic alliances and collaboration [47]. Collaborative work is important and sometimes essential in number of areas. Collaborative computing is the computing platform used for collaborative work.

Collaborative computing has set an important technology trend that changed the information processing in recent years. For example, distributed healthcare information system enables medical staff to gain access to a service for collaboration between different health care actors [3]. Google Drive is a typical example of collaboration for data sharing. Collaboration is a recent trend in supply chain management [14], [17], [40]. Companies that collaborate effectively across the supply chains have enjoyed dramatic reductions in inventories and costs, together with improvements in speed, service levels, and customer satisfaction [8]. Collaborative supply chain management in Business to Business (B2B) e-commerce is found to be beneficial apart from the volume growth of procurement and selling. For example, a joint initiative by Wall-Mart and P&G helped sales forecast of P&G products at Wall-Mart stores and plan the replenishment strategies accordingly. This ensures no gap between what Wall-Mart plans to sell and what P&G plans to produce [5]. EDI, an inter-organizational information system is a type of collaboration between trading partners [36]. When companies or departments collaborate, they are able to utilize the strengths, skills and resources of everyone involved. Even competing organizations having conflict of interest may collaborate for mutual benefit taking proper care of individual interest. Competitive collaboration between two companies through joint ventures or strategic alliances can strengthen/benefit both companies against the outsiders. Competitive collaboration enhances company's internal skills and technologies as well as guard against transferring competitive advantages to ambitious partners [33]. Many complex problems in business as well as in scientific areas demand participation of multiple organizations. Collaboration is a natural choice for solving such problems. The collaborating organizations share resources, which are distributed, dynamic and heterogeneous.

Importance of collaboration is emphasized by Peter Drucker [7], [27], [47], the founder of modern management. Today's boom of e-commerce, also called collaborative commerce [20] finds emergence of companies like Amazon, Flipkart etc. which are in line with the collaborative organizational form envisaged by Drucker [27] long ago. The workbook "Meeting the Collaboration Challenge" the Drucker Foundation, demonstrates how nonprofit organizations and businesses can effectively partner for mutual benefits and social goods. "Twenty-first century will be the age of alliances. In this age, collaboration between nonprofit organizations and corporations will grow in frequency and strategic importance. Collaborative relationship will increasingly migrate from … toward deeper, strategic alliances." [47].

Collaboration is a purposeful and strategic way of working that must optimally use the resources of each party for the benefit of all by exchanging information in an environment of trust and transparency. Collaboration is built into business processes to create new models of people working together to achieve common goals within the extended enterprise [21]. Collaborative computing is a distributed computing technology and has evolved from parallel computing, cluster computing, grid computing, to recent cloud computing to support full-scale collaboration between systems and people [53]. It has long range of applications, offers a lot of research and development opportunities in many areas and has attracted attention of many researchers. The technologies which are contributing to the emergence of collaborative computing include Computer Supported Cooperative Work (CSCW) and groupware [32], software agents and multi-agent systems [3], [15], [22], [50], web services [20], social networks and semantic web [10]. Range of collaborative computing applications is wide and growing. Collaboration is useful in many application areas in scientific [48], academic [28] and business.

Some areas of collaborative applications include Collaborative Planning [15], [29], Cooperative Business Process Management and MPC [14], [20], [59], Multi-party Negotiation [11], [13], [16], [19], Collaborative Computing in Optimization [16], [17], [49], [51], Cloud Based Systems and Collaboration [2], [25], [56], Enterprise System and Collaboration [26], [52], Collaborative Computing in Auction [22], [24], Collaborative Computing in Market Places [11], [18], Collaborative Computing in Supply Chain [14], [17], [40], Collaborative Computing in Pricing [12], [17], Collaborative Information Retrieval [9], [34], [43], [46], Collaboration in Health-care Environments [3], [23], Collaborative Data Mining [42], [57], Collaborative Technologies for Creation and Deployment of Services [20], Security, Privacy and Trust Management in Collaborative Computing [41], [55], [57], [61].

