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An Overview of Workflow Management on Mobile Agent Technology

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Abstract
Mobile agent workflow management/plugins is quite appropriate to handle control flows in open distributed system; basically it is the emerging technology which can bring the process oriented tasks to run as a single unit from diverse frameworks. This workflow technology offers organizations the opportunity to reshape business processes beyond the boundaries of their own organizations so that instead of static models, modern era incurring dynamic workflows which can respond the changes during its execution, provide necessary security measures, great degree of adaptivity, troubleshoot the running processes and recovery of lost states through fault tolerance. The prototype that we are planning to design makes sure to hold reliability, security, robustness, scalability without being forced to make tradeoffs the performance. This paper is concerned with design, implementation and evaluation of performance on the improved methods of proposed prototype models based on current research in this domain.

Keywords: Mobile agent; security; control flows; prototype models

I. Introduction

Shared business processes among multiple organizations bring up this unique notion i.e. from Workflow management systems (WFMSs) to the world. This paper draws the attention on current research paradigms, flaws and improvements on prototypes. Workflow management systems have significant contribution on mobile agent technology that automates business processes to improve the mobility, reactivity adaptability and manageability of an organization's business flows. Research on this technology makes fascinating as agent technology in designing collaborative workflow can provide overhead envision of benefits.

Highlights major key points

1. Interoperability and communication pattern among the agents.
2. Appropriate mobility ontology
3. Workflow coordination mechanism and Agents integration mechanism
4. Exception Handling and Recovery of failed agent states
5. Security concerns intra and inter agent business processes of organizations
6. Extended to complex and heterogeneous distributed networks
7. Effective distributed programming languages to analyze the controls flows

II. Related work

Chebbi et al [1] presented important steps to provide support for inter-organizational workflows in cooperation. The relevance of inter-organizational workflows is best seen when considering emerging virtual organizational forms, consisting of geographically dispersed teams and their respective business processes. However, which allows for partial visibility of workflows and their resources, thus providing powerful ways for inter-organizational workflow configuration. Hagras et al. [2] defined the soundness of the inter-organizational workflow i.e global and the local workflows successfully. Wombacher and Aberer [3], Wombacher [4] has implemented an approach of a decentralized solution that relies the soundness of a constructed view based on the local workflow combined with the party's view on the global workflow, which is not specified explicitly. In particular, the local workflows are extended by bilateral interactions they are involved in. Amor et al. [5] explained the production of maintainable and how a reusable agent depends on the agent architecture. As most of the commercial agent toolkits provide an Object-Oriented framework, where agent architecture does not facilitate separate use or reuse of the domain-specific functionality of an agent from other concerns. Amor et al. [5] also explained that Malaca supports the separate use of the domain-specific functionality of an agent from other communication concerns, which providing explicit support for the design and configuration of agent architectures and allows the implementation of agent-based software so that it is easy to understand and reuse properly. However, Malaca is implemented in Java and the coordination part interprets in finite state machine (FSM) specified in ProtDL but is implemented in Jess [6]. Whereas, the COTS

components supported by the current implementation can be developed in Java, EJB [7] or may be Web service.

As mobile agent (MA) programming standard are still deficient due to several mobile agent platforms with different design and implementation procedure makes the services diffused [8]. Apart from the security point of view mobile agent technology claims that interoperability between legacy systems MAs and heterogeneous MA platforms is a major obstacle to the MA diffusion [8]. Philips et al. [9] proposed orchestrating services in nomadic or mobile ad hoc networks challenge as these environments are built upon unstable links because mobile devices are exposed to network failures and may be considered the rule rather than the exemption. Therefore, Philips et al. [9] proposed a dedicated workflow language built on top of an ambient-oriented programming language that supports discovery of dynamic services and communication primitives flexible to network failures and finally the proposed workflow language has support for high level workflow abstractions for control flow, dynamic data flow between the services in the environment rich network and service failure detection, failure handling through compensating actions respectively. The addition of these intentional descriptions also gives rise to the need for compensating actions when constraints are violated and want to enable writing constraints for groups of services by writing logical rules in Crime [10], a logic-based coordination language developed by Philips et al. [9].

