PRINT ISSN : 2395-6011
ONLINE ISSN : 2395-602X

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH IN SCIENCE & TECHANOLOGY

VOLUME 1 ISSUE 2 MAY JUNE - 2015

IJSRST

Web Site : www.ijsrst.com

Email : editor@ijsrst.com

International Journal of Scientific Research in Science and Technology

Print ISSN: 2395-6011 Online ISSN : 2395-602X

Volume 1 Issue 1 March April-2015

International Peer Reviewed, Open Access Journal
Bimonthly Publication

Published By

Technoscience Academy
(The International Open Access Publisher)

Email: info@technoscienceacademy.com
Website: www.technoscienceacademy.com

Advisory/Editorial Board

International Journal of Scientific Research in Science and Technology

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© 2015 IJSRST | Volume 1 | Issue 2 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Engineering and Technology

Analysis of Rice Grains Through Digital Image Processing

Kataria Bhavesh
Department of Computer Engineering and Information Technology, LDRP Institute of Technology and Research, Gandhinagar (Gujarat-India)

ABSTRACT

In the food analysis there are various foodstuffs in the form of grains. Rice is of particular importance being a commodity crop. There are issues in identifying different varieties of rice. Digital imaging approach has been devised in order to investigate different types of characteristics to identify different rice varieties. Four different common rice varieties were used in tests for defining features. These include aspect ratio, length, Chalky and Paddy rice etc. There are different techniques in image processing to analyze rice which shows the dissimilarity between different varieties to a degree that would allow successful identification.
Keywords : Aspect Ratio, Chalky, Paddy Rice

I. INTRODUCTION

Some properties of rice with low percentages of stress cracks and broken kernel are desirable for food or milling et al. Physical and mechanical stresses developed in rice kernels as they are harvested, dried, stored and handled induce various quality defects.

The image analysis here centers on the shape and Length, Chalky and Paddy features of grains. The following parameters are determined for the present work.
Average Length (La) is the simplest feature considered. Using the per pixel length of the image it is possible to determine the absolute length of each grain. This per pixel area and length is determined through calibration. Lm is determined from the image by measuring the Euclidean distance between the two most distant points on the perimeter of the rice grain.

Shape features using diameter lengths are devised from the recorded chain code of each shape. Here, using pixels on opposing halves of the chain code as opposing diameter distances provided a reasonable standard of internal diameter.

II. METHODS AND MATERIAL

A. Imaging system setup

A commonly used static imaging approach is adopted here to capture images of rice grains [4,5]. The actual implementation is illustrated in Figure 1. Tray, Scanner, Computer, Entry and Exit point for rice and communiation port.

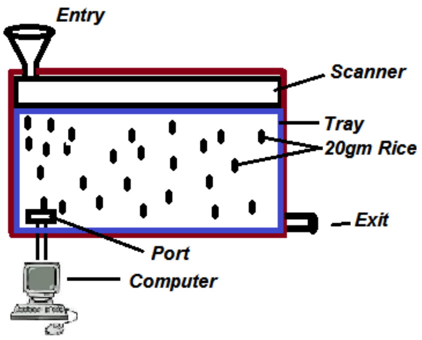

Figure 1: Imaging setup

Here computer is attachted with system to get image and do apply image processing techniques to identify the charactristics of rice grain.

B. Image processing algorithms

Image processing is used to analyse the grain images acquired. Final correction of any physical issues that occur in hardware is also possible, such as removing noise, determining uniformity of illumination and adjusment of rice on tray.

The image analysis here centers on the shape and texture features of grains. The following parameters are determined for the present work.

