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Context Aware Middle Layer Architecture for Service Discovery in MANETs

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Abstract - **In MANETs, Service discovery is considered to be a crucial entity since they don't possess a centralized infrastructure for communication between nodes present in the environment. In addition, the level of security varies for each and every variety of services provided by through the network. Hence, there arises a necessity for deploying an efficient adaptive intelligent context-aware approach omnipresent in each and every node existing in the ad hoc scenario enabling reduce the complexity in providing the services to the network users. In this paper, we formulate an Adaptable Intelligent Discovery of context-aware services framework (AIDCS) along with the context modeling approach in order to introduce a middleware-level method that support user-centric semantic service discovery process for mobile users. In our approach, we modify the identifying relation among the different context by introducing a middleware-level approach that implements semantic languages to model the properties of interacting entities and environment. The Profile Matching Engine (PME) supports a matching algorithm that performs the matchmaking process between the offered and requested capacity in order to determine the degree of semantic compatibility between user/device and service profiles. This algorithm provides user with desired service features along with the flexibility of matching according to user's preferences that provides the user with modified information on available services. The performances of AIDCS are studied with the help of evaluation parameters such as packet delivery ratio, throughput, control overhead, total overhead through ns-2 simulations by varying the number of compromised nodes. From the simulation results obtained, it is proved that the proposed mechanism performs well when compared to the other service discovery mechanisms available in the literature to a optimal margin.**

Keywords : AIDCS, PME, MAM, DYM, CONM

I. INTRODUCTION

Service Discovery requires higher degree of co-ordination providing co-operation among the mobile nodes in a MANET is a critical issue that is not explored by most of the researchers in the past decade [1]. This is due to the lack of central infrastructure and dynamic nature of the ad hoc network. If the nodes in an ad hoc environment deny cooperating, then the network performance degrades [2].

A. Context Aware Service Discovery

The term context can be defined as the information that is required to exemplify the situation of the entity. The entity here it is referred as a person, place things etc. This contextual information is obtained based on the interactions that occur between the user and application [3]. On the other hand, the context awareness can be defined as one of the characteristic of the system which utilizes the contextual information to offer the user desired service in an optimal way by incorporating the quality aspects. Similarly, context aware service discovery can be defined as the one which comprises of set of methodologies for searching and discovering the most relevant service for the users' request based on the obtained contextual information. The main objective of the context aware system is to meet the users requirements in an optimal way without their interventions. The design of the context aware systems primarily consists of two parts, viz., sensing part and adapting part [4]. The sensing part of the system senses the various context scenarios for service discovery and adapting part analyses the changes in the context scenarios according to the user requirements. This context aware service discovery also does the process of filtering the obtained service information according to the

contextual information for optimal service selection process [5]. This filtering process in the context aware service selection system allows only the transmission of the relevant data and services which results in two major advantages such as efficient usage of band width and cost effective processes.

In addition to the basic components such as sensors and actuators, the context aware system consists of the following components for its effective performance.

The components include a mechanism that does a processing with the output produced by the sensor which finally results with the contextual information. This contextual information is used in the application for the mapping process and the results of the mapping process are used to enhance the operation of the actuators.

A mechanism that stores the contextual information and retrieval of such information is enabled by means of the advance query functionalities. This component is named as the repository component.

A mechanism for identifying the environmental characteristics such as user's location, time information, the profile about the user etc., and communicating to the computing device which transfers the information to the user relevant to the current context[6]. This component also derives the name of the user, their objective of the work etc., by means of the mobile application. There are also some of the programming components which provide the application layer support to the context aware systems.

B. Middle Layer Architecture

The middle ware based context aware systems are implemented by means of the layered architecture. The main advantage of the layered approach is that the transparency feature adopted by the layers in this architecture. This feature enables in hiding the lower level functionalities and implementations from the high level layers. In contrast with the existing techniques, the middle layer architecture offers low level complexity in enhancement and provides hardware independent sensing code which can be reused. The functionality of the middleware includes service discovery, context information management, and network resources management, Designing of user interface and messaging in asynchronous mode.

The requirements of middleware based context aware system can be defined as follows.

1) Heterogeneity: The programming languages and networking interfaces must support various types of hardware components such as sensors, actuators, mobile client, and server etc., used by the context aware systems [7].