Spyridon et al. [11] presented a two-layered Workflow Management System (WfMS) approach that resides both on the platform services layer but within virtualized environment by taking into consideration service-oriented applications. As Workflow Management subsystem plays a central part [12-15] in the context of Cloud ecosystem with stringent time requirements. Therefore, any workflow management system targeting the area of soft real-time applications must be supported the components into a complete workflow or modeling of application modules that takes into consideration Quality of Service (QoS) requirements, while being able to dynamically react either by the user or the platform.

Karsten et al. [16] discussed regarding privacy-requirements of the involved workflows and their mutual dependencies. As workflow views are a promising approach to address the issue of privacy, however this approach requires interdependencies between workflow and adjacent private workflow. Karsten et al. [16] also clearly explained the difference between tightly couple private workflow and workflow view with state dependencies at the same time described the loosely couple workflow views with control flow dependencies and considered the interconnecting business process across system and organizations. However, business process gave significant benefits such as: higher degrees of integrations and higher throughput in a particular time interval.

Papazoglou et al. [17] explained how workflow systems increased attention of the enterprises by smoothen the business activities. As automated support system and operational models was allowed the workflow applications to multiple servers according to business rules and routes. The researchers also explained the Transaction-Oriented Workflow Environment for programming workflow activities. The basic concept used in the Transaction-Oriented Workflow system is based on the symbiosis of object-oriented programming and inter-process communication concepts. However, traditionally workflow systems have used only office functions and procedures. Hence, descriptions were generally based on extensions of well-known formal models such as Petri-nets, production rules, and flow-chart [18]. Similarly, Waechter and Reuter [19] proposed the contract transaction model for advanced database.

Kyriazis et al. [20] explained the computational intensive problems in a reliable and cost-effective way for Grid environments because workflow systems carry more complex and critical applications as quality of service serves to predict each application should closely meets user requirements. Based on the above concept a new novel algorithm was presented which allows the workflow processes to grid provided services by assuring the user defined parameters and preferences and finally demonstrated the operation of the proposed algorithm effectiveness using Grid scenario based on a 3D image rendering applications. However, in Grid environments, the workflow can be defined as the orchestration of a set of activities to accomplish a complicated goal along with application processes, business processes and infrastructure processes [21]. Another group [22-25] proposed the important and generic capabilities supported by well-recognized complete workflow systems such as workflow design, workflow execution, workflow repositories, workflow scheduling, fault tolerance, and data management respectively.

Ludascher et al. [26] explained scientific workflow management and the kepler system for scientific communities by sharing their data and computational services, and are thus contributing to a distributed data and computational community infrastructure. However, this infrastructure is only a means to an end and preferably scientists should not be too concerned with its existence.

Zhang et al. [27] proposed a hybrid re-scheduling mechanisms for workflow applications on multi-cluster grid system. As grid computing is possible computational paradigm for executing large

scale workflow applications. Therefore, the aspects of performance optimization may be remained a challenging task for future researchers. Hence workflow scheduling mechanism was one the most practical techniques for workflow applications. As most of the work on static scheduling approaches for workflow applications are in parallel environments only and very few work has been done on a real-world multi-cluster Grid environment.

Sánchez et al. [28] explained how parallel computing has been radically evolving now a day from super computer multi-processor in view of the modern distributed approaches and they proposed an improved technology and reusability of grid like parallel computing architectures. As agent based architecture is able to manage parallel task independently one or more heterogeneous computer networks. It has also been comprehensively tested using a complex problem for large-scale web knowledge acquisition. Joseph & Fellenstein [29] clearly explained grid like computing architecture for medium sized tasks with minimum overheads. However, in comparison to other reported approaches, the benefits offered by the designed platform are more flexibility. However, on the contrary to some other related approaches (Fukudaet al. [30]) which propose an ad hoc design to solve concrete problems and the platform components have been designed in a generic way by allowing to model easily in different problems. As components can also be fined tuned to adapt the system's behaviour to the concrete characteristics of the tasks to execute, potentially improving the performance.

Papadakis et al. [31] explained briefly how a mobile agent technology is an important technique for large scale network-based system structures and also proposed a Java-based agent environment which integrates agent execution platforms into World Wide Web server's by promoting a worldwide infrastructures for Mobile Agent. The development and validation of new system which commercially significant for multilingual premium services mainly focused on thin clients like mobile phones and personal digital assistances.