Although collaborative computing can bring significant benefits to business and the society at large, exploiting its full potential need serious considerations of the following issues. One of them is legal. Privacy laws (e.g. HIPPA[1]) often acts as a barrier to share sensitive / personal information. Therefore, exchange of original data which are sensitive and /or prohibited by law are not allowed. Even when it is legal, organizations are reluctant to share information for the fear of losing control over its subsequent misuse. To prevent this and encourage fearless participation of organizations, the system should be supported by techniques for jointly and collaboratively computing answers without revealing any private data, even though the computed answers are built as if working on all the participants' private data. Another issue is the data may even be outsourced to clouds and encrypted. Thus proper security measures would encourage more and more people / organizations to collaborate.

1) Cooperation vs. Collaboration

Cooperative computing is another close term used in distributed computing domain. This has similarity with collaborative computing. Collaboration is often used interchangeably with the word cooperation but there is a fundamental difference between them. In collaboration people work together to achieve a single shared goal. In cooperation people perform together for a specific purpose but otherwise they work independently [39]. For collaboration each stakeholder has to agree to fundamentally change for the common goal otherwise collaboration may fail even though the parties are highly cooperative. People generally think they are collaborating when they are merely cooperative which means they have not been fully involved for a common goal but cooperate whenever needed. And of course collaboration implies cooperation as non-cooperation cannot lead to collaboration but cooperation alone does not ensure collaboration. Collaboration involves change management, the collaborators need to get trained and change their mindsets. It is much more than just cooperating with each other.

"*Very few managers admit to being poor collaborators, mostly because they mistake their cooperativeness for being collaborative. And indeed, most managers are cooperative, friendly, and willing to share information — but what they lack is the ability and flexibility to align their goals and resources with others in real time*." [62].

2) Collaborative Information Service

Information service of an organization is usually provided by the information system department. Typically, this serves the purpose of business and technically termed as management information system or MIS. Modern MIS extends beyond the organization boundary giving rise to

[1] HIPAA (Health Insurance Portability and Accountability Act of 1996) is United States legislation that provides data privacy and security provisions for safeguarding medical information.

supply chain and CRM. This is a common scenario in today's environment. Organizations are heavily dependent on IT and information service is the backbone of today's business. In a collaborative scenario when number of organizations join hands for a common purpose, be it scientific or business, information system again play a major role. This calls for collaborative computing which requires different approach of problem solving techniques [1], [6], [30] compared to computing scenario within a single organization.

In this work we look at information service from a different view-point. A set of participating organizations collaborate for an information service which could be provided for a business or one can create a common service for public use. We propose a robust *Collaborative Information Retrieval Service* (**CIRS**) which requires assimilating data available with other data owners. The service is provided by a service provider. The data owners of these data sources either lend their data from their own premises or their data could be hosted in cloud. In the later case different clouds may need to collaborate.

Information retrieval is basically a data read operation. By allowing the data owners to write/update data in other data owners' databases (with their permission) we have proposed collaborative information service (CIS). This added *write* operation enables multiple parties to jointly run a collaborative application rather than just information seeking.

II. COLLABORATIVE INFORMATION RETRIEVAL SERVICE (CIRS)

CIRS is perceived as a multi-source information retrieval service. Its range of information requests (queries) vary from simple to complex and the service is generally positioned to answer complex queries which require assimilation of data of more than one data sources. Number of independent and autonomous data sources (the data owners) collaborates for the service. For simplicity we assume that each data source belongs to a data owner and no data owner owns more than one data source. The service is provided by an information service provider (ISP) who could be also a data owner or an independent organization. The ISP acts as a coordinator to find the data sources and make necessary agreements (financial and legal). System architecture of CIRS is presented in Fig. 1. Examples of few queries targeted by CIRS are:

Query 1: *Finding historical information of ancient Rome, Italy and corresponding tour plan from Kolkata, India during summer of 2017*

Query 2: *Finding the most memorable scenes from Charlie Chaplin films*

Query 3: *Locating a terrorist on move in different countries given his voice samples or finger prints or photographs*

Query 4: *Locating a person within a group photograph given an image of that person*

Query 5: *Striking deals with online shops for purchasing dresses for a dance troupe going on a world tour in winter*

Query 6: *Seeking suitable partner from different matrimonial sites with samples of cultural orientation of the candidate such as singing, painting, dance or drama and educational background*