Aspect Ratio (Ra) feature is defined as the ratio between the shortest (d_{min}) to the longest (d_{max}) diameters: d.

$$Ra = \frac{d_{\min}}{d_{\max}}$$

Grain appearance is largely determined by the endosperm opacity and this is commonly classified as the amount of chalkiness. Opaqueness has an overall chalky texture caused by interruption of final filling of the grain. Though chalkiness disappears upon cooking and has no direct effect on cooking and eating qualities, excessive chalkiness downgrades the quality and reduces milling recovery. A visual rating of the chalky proportion of the grain is used to measure chalkiness based on the standard Evaluation System SES scale presented below: Select, segregate and weigh the chalky grains (SES Scale 9). Determine the % chalky grain using the equation

$$\%\ Chalky\ grain = \frac{Wt\ of\ chalky\ grains}{Wt\ of\ milled\ rice}\ x100$$

Table 1: Area of chalkiness in Rice

Scale	% area of chalkiness
1	less than 10
5	10-20
9	more than 20

Follow the procedure of determining grain shape of paddy. Based on the length to width ratio, the shape of the milled rice will be determined. The ISO Classification is as follows:

$$L/W\ ratio = \frac{Avg.\ length\ of\ rice}{Avg.\ width\ of\ rice}\ x\ 100$$

Table 2: Length and width ratio of Rice

Scale	Shape	L/W ratio
1	Slender	Over 3.0
3	Medium	2.1 – 3.0
5	Bold	1.1 – 2.0
9	Round	1.0 or less

Here in above all mathamatical equestions are used to identify charactristics of rice grain using image procesing techniques.

III. RESULT AND DISCUSSION

Experimental tests were conducted using the imaging setup (Figure 1). The first adjust rice in tray, then it has produced a set of images of rice grains using scanner. Algorithms identified characteristics of rice grain and produce result data which includes aspect ratio, length, Chalky and Paddy of rice grain.