Aalst [32] studied loosely coupled inter-organizational workflows system by crossing organizational boundaries in the modeling and analyzing workflows environment. As inter-organizational workflow offers companies the opening to reshape business strategy beyond the limit of their own organizations and addressed two important questions one what are the minimal requirements any inter-organizational workflow must be satisfied and the second one how does one decide whether an inter-organizational workflow modeled in terms of Petri nets, is consistent with an communication structure through a specified message sequence chart. However, for an organizational workflow let composed of n local workflows we need to find out the liveness and boundedness for n+1 workflow (WF) nets and developed a tool, namely Woflan [33], to verify soundness. As Woflan can interface with several workflow products and can be downloaded via the word-wide-web (WWW).

Similarly, Feng and Cai [34] developed a coordination in mobile agent-based distributed job workflow execution system and ensuring that an agent executing a subjob can locate its predecessors execution results. First, arrangement of the existing execution coordination techniques is developed for mobile agent systems and secondly put the discussion into perspective framework for mobile agent-based distributed job workflow execution over the Grid is described. Finally, a predictive study has been conducted to evaluate three coordination techniques using real and simulated workflows job. Feng et al. [35] discussed all the three steps (i.e design, implementation and evaluation of algorithm) for communication partner classification in mobile agent based distributed job workflow execution. They initially describe a framework for distributed job workflow implementation over the Mobile Code Collaboration Framework (MCCF) and then design a subjob grouping algorithm for preprocessing the job workflow's static specification in MCCF. Finally the desired output is used in both static and dynamic algorithms to identify partners for agent communication. However, Brazier et al. [36] proposed the migration of mobile agents in heterogeneous environments. As Mobile Code Collaboration Framework is such a system that supports distributed execution of job workflows. The Light weight Mobile Agent (LMA) and Code on Demand technologies is implemented in the assembly of the MCCF. However, LMA in the MCCF is using *agent core* (AC) and AC is like a blueprint [36] which is transferred amongst computational resources. Therefore, agents are created on its behalf and carry out the required work where AC may be replicated when required. Similarly, Chen and Hsu [37] analyzed the static partner algorithm and the experiments, whether or not redundant partners need to be included depends on the topology of the workflow. They believed that the partner identification algorithms may be used to support other mobile agent communication methods and considered that the preprocessing based partner identification algorithms can be used in other applications areas such that that inter-enterprise business process management [37] that required distributed execution of workflows. Hence, after further investigation the number of AC replicas and subjobs assigned to an AC replica will affect the communication as well as the execution cost. Mobile agents act as the task executors in migrating workflow system when the size of workflow is

increased by including many tasks and branches, when multiple mobile agents may be used each agent is responsible for a branch of the workflow process and fulfills the workflow goal by cooperating with its partners [38]. However, when the workflow process needs partitioned into a set of sub-processes before execution each sub-process can be assigned to any one mobile agent. The former partitions a structured process into a set of sub-processes with central relations and each sub-process consists of a sequence of tasks. The latter distributes QoS objectives, such as the expected deadline of the total workflow, over all of the sub processes. The experiment analysis showed that the effects of workflow partition method and Markov Decision Process (MDP) based process planning method are sounder as compared with other processing methods.

Yang et al. [39] describes that an implementing of a multi-agent architecture to support enterprise notions in the principles of intelligent systems design and the multi-agent architecture applied to the workflow management system in ASE (Advance Semiconductor Electronic) Inc., which is the world's known largest provider of independent semiconductor for manufacturing services in assembly and test. Therefore, the proposed Foundation for Intelligent Agent (FIPA-OS) autonomous workflow management system uses a workflow co-ordination mechanism and an agent integration mechanism to enable the routine daily jobs error handle. Our vision for extending the FIPA-OS architectural elements to cover the development and implementation of generic web-Centric collaborative applications concludes the paper. The major contribution in is the development of novel multi-agent system architecture for enterprise and its application to a collaborative workflow management system in ASE, an instance of inter-enterprise collaboration with a proof-of concept prototype to simulate the order entry. The proposed approach is particularly suitable for integrating the FIPA-OS agent framework and enterprise software existing within an organization or among collaborative units. Finally, an efficient integration of multiagent workflow management, namely the FIPA-OS agent frame work with real-time behavior in an enterprise environment. Now-a-days workflow management system has successfully been implemented to monitor and control business design processes [40]. As major of factors have continuously changes based on the market requirement such as: components required more efficient, flexible and competitive, marketplace goods, design of integrated circuits etc. Therefore, the agent based workflow management systems have successfully been used to monitor and control business design processes effectively. In this paper, intelligent agents are applied to the collaborative system-on-chip (SoC) design environment [40]. Therefore the JADE-based autonomous workflow management system (JAWMS) uses a workflow coordination mechanism and the integration mechanism to enable this analysis. The agent integration mechanism supports an agent to network with other JADE-based agent platforms to coordinate and monitor workflow coordination messages properly. The use of the workflow definition template based on workflow metadata ontology increases the system flexibility.