Query 7: *Finding information of MBA degree from Universities/Colleges in Europe given candidate's academic degrees and grades, score in GRE, TOEFL etc.*

Query 8: *Drawing up a complete tour plan of Europe with details of flight information, important places to visit, hotels to stay, local sightseeing, costs etc. for a couple in April/May for a month*

Query 9: *Searching a good location to start a factory given all required parameters like availability of raw materials, labor, local political scenario, demographic conditions etc.*

Query 10: *Looking for houses along with the landscape, building plan and interior design from real estate companies having certain demographic features within a budget range*

Query 11: *Discovering fraudulent transactions across the globe connected to a group of suspected criminals*

Query 12: *Find out the evolution of architectural types in modern India*

The data owners of these data sources share their data in this collaborative service. Each data source in collaboration follows the steps of protocol during processing of the query and as per the rule of collaboration they do not break away from the protocol. To serve a query the ISP would require information from many data sources. For example, for Query 1 the ISP would need to collect information of history data source, tour & travel data source and may be multiple such of each type for completeness. The ISP who acts as a facilitator has the full knowledge of what information each data source can provide. After receiving a query, the ISP analyses it to find the information content required and then with the consent of relevant data sources fix them up for serving it. At this stage the ISP has generated number of sub queries from the main query depending on the information content of the data sources. One such sub query is sent to each data source. The data source processes the sub query and returns the (part) result to the ISP. ISP computes the result of the query by collating/merging part results of the data sources. It may so happen that the ISP may not be able to give answer of a specific query due to non availability of relevant data. Even then it should attempt to help the user with partial answer. The databases maintained in the independent sites of the data sources are likely to be heterogeneous (different database product and versions). Handling heterogeneity of the data sources is an aspect of this processing. The issues for this

multi-source data retrieval are:

- *Ease of making query* – the information seeker should have access to an easy user interface to submit his query. Querying in simple English would help the users.
- *Maximizing voluntary participation of relevant data sources* – the system should be so built that it attracts appropriate data sources to join this collaborative service by safeguarding their business interest.
- *Maintaining independence of operation of individual data sources* – each data source must be able to operate within its resources and provides answers to the sub query sent to him by the ISP. There should not be any other intervention either by the ISP or from any other data source.
- *Efficiency and accuracy of the results* obtained through merging and mixing (sometimes very complex) of results obtained from separate sources – this aspect needs to be ensured by the ISP.
- *Secure operations of the data sources* – this is security aspect of operation and would require cryptographic solution
- *Managing heterogeneity of data sources at different levels* – the independent and autonomous data sources are not expected to be homogenous as far as database technology is concerned. A number of approaches have been proposed in the literature, *mediator* based approach being the most prominent [54].
- *Building privacy and trust of the collaborators* – the information seeker, the ISP and the individual data sources. Cryptography and SMC [64] will play major role here. Building trust in the system would encourage more and more data source to join this service.
- *Pricing structure of the services* – Revenue sharing patterns among the parties are manifested through the pricing structure for the services rendered to the querier and profit sharing between the ISP on one side and the data sources on the other.
- *Data source management* – An important task for the ISP is data source management for the service. ISP has to establish relevant data sources for given information request, and manage addition or removal of data sources.
- *Scalability of the service* – Scalability is another important issue of CIRS for the ISP [31], [38], [54] to remain successful in the business. The scalability issue is not just limited to the volume and/or heterogeneity of data that is retrieved or moved in the process of computation needed for a given query or their frequency of occurrences, but more importantly the performance issue could arise from heterogeneity factors.