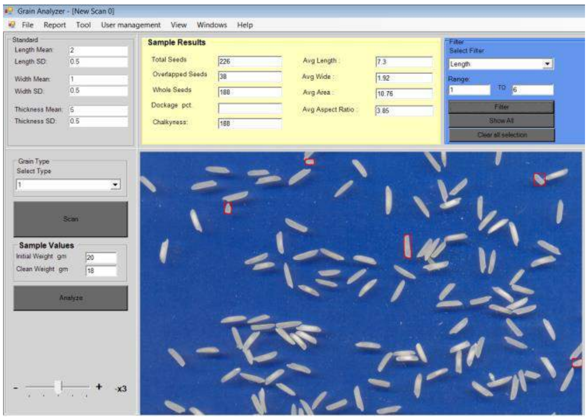

Figure 2: Length of Rice Grain

Process: Calculate Length and highlight the rice of given range

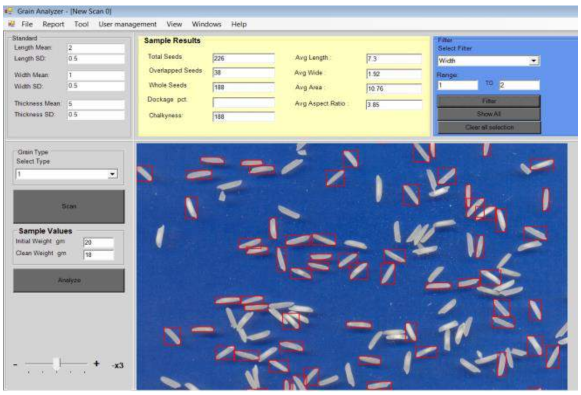

Figure 3: Width of Rice Grain

Process: Calculate width and highlight the rice of given range

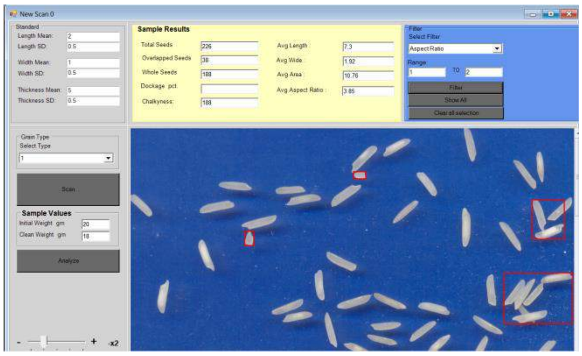

Figure 4: Aspect ratio of Rice

Process: Calculate Aspect ratio and highlight the rice of given range

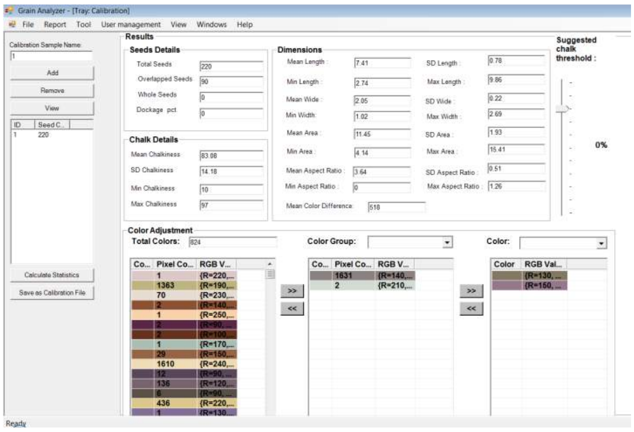

Figure 5: Statistics of 20gm Rice Image

Process: Calculate Statistics and produce result which includes Total Seeds, Overlapped Seeds, Whole Seeds, Dockage pct., Chalky seeds, Chalk impact, Mean Length, Mean Width, Mean Area, Mean Aspect Ratio, Color Details.

IV. CONCLUSION

Digital image analysis has proven to be a viable approach to the quantitative characterisation of rice grains. The results presented have demonstrated that the separation of short, medium and long, as well as brown and white rice varieties is achievable using a combination of the descriptors including aspect ratio, length, and Chalky and Paddy rice. Expansion on this work can target identification of rice based on more specific guideline requirements for certain rice varieties, such as Basmati. Also the use of surface texture and intensity features is applicable to the identification of white area in milled rice, known as a factor in grain chalkiness. It is clear, given the serious role of organizations such as the IRRI, that effective feature identification for the characterisation of rice grains could play a vital role for the food industry in the future.

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Themed Section: Engineering and Technology

Study on Issues and Remedies of Waterlogging in Hirakud Command - Key to Enhance Crop and Water Productivity

Balram Panigrahi, J.C. Paul, B.P. Behera
Department of Soil & Water Conservation Engineering, College of Agril. Engg. & Tech.,
Orissa University of Agriculture & Technology, Bhubaneswar, Odisha, India

ABSTRACT

The present study deals with finding out the causes of rising groundwater table that creates waterlogging in the Hirakud command of Odisha. The study reveals that during the 55 years of construction of the project, the groundwater table in the command has risen by more than 5 m. In the head reach, the rise is more as compared to the lower reach. The main factors that contribute to the waterlogging are (i) faulty water management practice (ii) intensive rice-rice cultivation (iii) plot to plot irrigation in rice field instead of using field channel (iv) continuous canal flow etc. Some remedies to reclaim the waterlogged areas and decrease the groundwater table are also mentioned in this paper. Construction of parallel field surface drain at 10 m drain spacing is recommended in the ayacut to decline the rising groundwater table which may facilitate the farmers to grow even some non-rice crops in the ayacut and increase water productivity.

Keywords: waterlogging, alarming rate, evapptranspiration, waterlogging, percolation, Faulty water management practice, Intensive rice-rice cultivation, irrigation system, crop diversification, Drainage congestion, toposystem