Wu and Zeng [41] described the interrelationship between goals description and its applications in migrating workflow system. However, goal described only the states that an agent would like to realize, is an important concept for intelligent agent systems and the representation of goals ability to reason about them are the major problems in goal-oriented analysis. As goals are more stable than other abstractions the description Logics (DLs) is a formal tool of knowledge representation and reasoning. In addition, goals logic, particularly goal matchmaking in GDLs, is studied using its effective judgment to concept subsumption. However, there are several works still concerned with defining appropriate frameworks for advanced, intelligent, and automated problem solving using goal-driven architecture [42]. Hindriks et al. [42] also developed an agent programming language called GOAL (Goal Oriented Agent Language). They also provided a logical formalism, set of formal semantics and a programming language that correlates the logical formalism to the programming language.

Gotthelf et al. [43] discussed the multicast services for mobile software agent platforms in a decentralize ways. However, for the above analysis there is no need to required heavy bandwidth and the types of applications required to cooperate in a fair and decentralized ways. Gotthelf et al. [43] developed Group Management Agent Cast (GMAC) was an overlay multicast network for mobile agent platforms on the internet and compared the GMAC with other approaches that GMAC is a scalable and robust solution to provide multicast services in a decentralized way to mobile software agent platforms. Now-a-days the term P2P (Peer to Peer) networks [44] is successfully attract the attention of the Internet community. However, GMAC works in a completely decentralized way and building an overlay network in a binary tree form. Therefore, tree is required to establish first then the internal nodes forwards incoming messages to their neighbors. This approach is only possible since the recursive nature of the binary tree allows the ascending control message heuristic. Hence a parent node receives only one control message from each child node and summarized the control state information of that entire branch. Hence, upward nodes are not overloaded by control messages. In contrast, most

scalable self-organizing P2P approaches do not have a defined overlay network structure that could instrument a similar control message scheme effectively [45-49].

Vivas et al. [50] discussed regarding the security framework to develop the generic grid platform for Grid Enabled to Rich Media Content (GREDIA) European project. Again Vivas et al. [50] followed *Open Grid Services Architecture* (OGSA) standard in order to get better design in security framework by using grid security infrastructure (GSI). However, GSI already consists of some of the most important security services that are required for ensuring better security in grid environments, but others must implement by the developers. Whereas GSI is the part of the Globus Toolkit that must be implemented security functionality.

Manzoor and Nefti [51] explained the agent based system for activity monitoring network to monitor the resources over a network. As monitoring resources over a network a suitable campus area network is required because network recourses is a challenging job for an IT professional however it may be difficult humanly. However, multi-agent system is composed of several different agents that collectively capable of achieving goals which are difficult to achieve by an individual agent or monolithic system. Hence, multi-agent system is fully self-directed and initialized with the given rules and domain knowledge activity monitoring on network (ABSAMN) manages resources on its own with the help of mobile agents by evaluating this architecture on the university campus having seven labs equipped with 20–300 number of PCs in various labs. Results were very promising and support the implementation of the solution. Bellifemine et al. [52] suggested that agent technology is considered to be one of the most innovative technologies for the development of distributed software systems and it was not yet a mainstream approach in software engineering at large scale. As agent technology has been done lot of work and many research applications have been presented. One of these is JADE, a software framework that facilitates development of interoperable intelligent through multi-agent systems and that is circulated under an Open Source License. However, JADE is a very mature product, used by a heterogeneous community of users both in research activities and in industrial applications. Whereas, artificial intelligence (AI) tools are the conviction of the benefits of AI and agents is more consolidated in the scientific community than in the industrial one. The reasons for that are outside the scope in this research and have been plentifully treated in several other fora. While not yet a mainstream approach in software engineering at large. JADE can be arguably considered as the most popular software agent platform available today.

