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Urban Transportation Systems Using Cloud Computing

LINGAMANENI BHARGAVI[1], R. VIKRAM[2]
[1]Student, M. Tech (CSE), Narayana Engineering and Technical Campus
[2]Assistant Professor, M. Tech (CSE), Narayana Engineering And Technical Campus
Email: bhargavi.lingamaneni@gmail.com

Abstract: Intelligent transportation clouds could provide services such as decision support, a standard development environment for traffic management strategies, and so on. With mobile agent technology, an urban-traffic management system based on Agent-Based Distributed and Adaptive Platforms for Transportation Systems (Adapts) is both feasible and effective. However, the large-scale use of mobile agents will lead to the emergence of a complex, powerful organization layer that requires enormous computing and power resources. To deal with this problem, we propose a prototype urban-traffic management system using intelligent traffic clouds.

Key words: Adapts, Decision Support, Clouds

1. Introduction

A UTMC system shall have a documented architecture which includes:

In this system diagram based on and similar to the Logical Reference Model, indicating the physical components and connectivity between them. . A functional diagram based on and similar to the Functional Reference Model, indicating the applications and interfaces between them.

Logical Reference Model:

The Logical Reference Model describes a UTMC system as a series of interconnected nodes (see figure 1). UTMC nodes are defined as:

a. Node A: fixed gateways to external systems including other UTMC systems;
b. Node B: UTMC management centres;
c. Node C: UTMC outstations;
d. Node D: UTMC controlled units; and
e. Node E: mobile units.

The following restrictions on configuration shall apply:

a. there may be zero or more Nodes A;
b. there shall be one and only one Node B;
c. there may be zero or more Nodes C;
d. there may be zero or more Nodes D;
e. there may be zero or more Nodes E; and
f. There shall be at least one Node D or Node E in a UTMC system.

Node B may be physically distributed in several locations, but shall act as a single logical node. Node B will typically host a range of components and applications, including databases. Nodes C may be capable of acting autonomously taking higher level control decisions. Nodes C may be permanent or temporary installations.
Nodes D cannot act autonomously. Nodes D may be permanent or temporary installations. Nodes E may range from simple units to sophisticated units with local processing power.

There may be links between the following:
a. Nodes A and Node B;
b. Node B and Nodes C;
c. Node B and Nodes D;
d. Node B and Nodes E;
e. Nodes C and Nodes C;
f. Nodes C and Nodes D;
g. Nodes C and Nodes E; and
h. Nodes D and Nodes E.

Links may be one-way or two-way. There may be single or multiple logical channels per single physical

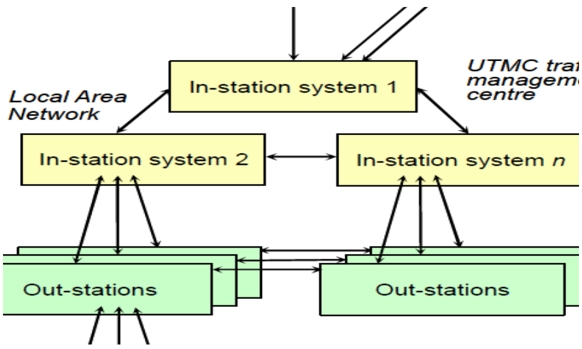

Fig 1: UTMC Node

Functional Reference Model:

The elements of the Functional Reference Model are:
a) User interface;
b) Applications;
c) System management services;
d) Communication services.

a) **Information Level** – Standards for the data elements, objects, and messages to be transmitted.

b) **Application Level** – Standards for the process and structure of information exchange, and of session management.

c) **Transport Level** – Standards for data packet subdivision, packet re-assembly, packet error detection and re-transmission, and routing.

d) **Sub-network Level** – This level provides standards for the physical interface and the data packet transmission method.

e) **Plant Level** – Standards for the physical transmission media.