I. INTRODUCTION

The populations of the world which was 250 crores in half a century ago has already crossed the 700 crores mark and is likely to cross the 900 crores mark in the next 25 years. In India, we have touched 126 crores population and is expected to touch 164 crores by 2050 A.D. To feed such a great population, about 450 million tons of food grain production is barely needed which requires about 100 percent increase in the total food grain production. This will be possible if we enhance the natural resources including both soil and water optimally in a very judicious manner. Irrigation development in India during the post-independence era has greatly facilitated enhancement of agricultural production by increasing the irrigation potential. However, in the wake of such phenomenal strides of irrigation development from 23 M ha (million hectare) in the early 1950's to nearly 109 M ha at present, twin problems of waterlogging and salinity have also come up in the irrigation commands due to hydrologic disturbances beyond the capacity of natural drainage systems. The abundant loss of water in the form of seepage in the conveyance systems is because of earthen canals/channel sections, badly damaged canal outlets etc. coupled with low water application efficiency in the crop field due to improper water management practice. This has resulted in waterlogging and salinization thus rendering vast areas to be unproductive. They not only threaten the capital investment but also the sustainability of irrigated agriculture and have become an environmental concern too. The waterlogged saline soils are found to occur all over the country; about 8.5 M ha area has been salt-affected, of this, 5.6 M ha is waterlogged saline area in the commands of irrigation projects and is commonly referred to as man-made or wet deserts (Balakrishnan et al., 2001). Based on the extrapolation of the data on individual schemes, it is estimated that irrigation induces salinization and waterlogging on an average of 10% of the net irrigated areas (Jain, 2002).

Recently in India, waterlogging in canal irrigated areas is increasing at an alarming rate. In Tungabhadra Project in Karnataka, more than 33000 ha has been reported to suffer from waterlogging and salinity and these areas are increasing at the rate of 600 ha/year. Large areas in Haryana have been rendered waterlogged after introduction of Bhakra canal irrigation. Rising water table in Gujarat has also been observed due to the flow of water in Mahi command.

Rice is the most important crop of India and the second most important crop of the world and is the staple food for nearly half of the world population. Among the rice growing countries, India has largest area under rice in the world (about 43.2 M ha) and ranks second in production, next to China. Rice in India consumes about 66% of irrigation water in the country. The water requirement of rice invariably is put 1000 to 2000 mm (for the irrigated transplanted crop) depending on soil type and climate. Rice is considered to be an inefficient water consumer. Unlike in other arable crops, seepage and percolation losses (SP losses) in rice greatly exceed the evapptranspiration (ET) demand. The SP losses are dependent on soil texture, irrigation practices and crop duration and could vary within 52-93% of the total water expenses (Pande and Mitra, 1992, Panigrahi, 2001). The SP losses in the rice field along with inadequate drainage facility are the major factor to cause waterlogging by raising the groundwater table. Research on drainage requirement of rice or management of the drainage water in India is a neglected component in water management, knowing fully well that when irrigation comes, drainage cannot be left behind. Drainage is an integral part of irrigation water management which provides desirable environment in the crop root zone for healthy growth of crops.

II. METHODS AND MATERIAL

Waterlogging in Hirakud Command

After the construction of the Hirakud dam (Figure 1) across the river Mahanadi in Odisha, there has been a gradual increase in irrigation potential in the pre-divided districts of Sambalpur and Bolangir of Odisha. This project now commands an area of 1.59 lakh ha in kharif and 1.12 lakh ha in rabi. The command area of Hirakud covers 5 blocks in Sambalpur, 6 blocks in Bargarh 2 blocks in Sonepur and 1 block in Bolangir through 4 canal systems i.e. Baragarh main canal, Sason main canal, Sambalpur distributary and Hirakud distributary. Basic details of canal systems of the command are presented in Table 1 (Anonymous, 2005).

Because of the introduction of the project, the average cropping intensity of the command has increased from 110 to 187% during the last 55 years of initiation of the project. The watershed of the command can be divided into 6 major streams which discharge water into the Mahanadi. The sub-watersheds are Ong, Jira, Jhan Jhor, Kuler Jhor, Harda and Malati. The topography of the ayacut is undulating marked by ridges and valleys. The land slope of the ayacut goes as high as 10%. The topography of the command is classified as att (unbunded upland), mal (bunded upland), berna (medium land) and bahal (low land). The major soil texture of the command area is sandy loam and clay loam. Climate is warm, sub humid characterized by hot dry summer and short and mild winter. The average rainfall of the command is 1419 mm. Average temperature varies from a minimum of 90C to a maximum of 45oC. The average groundwater table in the irrigated areas has come up by more than 5.8 m during the last 46 years. There are some pockets in the command where it lies only 0.15 m below the ground level. Commensuration of the project has caused about 20% of the total cultivated area waterlogged in the command where crop diversification is impossible or not cost effective (Behera et al., 2001).