Wang et al. [53] proposed a novel ambient intelligence (AmI) platform to make possible for integration of different control algorithms, device networks and user interfaces. This platform explains the overall hardware/software architecture and communication standards. As ambient intelligence consists of four different types of layers such as the ubiquitous environment, middleware, multi-agent system and application layer respectively. However, the multi-agent system is implemented by using Java Agent Development (JADE) framework and allows users to incorporate multiple control algorithms as agents for managing different tasks. The real time performance analysis shows that the potential of the proposed AmI platform to be used in real-life AmI applications only.

Crasso et al. [54] explained the repository of static data and the worldwide network information and services formally known as the Semantic Web gradually improves the Web. This environment autonomously interacts with Web-accessible information and services through programs. As mobile agent technology should help efficiently exploiting in new Web in a fully automated way such Semantic Web resources are described in a computer-understandable way. In addition, its semantic match making and discovery support helps the agents to find autonomously and invoke Web Services. However, Zunino and Campo [55] explained that meeting scheduling is a time-consuming and tedious task that often involves negotiating conflicting interests among groups of people. Therefore, Chronos: a multi-agent system that helping the users in organizing their meetings and system assigns an intelligent Organizer Agent to each user. These agents are able to program the events between the negotiating time, place, day, etc. according to users' habits and preferences. However, Chronos agents do not reveal users' habits or calendars to other users in order to maintain privacy. Thereby, a software agent may be able to autonomously interact with Web Services or any kind of Web resource.

Wray et al. [56] explained autonomous systems require not only large knowledge and knowledge sharing and they also require efficient run-time performance. However, Ontologies give useful technology to organize and manage large-scale knowledge bases and enabling interoperability in heterogeneous agent environments. Wray et al. [56] also combined ontology representations and tools with agents optimized for better performance and capitalize on the strengths of the individual approaches to reduce their weaknesses. The main strategy is to use automatic translators that convert ontological representations to agent representations, hand coded agent knowledge for ontological

inference, and explanation-based learning to cache ontological inferences. As Ontologies [57] is the vital tool for addressing the limitations of procedural systems and the specifications of the terms used in a particular domain and their relations to other terms. Fortino and Russo [58] presented the effective analysis, design and implementation of distributed software systems to demonstrate the agent-based computing paradigm, e-Commerce, content management and distributed information retrieval etc. However, few of them among provide effective substantiation methods to analyze the design objects at different degrees of refinement before their actual implementation and deployment. However, ELDAMeth is a simulation-based methodology for distributed agent systems (DAS), which enables rapid prototyping on visual programming, validation, and automatic code generation for JADE-based DAS. The grid vision, of sharing diverse resources in a flexible and secure manner strongly depends on metadata [59]. However, now-a-days grid metadata is generated to use in an ad-hoc fashion which much of it buried in the grid middleware code libraries and database schemas. This ad-hoc expression and the use of metadata cause chronic dependency on human intervention during the operation of grid machinery. Therefore, Semantic Grid is emerged as an extension of the grid which is rich in resource metadata exposed to handle explicitly, and shared via grid protocols [59].

José et al. [60] discussed the model-driven engineering techniques for the development of multi-agent systems. Model-driven engineering (MDE), implicitly based upon meta-model principles and is gaining more attention in software systems due to its inherent benefits. However, MDE is normally used to improve the quality of the developed systems in terms of productivity, portability, inter-operability and maintenance. Therefore, its exploitation for the development of multi-agent systems (MAS) emerges in a natural way. As agent-oriented software development (AOSD) and MDE paradigms are fully integrated for the development of multi-agent systems whereas, meta-modeling techniques are explicitly used to speed up the several phases of the process effectively. Corradini and Merelli [61] reported that Hermes is a middleware system for execution of activity-based applications and for designing distributed environments. It supports mobile computation as an application implementation strategy. As middleware system used for mobile computing that has been developed to support physical and logical mobility. Hence, Hermes provides an integrated environment where application domain experts can be focused on designing activity of workflow and ignores the topological structure of the distributed environment. Mobile agents are used to trace products and support self-healing. In the bionformatics domain, mobile agents are generally used to support data collection and service discovery, and to simulate biological system through autonomous components interactions.