2) Mobility: All the components of context aware system could able to work properly in the mobile environment. This scenario makes the communication links to provide efficient routing mechanism for migrating the contextual information among the components. The environment formed here is structure less, so that new components can be added dynamically.

3) Scalability: The processing components and communication protocol can able to scale from few components to the more number of sensors, actuators and application components.

4) Privacy: The migration of contextual information from one component to the other component of the context aware system should be done according to the privacy policy [8].

5) Traceability and control: The state of art of the context aware system components and information transfer between the components must be well defined and traceable. This enables in finding out the errors during transmission and to control the users.

6) Fault tolerance: The failures like sensor failure or any other component failure, must be handled without the halting any of the operations of the context aware system [9].

7) Deployment and configuration: The hardware and software components of the context aware system should be easy to deploy and configure, even by the untrained users.

C. Issues of Context Aware Service

Some of the issues that are faced by the context aware service to provide a robust environment for the different application can be listed as below:

The following are considered to the crucial aspects of the context aware service in providing an efficient environment for the different application.

1) Failure in service discovery and reconfiguration: The entire

application may fail if it is failing to find the resources for the application and fail to find the services for context based reconfiguration.

2) Failure in Service – level binding: The binding of the application with an active space service may fail due to the network disconnectivity, service break downs and several re-invocations of services. This may disturb the tie up between user and current session with the service.

3) Exceptions at service level: Exceptional conditions may arise when there is a interactive session between user and the active session with a service. The cause for the exceptions may include access to resources through in compatible protocols, security issues in the applications and fail to execute the service oriented function completely.

4) The invalidation of context: Each and every context in an application is associated with the assertions. Assertions are conditional statements, which should be true during the execution of the application. The violations of assertions cause failure to the applications.

The rest of the paper is organized in the following manner. Section 2 details some of the related works on context aware service discovery and also enumerates the limitations of those works. Section 3 details about the proposed trust based mechanism for service discovery to facilitate a node to provide a optimal service to user. Section 4 presents the algorithmic steps for context aware service discovery using middleware architecture. The experimental study for the evaluation of proposed mechanism is illustrated in section 5. Results analysis and the Conclusion of the work are portrayed in section 6 and 7.

II. LITERATURE REVIEW

In the literature, researchers have proposed various trust based approaches for reliable service discovery for nodes which enables it to provide an optimal service for the user in the ad hoc networks. These approaches can be primarily classified in to two categories viz., first hand trust based mechanism and second hand trust based mechanism. Some of the works related to the above stated mechanisms are illustrated below.

Initially, Hua Xiao *et al* [10] has presented a context modeling mechanism that captures the potential services according to the user requirement based on context types and values. In this, authors have also used ontology to acquire the exact meaning of the user context values which enable to identify the relationship among the context values. The performance of the proposed mechanism is evaluated by means of a case study and results shows that the proposed approach finds the user desired services with high accuracy rate.

Further in 2010, Devdatta kulkarni [11] has proposed a forward recovery model for all types of context aware applications. This model comprises of two mechanisms viz., asynchronous event handling mechanism and synchronous exception handling mechanism. These mechanisms were designed to enable various kinds of fault tolerance actions to handle three different types of failure in context aware applications. The failure may be classified as service discovery failures, service composition failures, service exception failures and failure due to invalid contexts. These recovery approaches are integrated to build a framework for context aware collaborative applications.

Furthermore, Paolo Falcarin *et al*., [12] have proposed a framework for context data management based on open standards like XMPP and REST for context aware applications. This model has special features such as interoperability and domain independence in handling context data information. This model also proposes a context meta language for data representation and context query language for data filtering.

Incorporation of Quality in user desired service discovery has been initiated by Kyriakos Kritikos *et al* [13] in 2011. In this the requirements are analyzed semantically based on QOS web service description using WSDM. The service discovery is done by means of WSDi process. In addition, this paper also finds a way to provide solutions for QOS based web service composition and composition of service level agreements (SLA) with semiautomatic production and validity checking.

In addition to the above mentioned approaches, Dionisis athanasopoulous *et al* [14] has presented a new approach namely CoWSAMI. This approach enables the context aware solutions for the users in the frequently moving environments. CoWSAMI provides the dyamic methods

which could able to integrate the context sources arise at run time and to handle the moving users. This approach utilizes the web services as interfaces for context sources and vigorously modifies the views of contexts. This result in modification, storing, retrieving, analyzing and compiling contexts based on the interpretation of context rules.