Figure 1. Views of the Hirakud Dam across the river Mahanadi, Odisha

Table 1. Basic details of Hirakud Canal System

Types of canal	Length, km	Area irrigated, ha (*kharif*)	Discharge at canal head, cusec
Main canal (2)			
Bargarh main canal	88	6900	3800
Sason main canal	23	1900	680
Branch canal (2)	35	4070	506 - 906
Distributaries (35)	444.44		7.5 – 38.1
Minor canal (84)	293.64		5.6 – 96.8
Sub minors (32)	74.88	146,091	4.0 – 50.0
Sub sub minors (4)	12.60		3.0 – 10.0
Water courses (2985)	2433.70		1.0 – 3.0
Total	3406.66	158961	

Causes of Waterlogging in the Command

Farmers in the command, especially in the head end of the canal system cultivate rice-rice and grow them under shallow to deep submerged condition. About 97% of the total irrigated area in kharif season is cultivated with rice where 98% of the total irrigation water is consumed by rice. Similarly about 70% of the total irrigated area in rabi is grown with rice consuming about 91% irrigation water. Most of the farmers in the command, especially in head end maintain 15-25 cm ponded waster in the rice field. This has caused serious problems of waterlogging in the command especially in the head and mid reach of the command. In general the main causes of water logging in the command are as follows:

- Faulty water management practice
- Intensive rice-rice cultivation
- Absence of field channels to irrigate the fields
- No rotational irrigation system
- No control over flow i.e. absence of volumetric measurement device to measure and supply irrigation water
- No crop diversification
- Drainage congestion in outlets
- Unlined /badly maintained channels causing major seepage losses in canal system
- Mismatch between the demand and supply system
- Lack of land development and
- Inadequate drainage facilities

One of the most important problems of waterlogging and drainage in the command is the land locked toposystem. The canal that flows in the upland called locally as att land suffers from severe seepage loss. This seepage water continuously flow down and also laterally from the att land to the bahal land (low land) causing stagnation of water in the bahal land (Figure 2). Thus the att land suffers from moisture stress whereas the bahal land suffers from severe waterlogging. It is needless to mention here that both the deficit and excess moisture in the crop field are not congenial to crop growth.

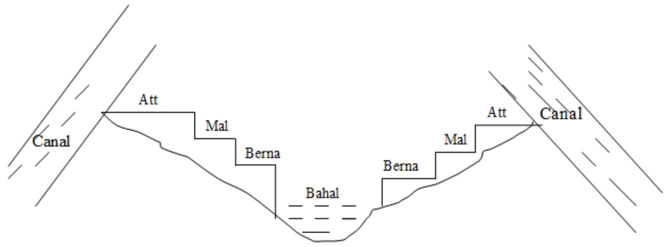

Figure 2. Land lay in Hirakud ayacut

Spatial Variation of Groundwater Table in the Command

Data on rise of groundwater table in the command were collected from different sources for 28 years (1985 – 2012). The four different sources from which data were collected are (i) irrigated area, (ii) areas near to canal (iii) uncultivated areas and (iv) dry farming areas). The depth of water table below the ground level was measured at weekly interval throughout the year for 28 years as mentioned above and the data are presented in Table 2 below.