Meng et al. [62] describe in this work how ad-hoc workflow, mobile-agents and service brokering participate synergistically in realizing the e-business processes. Unfortunately, there is no easy way to correlate these related services together to fulfill an e-business opportunity. As ad-hoc workflow reduces to a great extent which is requirement for a workflow designer. The combined use of mobile agents, business rules, and brokering service makes the ad-hoc workflow agreeable to dynamic change. It also provides the needed flexibility that would allow different, non-interoperable service providers to participate in a workflow instance autonomously, and without totally understanding the workflow technology.

Merz and Lamersdorf [63] discussed about Common Open Service Market (COSM) infrastructure and which allows business applications to cooperate on one side but also to preserve their local autonomy on the other. Hence, Merz and Lamersdorf [63] chosen mobile agent approach for flexible market-oriented which in integration of commercial services on the basis of the COSM infrastructure and further discussed on the basis of a representative application design options for a possible implementation of such a workflow environment that is based on an MA platform. Finally, mobile agent approach helps to break up domains of conformance for closed distributed applications. As MA infrastructure has already been implemented based on several publisher Common Open Service Market (COSM) concepts and components such as the generic client, the service representation, the catalogueservers, etc. The integration of additional security mechanisms such as non-repudiation services or the support electronic payment functions is a current subject of research that is discussed by Merz et al. [64] and Merz et al. [65] in two platforms. However, MA-based Workflow management infrastructure of COSM mainly lacks a flexible, individual implementation of application code etc. But the only existing application servers are accessible and coordinated by the mobile agent framework of COSM and additionally, the local agent code for user interface control, computation results are synchronization that has to be externalized to these application services as well. Another shortcoming of the current implementation is the entire transparency of the information contained in the service representation. This concerns both control flow description and data. As a solution, Java's flexible binding and loading mechanism combined with the given distribution transparency allows us a smooth transfer of code. However,

possibilities exist to accomplish this: Either Java abstract machines need to be enhanced for a persistent execution management [66] or Java libraries need to be further developed. So that which allows application programmers to define constant objects as well as a suitable migration mechanism [67].

Bubendorfer and Hine [68] discussed a novel solution to the design of a distributed location service for large scale mobile object systems and to optimize the distribution of the location tables, limits the impact of the majority of up dates to these small and infrequently mobile data structures. Now-a-days services are provided in an ad hoc fashion in a fixed location, which users locate and access manually. However, mobility adds a new dimension to the location of such services in a global environment. Therefore, most of the systems supporting mobility rely on some form of home-based redirection which results in unacceptable residual dependencies. As 'Nomad' is a middleware platform for highly mobile applications and the significant contribution of the Nomad platform is a novel global object location service that involves the participation of both applications and global structures.

Fischmeister et al. [69] described the research effort to design and implement security middleware for mobile code systems in general, mobile agent systems in particular and security issues in mobile agent systems. The basic focus was to understand and evaluating the security mechanisms of existing mobile agent systems. The evaluation was performed by deploying several mobile agents systems in a test bed network, implementing attacks on the systems, and evaluating the results. In addition, the use of a reference model highlights the security abstractions available in the different languages. Complex applications may be required for sophisticated security abstractions such as policies, different types of principals, and so on.

Jingshan et al. [70] discussed on the security of mobile agent in the grid environment not only has the great significance in theory and technology, but also has a wide application prospects and value in use. Also introduced a method for authenticating mobile agent based on chain of one-way signature function to carry out security authenticate by enabling trust relationships between agent platforms. It can avoid mobile agent platform being attacked by malicious agent in grid environment. However, due to hardware constraints, they do not conduct joint testing on dynamic planning mechanisms and authentication protocols.

Akilandeswari and Gopalan [71] discussed on the work related to hidden Web, the architectural framework of the crawler, experimentation and evaluation details. The evaluated results show that the crawler is able to perform efficiently by focusing the search in particular domain and also able to learn effectively to reduce the time consumed in retrieving searchable forms. The coordinating agent in the model can be built to incorporate fault tolerance mechanism too gracefully and shut the multiple crawling agents in case of network failure, agent failure.