Finally, Alessandra Toninelli *et al* [15] have proposed an approach based on middle ware level which enables web service discovery in a user centric manner. In this, AIDAS, the middleware is utilized for context aware service discovery. This context awareness is defined by means of the views of user, supported services by the devices and Meta data provided for the service. Furthermore, this paper also handles the challenging issue of providing resources in a unconstrained manner for portable devices. This results in computationally less complex methods in terms of both space and time for semantic based web discovery.

A. Extract of the Literature

The literature survey carried out for analyzing the pros and cons of the existing context aware service discovery schemes is considered to have the following shortcomings. They are:

a. Context aware middle layer architecture for enhancing service oriented communication are not much explored.

b. A framework which could predict a node's maliciousness during service discovery based on context i.e. the role played by each and every mobile nodes to provide some services to the user has not been proposed to the best of my knowledge.

These limitations of the existing service discovery architectures motivated for devising a context aware mechanism that helps in enhancing the process of service discovery by isolating the untrustworthy nodes during routing.

III. Proposed Solution

A. Overview

In this paper, we propose an Adaptable Intelligent Discovery of context-aware services framework for establishing service discovery in MANET in the presence of compromised nodes. The proposed Adaptable Intelligent Discovery of context-aware services framework works based on the level of the interaction and behavior between a user and a service by including the user and the facility offered in the network. Thus, the mechanism offers efficient middle layer architecture to enhance the service discovery in MANET and guarantees both reliability and security at hand.

B. Adaptable Intelligent Discovery of Context-aware Services Framework (AIDCS) for Service Discovery in MANET

AIDCS approach facilitates the possible middleware services that could be enabled by MANETs could be into two groups according to their logical context, one of them targeting at addressing specific management functions and the second one is the Discovery manager set, which consists of a set of mandatory functionalities for enabling service discovery based on considering both the information on user context and their choices of alternatives.

The configuration manager enables any mobile nodes to broadcast their route discovery packets to their neighbor nodes in order to discover zone based service provision and forward or relay packets based on that rule of trust.

The architecture consists of a Meta Manager (MAM), Discovery manager (DYM) and Context manager(CONM).in which, Meta Manager (MAM) the provides enough support for checking the level of confidence, integrity and semantics of service discovery prolonging in the ad hoc scenario. MAM also innovates thresholds of trust for the mobile nodes by specifying the mobile nodes profiles. The Discovery Manager (DAM) is mainly responsible for manipulating and storing the list of services that are said as accessible to the mobile users depending on the nodes context. In particular, among all the mobile services present in the network locality, The Context Manager (CONM) is responsible for calculating the user contexts for enabling the service discovery.

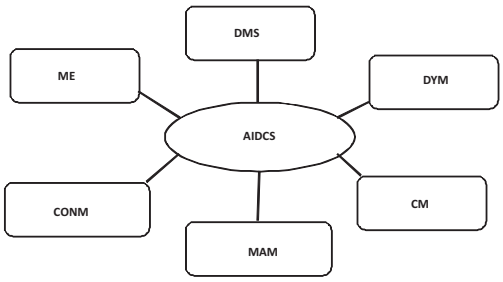

Fig. 1 AIDCS middle-layer architecture

The Matching Engine (ME) is mainly responsible for enabling the services based on the value called Adaptable

Intelligent Discovery of context-aware Coefficient (AIDCC). ME carries its function based on three scenarios, i.e., the first case when DM has to manipulate the context value, so that the mobile nodes could deliver visible services for each and every mobile users (i.e., the services whose profile is semantically compatible) ,when the QP could resolve any specific user request and for each request, the mobile nodes is verified by ME if the service profile contains one or more compatible capabilities.

IV. Adaptable Intelligent Discovery Of Context Aware Services Framework (aidcs) For Enhancing Service Discovery In Manets

Notations :
SRCN : The Source Node
DSN : The Destination nodes
AIDCC : Adaptable Intelligent Discovery of context- aware Coefficient.