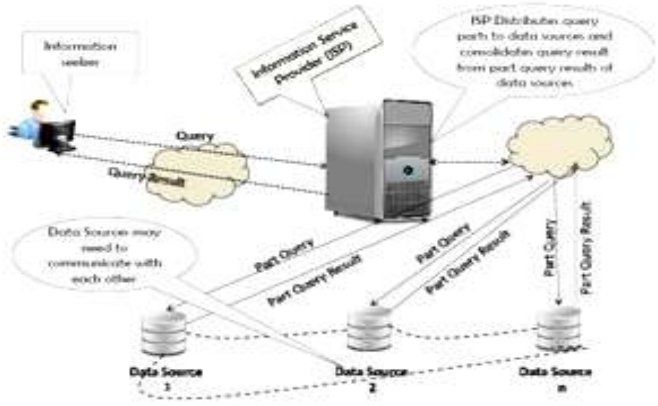

Fig. 1 System Architecture of CIRS

A. Classification of CIRS

CIRS aims to answer any query of user. The ISP setups this service with the goal of answering a variety of queries of different fields. However, answering any arbitrary query could be far from practical because of the limitations of arranging relevant and potential data sources of many fields. Commercial aspect also needs considerations. We therefore look at the service from two different angles. In the first case, the service is well planned with number of data sources of different subjects or application specifics such as information from commercial banks/financial institutes, criminals' information from police and CID, tour and travel information from tour operators etc. The information seeker would know the kind of information they can get from the specific CIRS. We call it closed service. On the other hand, if the CIRS has to answer any arbitrary query, the ISP may have to arrange the data sources on the fly [43], [46]. We call such service as open service. Though open services are more promising, from the implementation point of view this is a difficult proposition though we believe it is achievable. For example, queries like *show me a few most memorable tragic scenes from the films made by Charley Chaplin* belong to open category whereas *get bank balances over 1 million US dollar of Mr. X alias Y in all foreign banks* is a closed one.

In the open category, we have discipline/subject oriented CIRS such as *Art-oCIRS*, *History-oCIRS* or *Police-oCIRS*. The *Art-oCIRS* has information of different forms of arts. Given a query it collects information from arts related data sources on the spot. Closed CIRS are centered on specific applications or business interests such as information related to commercial banks in India or tour & travel agents such as *Bank-cCIRS*, *Airlines-cCIRS* or *Tour & Travel-cCIRS*. For examples, suppose Kolkata Police department wants to find information of a criminal who commits a crime in one state and runs away to another state. They can take the help of police or criminal investigation departments in different states in India (*Police-cCIRS*). The data sources would be closed

according to the discipline, market or geography concerned for the specific CIRS provider and they will be registered with the ISP. The ISP in this category would have to be properly knowledgeable in the given area of specialization. The classification of CIRS is shown in Fig. 2.

The concept of closed and open CIRS can be further extended in the sense that the ISPs providing such services may again collaborate among them for providing more compact and complete information retrieval service. Even a closed CIRS may collaborate with an open service. For example, *Police-cCIRS* may collaborate with *CID-cCIRS* with some prearrangement and we may call it *Police+CID-cCIRS*, a joint IR service provider. This may help provide more accurate information about a crime by their joint effort. Similarly, bank CIRS of different countries may collaborate for information need of a person maintaining multiple foreign account and having committed a financial crime.

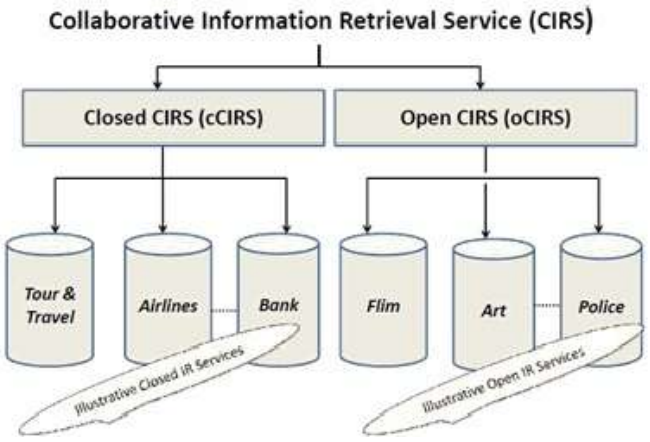

Fig. 2 Classification of CIRS

CIRS is an integrated information service. Here we propose to integrate data belonging to multiple sources and the databases are likely to be heterogeneous. A large multinational company can develop such information services country wise for their own internal consumption. This could be due to differences in operations and laws of different countries. These CIRS systems can further collaborate to create an enterprise CIRS. From the business point of view Enterprise CIRS appear to be highly effective for corporate, particularly the big ones. *Ent-cCIRS*, one instance is for one enterprise, e.g. *WM-Ent-cCIRS* for Wallmart, or more narrowly, *Mexico-WM-Ent-cCIRS*. It is possible that *WM-Ent-cCIRS* is same as *USA+EU+Mexico-Ent-cCIRS*, assuming that WM is spread across theses zones.