Zhang et al. [72] introduced a new mobile agent and Web services security architecture where this security architecture employs a novel identity-based public key system to provides a new authentication protocol without using the username/password pair, which is infeasible for mobile agents, and gives an alternative method to current security mechanism without using the Certification Authorities (CA) based public key infrastructure. This scheme provides an alternative to the current scheme without using Certification Authorities (CA) based-public key infrastructure. It can simplify the key management and reduce the computation particularly for group-oriented web services.

Padalkar et al. [73] introduced the design and implementation of SWIFT course registration system and discussed a brief performance analysis of mobile agents based workflow system. As most of the software solutions for workflow management systems do not model the real world situation perfectly. Moreover, the changes in the workflow result in many modifications to the application only. However, Mobile Agent paradigm not only provides a richer model for workflow systems that better resembles the real world scenario but can also be used to incorporate changes in the workflow in an elegant manner and introduced a prototype of workflow system by using mobile agents. But as far as security is concerned critical workflow systems remains a major problem.

Bouchoul and Mostefai [74] discussed three main points regarding multi-agents technology how can offer good solutions for modern workflow systems, complex formal verification and rewriting logic and The *MAUDE* language. As these systems are so complex so that the usage of formal tools for verification, simulation and prototyping to facilitate their design and their validation is essential and of great interest. Therefore, they established improved methods to insure the reliability, security and robustness of different components of automated business processes systems (workflows). As the demand for Workflow Management Systems (WfMS) continuously improving, improved coordination / efficiency and greater control across business processes. Heery [75] discussed mainly on the specification of static process to success in straight-through processing environments and to cope with the market shift towards human-oriented workflow, which demand more dynamic workload management capabilities as well as better knowledge

of organizational structures and resource suitability. The system is established in view of a prototype for the investment dealing domain, built using the Agent Factory platform, CARTAGO for the provision of a shared workspace, and introduces a new XMPP-based Message Transport Service (MTS) for agent communication and presence awareness. From this evaluation concluded that the system delivers notable efficiencies in human-oriented workflow management as well as providing useful information regarding the remaining obstacles hindering agent adoption in industry for workflow management [75]. However, Novel Workflow Management Model Based on Mobile Agents for Internet Electronic Commerce has gain immense attention to present market. Because workflow management is regarded as an effective mechanism for managing business processes behind the electronic commerce. However, today's workflow management model has many drawbacks in this field [76]. This gives a novel workflow management model based on mobile agents for Internet electronic commerce. However, another group [77] was working towards solving this problem by developing software agents based provenance model with mobility because it provides seamless automation and autonomy to the activity. Researchers in [78] proposed that mobile agents reduce the network load and enables execution autonomously in heterogeneous environment by encapsulating protocols. Whereas, *a* multi-agent based workflow management systems in grid environment as data architecture provenance models are designed for specialized domains which make them vulnerable for semantic grids which propose to use the services for all in seamless manner. The proposed model can work on generic data sets and the use of mobile agents makes it robust in simultaneous recording of provenance by different nodes. We have proposed to use tree based structure for storing the provenance. The model mainly based on Java based Aglets for mobile agents, dot Net based. Whereas, Semantic Grid is considered as an extension of current grid in which information and services are given well defined meaning. The integration of Grid with semantic web [79] provides simple and seamless automation which enables flexible collaboration and computations on global scale among projects of distinct domains. However, a robust dotNet based Agent platform will help to integrate the two technologies tightly to improve the processing efficiency. Most of the tests are needed to test it on large number of nodes on global scale. The only performance bottleneck is the centralized archive which can be solved by distributing it to among other nodes [80] provides some algorithms in this regard. However, the minor issues related to synchronization area of distributed systems [80] are required to solve, so that the model is dependent from unique ID of data and processes in the whole system with correct time stamp. There are some cases of recording similar time stamps by two nodes in our system. It is therefore required that data items are preoccupied at certain level to reduce complexities of the system. Gordon [81] suggested a new approach to use genetics algorithm for optimized traversal that will work on bit patterns. Similarly, Willard [82] proposed trees in a trie data structure that will improve the efficiency of tree traversal algorithm and the proposed model presented on the basis of ongoing research in the area of data provenance for Semantic Grid to maintain trust among nodes. As extensible Java-based Agent Framework (XJAF) is a pluggable architecture of the hierarchical intelligent agents system with communication based on KQML [83] and the workflow management system are implemented using mobile agents. It is generally suitable for highly distributed and heterogeneous environments. Dragoslav et al. [83] proposed that the workflow is concerned with automation of procedures where documents, information or tasks are approved between participants according to a proposed set of rules to achieve overall business goal effectively. Therefore, the entire user take care only work-agents which are currently on its node. Another group [84] applied another method for modeling workflow processes using a Petri net based multilevel formalism, which yields modular and hierarchical descriptions of the organization, the processes, resource management and finally the user interactions. The models allow the synthesis of agent based software in which mobile agents guide the cases through organization units. Therefore, modeling and simulation play an important role during the earliest stages of the developing life-cycle of workflow management systems. Similarly, Cao et al. [85] explained that workflow management systems (WfMSs) are software systems used to automate, coordinate and streamline business processes of organizations. Most of the existing research on WfMSs has been focused on well-structured and well-behaved business processes. However, its importance has been recognized and the handling of workflow exceptions has been tackled by the workflow community. Therefore, Cao et al. [85] classified the workflow exceptions into hierarchical levels and the corresponding design of different types of exception handling mobile agents and their cooperation. A prototype of the mobile agent-based workflow exception handling mechanism has been demonstrated by using the IBM Aglet platform. Therefore, an organization's mobile workforce is a vital and it is in the front line liaising with customers and also driving the sale of an organization's products and/or services. The mobile workers operate in an unreliable environment so that differing their types of support [86].