Table 2. Fluctuation of groundwater table in different areas (average of 28 years, 1985-2012)

Week No.	Depth of groundwater table below ground level, m			
	Near canal	Irrigated area	Uncultivated area	Dry farming area
1	3.93	0.38	3.92	2.42
2	3.60	0.37	3.95	2.33
3	3.90	0.35	3.91	2.25
4	3.91	0.33	3.85	2.30
5	3.95	0.40	3.81	2.31
6	3.99	0.42	3.75	2.18
7	3.86	0.45	3.54	2.28
8	3.95	0.51	3.60	2.34
9	3.93	0.33	3.53	2.36
10	3.87	0.32	3.48	2.20
11	3.92	0.41	3.48	2.23
12	4.03	0.45	3.36	2.40

13	3.90	0.53	3.42	2.45
14	3.65	0.55	3.48	2.50
15	3.77	0.33	3.36	2.34
16	3.89	0.30	3.42	2.52
17	3.99	0.30	3.48	2.65
18	4.05	0.35	3.81	2.28
19	4.19	0.33	3.96	2.35
20	4.28	0.41	4.18	2.36
21	4.39	0.42	4.35	2.41
22	4.55	0.40	4.46	2.45
23	4.60	0.45	4.47	2.40
24	4.28	0.50	4.21	2.15
25	4.05	0.47	3.96	2.02
26	3.81	0.41	3.80	2.00
27	2.25	0.40	1.85	1.85
28	2.28	0.41	1.75	1.65
29	1.98	0.45	1.55	1.54
30	1.95	0.42	1.49	1.50
31	1.65	0.28	1.35	1.32
32	1.87	0.22	1.30	1.25
33	1.58	0.23	1.28	1.22
34	1.55	0.25	1.20	1.20
35	1.50	0.31	1.15	1.24
36	1.53	0.46	1.12	1.32
37	1.58	0.50	1.25	1.30
38	1.60	0.51	1.31	1.25
39	1.75	0.52	1.26	1.20
40	1.80	0.54	1.29	1.46
41	1.99	0.47	1.52	1.50
42	2.00	0.44	1.48	1.52
43	2.02	0.38	1.82	1.54
44	2.10	0.45	1.80	1.45
45	2.65	0.44	1.85	1.50
46	2.85	0.51	1.88	1.88
47	3.10	0.55	2.25	1.90
48	3.05	0.39	2.30	2.02
49	3.25	0.46	3.10	2.10
50	3.18	0.47	3.23	2.25
51	3.83	0.45	3.56	2.35
52	3.88	0.41	3.96	2.32

From the observed data, it is revealed that the water table data in the kharif (standard meteorological weeks 27 to 47 are higher i.e. near to the ground surface than the rabi season in all the places. The depth of water table near the canal varies from 1.50 to 4.60 m, whereas the water table in the irrigated areas, uncultivated areas and dry farming areas varies from 0.22 to 0.55 m, 1.12 to 4.47 m and 1.20 to 2.65 m, respectively. The rise of water table in the irrigated areas is found to be significant compared to other areas. The entire command areas receive water almost throughout the year. The canal operation schedule (mean of last 20 years data, 1990 to 2009) is presented in Table 3. From the table it is observed that the average duration of canal opening period is 278 days and only for 87 days, the canal remains closed. The rise of water table causing water logging and drainage problem in the command areas are mainly attributed to three points. They are (i) intensive rice-rice cultivation, (ii) faulty water management practice especially maintaining deep submergence in the rice field and (iii) high rainfall in the rainy season in conjunction with continuous canal flow. The water table remains at a shallow depth as compared to other areas in the irrigated areas due to continuous infiltration, seepage and deep percolation from the rice field and seepage from the unlined canal systems. The rise of water table is less in the summer months of May to June because of less rainfall in these months and

Table 3. Canal schedule data of the Hirakud command (mean of 20 years)