B. Business Model of the ISP

The ISP is the business developer of CIRS. Its initial task is to find business opportunity for the information retrieval service. The ISP can do a market survey to find potential users (information seekers), their information need and the data sources (information providers) usually focused on an area of business. The data sources must be capable (information rich) and willing to join the collaboration. At this stage the ISP also strikes commercial deals with the data sources and accordingly works out his price model. Once the data sources agree to join the business coordinated by the ISP, they share their database schema with the ISP. The ISP then builds a *global schema* for the service. The ISP on receipt of an information retrieval task from the users, translates the query in database term involving the relevant data sources and their data and schema definitions, and finally executes the query for obtaining the result to be provided to the user. Appropriate privacy and security mechanism are to be maintained during query execution. The ISP looks for appropriate data sources by using his or her contacts, searching the net, or inviting for participation possibly through a bidding process, etc. Data sources would join the ISP depending on their interests, their knowledge about the ISP and also based on the amount of trust they have on the ISP and finally establish a business deal with the ISP (on revenue sharing and pricing schemes etc.). Ultimately, a list of data sources becomes part of CIRS. But this list will occasionally change, depending on entry of new source or existing source leaving CIRS.

Having established the data sources the ISP collects the meta information about the exposable data of each data source. Note that the data sources need not agree to expose the entire data but a part of it. The data could be heterogeneous in a number of ways, the content of data (text, audio, video), formatting of individual data elements, and data structure (e.g. flat file, relational database). The meta information of a data source contains data about the attribute details such as their names and data types. The ISP (the mediator software installed for the service) constructs a global schema by combining the individual schema, a set of mapping rules and rules for semantic integration to reconcile the similarities and differences [31], [38], [54]. This will be used in creating a uniform user interface for entering a query by the user. For each data source the service provider creates a wrapper which basically acts as an interface between the *mediator engine* (often a relational database manager) and the data sources. The customer query is posed to the mediator which acts as a central system with interfaces to the autonomous wrapped data sources for the information retrieval service.

III. COLLABORATIVE INFORMATION SERVICE (CIS)

CIRS is a collaborative information retrieval service initiated and offered by an ISP with the help of willing and information rich data owners who agreed to participate in this business. CIRS is a commercial proposition, basically an information service business. The idea of CIS is quite different. Let us have a look at an information service request to understand CIS. An investigating agency enquiring the case of a suspected fraud may want to *deactivate all the bank*

accounts of that person involving transactions over 100 million in the last five years. This would involve fetching such information, sending update requests to the banks and then receiving confirmation from the banks after successful updates for a consolidated report. Alternatively, this service request may go to a consortium bank who in turn forwards this to the individual banks for processing. Here the banks collaborate with the ISP for the service. And the service request involves data reads as well as updates. The deactivation of bank accounts in this case follows the usual information processing workflow as per the business rules of the banks. The above example illustrates collaboration of different organizations for performing a joint computation on their data involving data read and update. This is information service is collaborative and there has to be an agency that would provide this service to interested parties. This approach of *collaborative information service* is termed as CIS.

CIS can be looked at from another view point. Many companies are information rich. They have gathered large volume of historical data over the years. Mining / data analytics are natural value additions to gather knowledge from this large pool of data. These computations can be on stand-alone basis or joint. We propose a useful and profitable alternative for such data owners. These data owners may join hands for an *information service* which responds to *information service requests* of their clients. Unlike CIRS this information service is not just information retrieval. It allows its clients to modify the content of their / others' data sources as per the need of the computational logic. In a sense this service is an extended version of CIRS. Moreover, these service requests are more application oriented and this type of collaboration can be established among organizations on case to case basis. For example, two super markets want to do association rule mining on the union of their databases [63] for results that would benefit both of them. They setup a deal between them, may be with the help of some service organization who acts as a catalyst for this deal.