III. Concluding summery and future scope

Based on the above literature survey the following points have been drawn to improve the research procedure and methodology. The following points are as:

3.1. Why we need this

Today's date Mobile Agent Plugins/ workflow management is spreading its major significance inside the mobile agent (MA) domain but no specific plug-ins which can address almost all problems in among/between the mobile agent controls flows explicitly. Instead of overburdening the existing MA architecture, it will facilitate the processes which can serve better multiple organization. The main focus to make such dynamic workflow \ plug-in to stand by agent's end to end flows in distributed environments.

3.2. Current Hurdles

1. Failure to measure the different organization requirements and its usage
2. Lack of support on interoperability for different agents emerged from diverse MA frameworks
3. To make robust or dynamic Plug-ins/workflows
4. Dynamically co-Agent Identification to share their respective objects

3.3. Key Prospects behind This Design and Research

1. This architecture should be more generic type and dynamic to situation.
2. Going to Support multiple MA platforms. I.e. to support distributed and heterogeneity.
3. It can extend its functionality support either internal or external to mobile agent system.
4. Bringing the interoperability model among different agents developed by using diverse frameworks.
5. Stop overburdening frameworks now, smart to bring up Flexible plug-in design into MA domain.
6. Dynamic mechanism to determine protocols needed to communicate.
7. Understanding agents requirement and mapping to state Client map.
8. Builds the schema to full fill demand and supply chain for agents.
9. Troubleshooting through its intelligence procedures and facilitates through its design route and recovery of agents execution failures
10. Focus on security aspects when other agents start consuming Flexible plug-in Schema client
11. Communication protocol between intra components inside the client to preserve state of agent
12. Dynamic runtime service building to support communication pattern of heterogeneous and distributed environment
13. Implementation of Fault injection and Fault tolerance to access the models

3.4. Constraints/face-off on this architecture

1. Identify correct Inter agent communication protocol
2. Core design and its implementation
3. Interoperability among MA architecture.
4. security in inter workflow and also among the intra components of business processes need to address properly
5. To support interorganisational Workflow with appropriate mobility ontology.
6. Workflow management system has to be scalable to meet the requirements of crucial changes of organization.

3.5. Betterment/Improvement

1. Performance Tuning of design prototype based on Applications
2. Simulation/Mocking of real time models to check responses.
3. Measurement of profitability and throughput of design prototype.
4. Exception handling, troubleshooting and fault tolerance to recover the failed states of agents.
5. Key parameters to performance of this design could be heightened.

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