2. Agent Based Urban Traffic Control

We propose a system that autonomously can adapt to changing environments. In that system we get an Urban Traffic Control system (UTC) based on agent technology that is able to adapt and respond to traffic conditions in real-time and still maintain its integrity and stability within the overall transportation system and in the meantime get a system that makes better use of the capacity of intersections. The key aspects of improved control, for which contributions from artificial intelligence (AI) and artificial intelligent agents (IA) can be [2]

1. The capability of dealing with multiple problems and conflicting objectives;

2. The capability of making decisions on the basis of temporal analysis and developments;

3. The ability of managing, learning, and responding to non-recurrent and unexpected events;

4. Self adjustabilty is an integral part of IA based units;

5. The, more flexible, control unit can, pro-active, optimise while operating.

The most useful agent in UTC would be a traffic signal control device. have found that the use of quick response demand prediction models in saturated situations improve delay's per vehicle on a single approach intersection by 5% to 15 %. In saturated situations such an improvement is huge and is achievable by intelligent signal control. Such an UTC system requires: monitoring system of traffic, a rule- or model base for evaluation and adjustment, a model of the surrounds and an efficient diagnostic routine for both traffic light operations as well as rule- and parameter adjustments.

3. New Challenges

We need to send the agent-distribution map and the relevant agents to ATS for experimental evaluation, so we can test the cost of this operation during the runtime of Adapts. In our test bed, traffic-control agents [6] must communicate with ATS to get traffic detection data and send back lamp control data. Both running load and communication volumes increase with the number of intersections. If the time to complete the experimental evaluation exceeds a certain threshold, the experimental results become meaningless and useless. As a result, the carry capacity for experimental evaluation of one PC is limited. In our test, we used a 2.66-GHz [3] PC with a 1-Gbyte memory to run both ATS and Adapts. The experiment took 3,600 seconds in real time. The number of intersections we tested increased from two to 20. When the number of traffic-control agents is 20, the experiment takes 1,130 seconds. If we set the time threshold to 600 seconds, the maximum number of intersections in one experiment is only 12. This is insufficient to handle model major urban areas such as Beijing, where the central area within the Second Ring Road intersection contains up to 119 intersections. Scale of several hundreds of intersections. Furthermore, a complete urban traffic management system also requires traffic control, detection, guidance, monitoring, and emergency subsystems. To handle the different states in a traffic environment, an urban-traffic management system must provide appropriate traffic strategy agents. And to handle performance improvements and the addition of new subsystems, new traffic strategies must be introduced continually.[2] So future urban-traffic management systems must generate, store, manage, test, optimize, and effectively use a large number of mobile agents.[1] [5] Moreover, they need a decision-support system to communicate with traffic managers. A comprehensive, powerful decision-support system with a friendly human-computer interface is an inevitable trend in the development of urban-traffic management systems.

4. Intelligent Traffic Clouds

UTMS using intelligent traffic clouds have overcome the issues we've described. With the support of cloud computing technologies, it will go far beyond than any other multi agent traffic management systems [5], addressing issues such as infinite system scalability, an appropriate agent management scheme, reducing the upfront investment and risk for users, and minimizing the total cost of ownership.[6]

5. Prototype

UTMS based on cloud computing has two roles: service provider and customer. All the service providers such as the test bed of typical traffic scenes, ATS, traffic strategy database, and traffic strategy agent database are all [7] veiled in the systems core: intelligent traffic clouds. The clouds customers such as the urban traffic management systems and traffic participants exist outside the cloud. The intelligent traffic clouds could provide traffic strategy agents and agent-distribution maps to the traffic management systems, traffic-strategy performance to the traffic-strategy developer, and the state of urban traffic transportation and the effect of traffic decisions to the traffic managers. It could also deal with different customers' requests for services such as storage service for traffic data and strategies, mobile traffic-strategy agents, and so on [8]. With the development of intelligent traffic clouds, numerous traffic management systems could connect and share the clouds' infinite capability, thus saving resources. Moreover, new traffic strategies can be transformed into mobile agents so such systems can continuously improve with the development of transportation science.

6. Conclusion

The Agent-based computing and mobile agents to handle this vexing problem. Only requiring a Run-time environment, mobile agents can run computations near data to improve performance by reducing communication time and costs. This computing paradigm soon drew much attention in the transportation field. From multi agent systems and agent structure to ways of negotiating between agents to control agent strategies, all these fields have had varying degrees of success. Cloud computing provides on demand computing capacity to individuals and businesses in the form of heterogeneous and autonomous services.

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