We find a third option of CIS application. There are companies whose business process activities extend beyond organizational boundaries. The work flow of their business processes touches different organizations including their own. We can look at this type of business process as collaborative and computations for such collaborative computing would read/update any data source as if they are working within a single organization. Partners in a supply chain are automatic candidates for such computation e.g. online stores like Amazon and Flipkart connect different manufactures, vendors, payment gateway organizations and courier services. This type of information service can be seen as sequence of information requests involving either read or write in any data source. A single information request (either read or write) from any party is equivalent to one information request of a client of CIRS. The data owners can be any company and this kind of system requires handling complex databases spread across and they collaborate with other businesses.

Following examples of *information activity* would help us understand the proposed CIS [43, 44].

Activity 1: *Show me houses from different builders along with prices and payment schedule, landscape, apartment plan and interior design within a budget range and having a few location features.*

Activity 2: *Find a criminal along with records of his criminal activities from different police stations in the city given a few voice samples.*

Activity 3: *Locate a terrorist having multiple identities (aliases) on the move.*

Activity 4: *Strike deals online with reputed designers and dress makers for making costumes for a dance troupe going on a world tour.*

Activity 5: *Stop fraudulent bank transactions across the globe connected with a group of suspected criminals.*

The *information processing activities* presented above have the following features:

a. Collaboration among different data owners is needed.
b. All data sources needed may not be known a priori, some may become apparent only during execution (Activity3, Activity4).
c. Data sources can belong to a single (Activity1, Activity2), or multiple domains, (Activity3 through Activity5). The requirement of multiple domains may arise from differences in types of data (Activity4), systems (Activity5), or both (Activity3) [43, 44].
d. Information activities could be retrieval (read) (Activity1 through Activity3) or transactional (write) operations (Activity4, Activity5).
e. Maintaining privacy of each player, a data provider or a seeker of information, is crucial to the success of an activity.
f. Authorized people can only perform 'sensitive' activities (Activity2, Activity3 and Activity5). The players need proper access rights for both *read* and *write* activities.

This kind of computations comes under *collaborative computing*. Fundamentally such computation works on the principles of distributed system [60]. Security is a serious issue in collaborative computing [1], [4]. Security concerns are more serious when the participants do not have much knowledge of each other, e.g. a customer or a small business to a credit card company. Collaboration is successful only when the participants can keep trust in the system.

An important security concern in such collaborative computation is at data level. All the data elements belonging

to a given participant need not be equally sensitive with respect to specific opponents or its security may need to be traded with efficiency of the activity [58].

IV. CIS CLASSIFICATIONS

As discussed above CIS is applicable to three types of information services. They are:

Basic CIS – This basic model of CIS services single information service request of a client which may require database update over and above read. Each information request is independent of all other previous requests. Basic CIS is very similar to CIRS, only difference being it allows read as well as update on databases. Following scenarios illustrate the basic CIS:

a) *The central bank wishes to update the repo rate[2] in the commercial banks under its control effective from a date. It issues an update request which initiates the action of updating the rate in the databases of the commercial banks. The central bank normally cannot access the databases of those banks. But when the banks allow this in a collaborative scenario, one update request from the central bank is good enough. This is in contrast to the usual mode of correspondence from the central bank to the commercial banks each of whom in turn carries out the update and the central bank monitors.*
b) *An investor wishes to invest a sum of money for some period in two commercial banks in some ratio and wants to find the total return. The investor issues this information request to the service organization (ISP). The commercial banks collaborate with the servicing organization in this regard.*

Application CIS – Application driven CIS refers to a collaborative multi-party IS application which is executed following basic CIS principle. The application logic can be composed of a sequence of basic CIS service requests required to drive the application as if each service request is raised by one of the parties in the multi-party scenario. The multi-party computation may also involve a third party which could sort of act as an ISP of the basic CIS. Let us try to understand this CIS with the help of a simple example