1. The SRCN initially broadcasts the route discovery packets through all feasible paths in the topology.
2. The DSN acknowledges through route reply packets through backward routes established.
3. SRCN then forwards Data to DSN through optimal path established based on AIDCC computed for each and every Nodes acting as routers.
4. If (0.7 = AIDCC = .1.0) then.
5. Provide secure communication through middle layer framework.
6. If (0.3 = AIDCC = .0.69)
7. Provide non secure but critical communication through middle layer framework.
8. Else if (0 = AIDCC = .0.29)
9. Block service to the mobile nodes
10 Else if
11. Else if
12. End if

The provision of service discovery by a node depends on the computation of the coeffient called Adaptable Intelligent Discovery of context-aware Coefficient, which is based on the context or role of the mobile nodes participating in the ad hoc environment. If the value of AIDCC lies between 0.7 and 1.0, then,the secure communication is enabled through middle layer framework, if the value of AIDCC lies between 0.3 and 0.69,the architecture enables non secure but critical communication through middle layer framework. In the worst case, if the value of AIDCC lies between 0 and 0.29,then the architecture blocks the service to all other mobile nodes

V. Simulation Results And Discussions

The Context aware middle layer architecture for service discovery in MANETs is studied based on simulations carried out extensively with the aid of network simulator ns-2.26.Our proposed ad hoc environment consists of 50 mobile nodes deployed in a terrain size of 1000X1000 square meters. The results are computed based on the aggregate outcomes obtained from 30 simulation rounds. The maximum number of packets and the refresh interval used for carrying out our study are 1200 and 1 Sec respectively. The maximum size of the packet transmitted from the source node is 512 bytes with a channel capacity of 2 Mbps.

A. Metrics Used

The thorough experimental study and its analysis for the formulated Adaptable Intelligent Discovery of context-aware services framework for enhancing the degree of service discovery in MANETs were carried out based on the following network evaluation parameters.

1) Packet delivery ratio: Packet delivery is considered as the ratio obtained by dividing the maximum number of packets forwarded for the destination nodes to the actual number of packets generated from the source nodes for the destination nodes.

2) Control overhead: Control Overhead is considered to the maximum bytes of packets that are mandatory for enabling communication between the source nodes and the destination nodes.

3) Total overhead: Total Overhead is considered as the ratio obtained by dividing the aggregate sum of control packet and the data packet to the sum of data packets designated for the receivers.

4) Throughput: Throughput may be computed as the total

number of all the packets received by the destination node through the intermediate routers within an interval of time.

VI. DISCUSSIONS

Performance Analysis for Adaptable Intelligent Discovery of context-aware services framework (AIDCS) for service discovery in MANET:

i) Based on the number of malicious nodes'n' (Here n=10)

1) Packet delivery ratio: The performance of the Adaptable Intelligent Discovery of context-aware services framework degrades when the number of malicious nodes existing in the scenario increases. Since, the provision of service discovery by the mobile nodes in MANETS is inversely proportional to the number of selfish nodes existing in the environment. Hence, the need for the deployment of AIDCS arises. From the figure 1 it is obvious that the deployment of AIDCS in the AODV protocol shows a steady increase in performance in terms of Packet Delivery Ratio

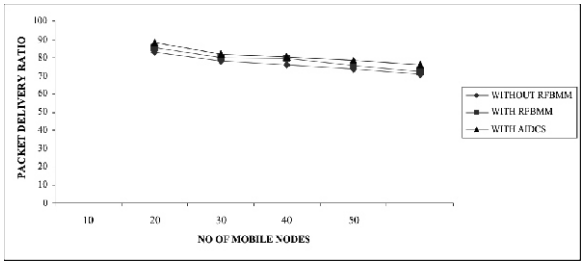

Fig. 2 Performance analysis for AIDCS based on number of malicious nodes with respect to Packet delivery ratio.

This Adaptable Intelligent Discovery of context-aware services framework when deployed exhibits a phenomenal increase of 12% in Packet Delivery Ratio.

2) Control Overhead: The Performance of Adaptable Intelligent Discovery of context-aware services framework is highly impacted in terms of control overhead when the number of selfish nodes existing in the scenario increases. Since, the performance of the framework evaluated based on the control overhead is directly proportional to the number of selfish nodes existing in the environment.Hence,a need for the deployment of AIDCS arises. From the figure 2 it is obvious that the deployment of AIDCS in the AODV protocol shows a gradual decrease in the control overhead.