a) *A person wishes to compute r=(x + y).z where x, y and z belong to party A, B and C respectively. For this computation the following sequence of steps involving basic CIS can be executed*
    1. *The person sends the information request to an ISP for computation of r = (x + y).z*
    2. *The ISP breaks up this computation as w = x + y and r = w.z*
    3. *The ISP issues the basic CIS for computation of w involving A and B and stores the result in w*
    4. *The ISP issues the basic CIS for computation of w.z involving C and stores the result in r*
    5. *The ISP sends the value of r to the information seeker*
b) *A trader deals with many items which are basically out sourced by him. A customer wishes to place an order to this trader for few items. The customer first needs a quotation and if he is satisfied he places the order. On receipt of the order the customer places orders on the parties from whom he out sources. For this activity the following steps can be followed:*
    1. *The customer sends an information request to the trader asking for the quotation of some items given the corresponding quantities he wishes to buy*
    2. *The trader in turn asks for confirmation from his suppliers whether they will able to supply the items of given quantities and the rate per unit of item. So the trader basically issues a basic CIS to each supplier. The suppliers in turn answer the trader.*
    3. *After receiving the replies from the suppliers the trader adds his commission for each item and send the reply to the customer*
    4. *At this stage the customer either breaks away if he does not wish to accept the rate. If he agrees he accepts the offer of the trader.*
    5. *The trader after receiving the customer's confirmation places order on individual supplier. Each order is basically an update CIS meaning the trader is allowed to update the supplier database with the order in collaborative situation.*
    6. *The trader then sends acceptance confirmation to the customer with details of delivery date etc.*

Business CIS – Consider a typical example from e-commerce. An on-line purchase by a buyer goes through a series of *information activities* such as finding the products of interests, checking their stocks in the warehouses, enquiring delivery status of the items from warehouse to the customer's address, receiving payment through some credit card company, waiting for return of some goods, etc. In another situation, for a bulk order involving different products and shipping addresses all or most of the above tasks could be performed without much of user interaction though the purchase could be on-line or off-line. Such applications can be designed as a *sequence of information exchange activities* which are collaborative in nature. Some businesses are of collaborative nature. Their business process depends on collaboratively working with some partnering organizations. In order to fulfill a transaction they have to work together with other organizations. Online shopping is an example of such business. Many organizations find that collaboration

[2] Repo rate is the rate at which the central bank of a country (Reserve Bank of India in case of India) lends money to commercial banks in the event of any shortfall of funds. Repo rate is used by monetary authorities to control inflation.

brings additional value to them. Information exchange or information sharing plays a major role in such joint activities. They work with different manufactures, vendors, payment gateway organizations and courier services for completing a sale. This type of information service can be seen as sequence of information requests involving either read or write in any data source. An online shopping transaction requires data write (update) for change of delivery status or shipment status or payment status, etc. Without loss of generality, one can assume that each entity owns a single *data source*, e.g. a de-normalized form of a database for the exposable portion of data. Let us have a look at the following example:

a) *A company sells watches of different brands. They stock those items from those manufacturers. They sale through their online shopping site. If any item is out of stock or below a certain quantity level, they place order on the respective manufacturer and update the order information in their database. The manufacturer in turn gives confirmation of receiving the order and expected date of delivery. When a customer places an online order they update the order information in their own database. They have collaborative relationship with the manufacturers, commercial banks for payment, and courier service organizations for delivery of the items. For tracking of the material in transit the courier organizations are allowed to update the company's database. For this information activity the following steps can be followed:*

   1. *An online order is placed by a customer in the shopping site (ISP in this case)*
   2. *The ISP updates the order in its database after completing all required details*
   3. *The ISP confirms the order to the customer packs the items and informs the courier company.*
   4. *The ISP updates the status in its database so that the customer can see the information.*
   5. *The ISP updates the order details like delivery address, delivery within date, order value, type of items in the order etc. in the courier company's database The courier company updates the tracking information from time to time for the ISP as well as the customer*

V. CONCLUSIONS

The importance of collaboration cannot be ignored in the days of increased use of computing and analytics, growth of Internet and distributed systems and the increasing tendency to use crowd sourcing for creative tasks. Thus, the use of collaborative idea of information activities is a growing research concern. We have proposed a collaborative information retrieval service (CIRS), a robust service for querying text and multi-media data of diverse fields. CIRS performs read operations on databases of data owners who collaborate for the service with the ISP. CIS has added *write* operation beyond *read* and also considered the problem as a collaborative model for any arbitrary joint information exchange activities. Existing works in collaborative information retrieval systems are not known to focus heavily on the security issues. Use of an explicit and comprehensive privacy model for developing a security system of an information service has not been sufficiently researched. [43], [46] is an exception where a detailed privacy model was proposed for the first time.

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