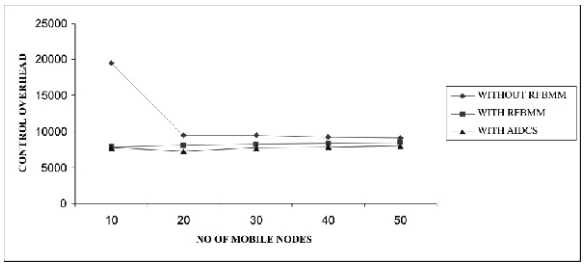

Fig. 3 Performance analysis for AIDCS based on number of malicious nodes with respect to Control Overhead

This Adaptable Intelligent Discovery of context-aware services framework when deployed exhibits a phenomenal decrease of 17 % in the Control overhead

3) Total Overhead: The Performance of Adaptable Intelligent Discovery of context-aware services framework is highly impacted in terms of Total overhead when the number of selfish nodes existing in the scenario increases. Since, the performance of the framework evaluated based on the Total overhead is directly proportional to the number of selfish nodes existing in the environment.Hence, a need for the deployment of AIDCS arises. From the figure 3 it is obvious that the deployment of AIDCS in the AODV protocol shows a gradual decrease in the control overhead.

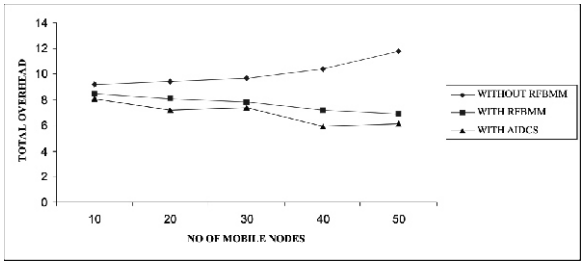

Fig. 4 Performance analysis for AIDCS based on number of malicious nodes with respect to Total overhead

This Adaptable Intelligent Discovery of context-aware services framework when deployed exhibits a phenomenal decrease of 31 % in the total overhead.

4) Throughput: The performance of the Adaptable Intelligent Discovery of context-aware services framework degrades when the number of malicious nodes existing in the scenario increases. Since, the provision of service discovery by the mobile nodes in MANETS is inversely proportional to the number of selfish nodes existing in the environment. Hence, the need for the deployment of AIDCS arises. From the figure 1 it is obvious that the deployment of AIDCS in the AODV

protocol shows a steady increase in performance in terms of Throughput.

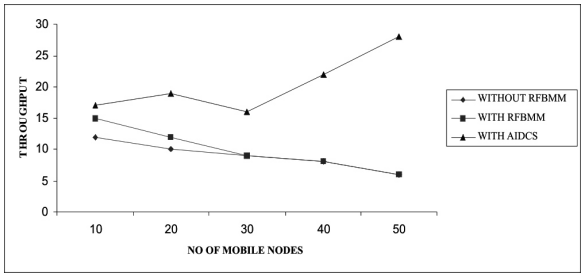

Fig. 5 Performance analysis for AIDCS based on number of malicious nodes with respect to Throughput

This Adaptable Intelligent Discovery of context-aware services framework when deployed exhibits a phenomenal of 24 % in Throughput.

ii) Based on the number of malicious nodes'n' (Here n=20)

1) Packet delivery ratio: The performance of the Adaptable Intelligent Discovery of context-aware services framework degrades when the number of malicious nodes existing in the scenario increases. Since, the provision of service discovery by the mobile nodes in MANETS is inversely proportional to the number of selfish nodes existing in the environment. Hence, the need for the deployment of AIDCS arises. From the figure 1 it is obvious that the deployment of AIDCS in the AODV protocol shows a steady increase in performance in terms of Packet Delivery Ratio.

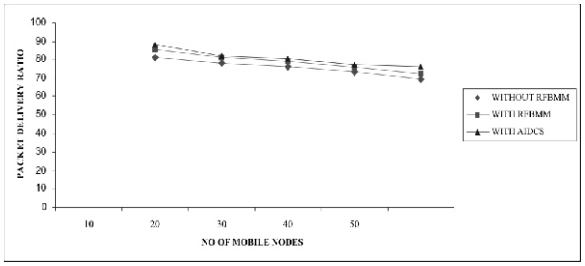

Fig. 6 Performance analysis for AIDCS based on number of malicious nodes with respect to Packet delivery ratio

This Adaptable Intelligent Discovery of context-aware services framework when deployed exhibits a phenomenal increase of 14% in Packet Delivery Ratio.

2) Control Overhead: The Performance of Adaptable Intelligent Discovery of context-aware services framework is highly impacted in terms of control overhead when the number of selfish nodes existing in the scenario increases. Since, the performance of the framework evaluated based on the control overhead is directly proportional to the number of selfish nodes existing in the environment.Hence, a need for the deployment of AIDCS arises. From the figure 6 it is obvious that the deployment of AIDCS in the AODV protocol shows a gradual decrease in the control overhead.

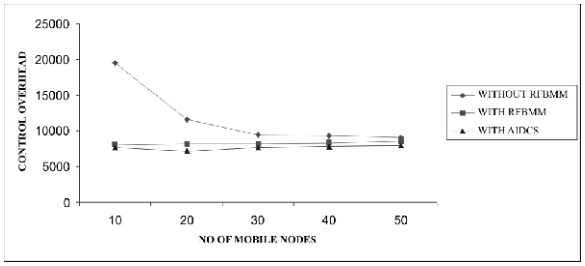

Fig. 7 Performance analysis for AIDCS based on number of malicious nodes with respect to Control Overhead

This Adaptable Intelligent Discovery of context-aware services framework when deployed exhibits a phenomenal decrease of 23 % in the Control overhead

3) Total Overhead: The Performance of Adaptable Intelligent Discovery of context-aware services framework is highly impacted in terms of Total overhead when the number of selfish nodes existing in the scenario increases. Since, the performance of the framework evaluated based on the Total overhead is directly proportional to the number of selfish nodes existing in the environment.Hence,a need for the deployment of AIDCS arises. From the figure 7 it is obvious that the deployment of AIDCS in the AODV protocol shows a gradual decrease in the control overhead.

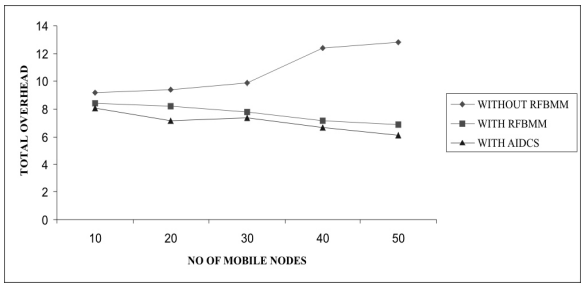

Fig. 8 Performance analysis for AIDCS based on number of malicious nodes with respect to Total overhead

This Adaptable Intelligent Discovery of context-aware services framework when deployed exhibits a phenomenal decrease of 15 % in the total overhead.

4) Throughput: The performance of the Adaptable Intelligent Discovery of context-aware services framework degrades when the number of malicious nodes existing in the scenario increases. Since, the provision of service discovery by the

mobile nodes in MANETS is inversely proportional to the number of selfish nodes existing in the environment. Hence, the need for the deployment of AIDCS arises. From the figure 8 it is obvious that the deployment of AIDCS in the AODV protocol shows a steady increase in performance in terms of Throughput

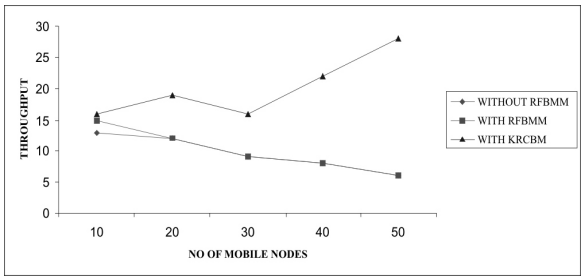

Fig. 9 Performance analysis for AIDCS based on number of malicious nodes with respect to Throughput

This Adaptable Intelligent Discovery of context-aware services framework when deployed exhibits a phenomenal increase of 24 % in Throughput.

VII. Conclusion

In this paper, we have presented an Adaptable Intelligent Discovery of context-aware services framework designed for service discovery in MANET, which is deployed in each and every node of the network. The performance of the proposed AIDCS designed for Service discovery outperforms other existing service discovery framework present in the literature in terms of network performance related metrics like Packet Delivery Ratio, Total overhead, Control overhead and Throughput. In the near future, new context aware service discovery architecture may be developed for enhancing the level of service discovery based on Probe packets.

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