Sl. No.	Month	Canal opening period	Days
1	Jan	1st Jan - 31st Jan	31
2	Feb	1st Feb – 28th Feb	28
3	Mar	1st Mar – 31st Mar	31
4	Apr	1st Apr – 30th Apr	30
5	May	1st May – 11th May	11
6	June	21st Jun – 30th Jun	10
7	Jul	1st Jul – 31st Jul	31
8	Aug	1st Aug – 31st Aug	31
9	Sep	1st Sep – 30th Sep	30
10	Oct	1st Oct – 31st Oct	31
11	Nov	1st Nov – 8th Nov	8
12	Dec	25th Dec – 31st Dec	6
Total			278

also due to less number of days of canal opening periods. In dry farming areas, the rise of water table is found to be higher than the uncultivated areas because of field bunds raised around the fields to conserve maximum amount of rainfall. This has hastened up the infiltration of conserved rainwater in the field causing rise of the ground water table. It is interesting to note that in the dry farming areas, the rise of water table is higher in the months of rainy season than the winter and summer. The reason may be attributed to the high quantum of rainfall that is received in the rainy season as compared to winter and summer.

The rise of water table is found to be different for different reaches along a canal. In the up end (head reach) of the canal the rise of water table is found to be higher than that in the middle and tail end of the canal. Observations were taken to record the ground water table in 5 places along the canal reach of Baragarh distributary of Hirakud command. Out of these 5 places, two were in the head reach, and two in the middle and one was in the tail reach of the canal. The average groundwater table position in head, middle and tail reaches were recorded for fifty five years (1958 to 2012) and are presented in Table 4 below.

Table 4. Position of groundwater table in the different reaches in the canal in different years

Years	Average groundwater table (below ground), m		
	Head reach	Middle reach	Tail reach
1958	9.66	9.05	10.2
1963	7.01	7.77	8.67
1968	6.45	7.02	8.01
1973	5.02	5.55	7.78
1978	4.11	4.90	7.56
1983	3.78	4.43	7.01
1988	2.65	4.02	6.89

1983	2.11	3.03	6.45
1998	1.89	2.60	6.21
2003	1. 59	2.33	5.98
2007	1.35	2.12	5.78
2012	1.29	2.05	4.80

Data of Table 4 reveals that because of extensive irrigation and continuous water supply in the canal head end, the ground water table has risen up more compared to other two reaches. In the last 55 years, the water table in the head end has come up from 9.66 to 1.29 m whereas in the middle and tail reaches, the water table has come up from 9.05 to 2.05 m and 10.2 to 4.80 m. Thus the data reveals that the drainage and waterlogging problems are becoming severe in the head reach than the middle and tail reaches in the canal in the command. It is apprehended that if the present trend of the irrigation and cropping system (rice-rice) continues, then by 2030 AD, about 45% of the areas of the command would become waterlogged consequently affecting the crop yield severely. It, is hence, felt imperative to study the techno-economically feasible drainage system to reclaim the waterlogged areas or to arrest the upcoming waterlogging problem in canal commands.

III. RESULTS AND DISCUSSION

Affects of Waterlogging

Waterlogging has the following ill effects:

- It decreases soil health
- It decreases microbial activities
- Affects growth and yield of crops
- Increase chance of flooding
- Affects soil temperature
- Causes soil salinity
- Causes water and environmental pollution and
- Hampers in crop diversification

Figure3 shows the affects of waterlogging on stunted crop growth in a chronically waterlogged area.

Measures to Reduce Waterlogging

Waterlogging in the Hirakud command is an alarming situation and unless some tangible measures are taken then the situation will go beyond control and the fertile land will turn into fallow after some decades. In the following paragraph, some of the important remedial measures are mentioned.

- Irrigating rice fields through field channels instead of field to field to irrigation
- Irrigating the rice by intermittent irrigation method instead of maintaining standing water in field always
- Encouraging crop diversification instead of rice-rice cultivation

Figure 3. Affects of waterlogging on stunted growth of crop

- Using accurate irrigation scheduling including proper methods of irrigation
- Adopting water saving irrigation techniques in the crops
- Proper land smoothing and grading using appropriate farm machineries
- Using high tech irrigations like sprinkler and drip especially in fruits, orchards and vegetables which has high application efficiency
- Reduction of seepage and percolation in crop fields
- Using cost effective mulching in crops fields to check soil evaporation and reduce the frequency of irrigation in crop fields
- Decreasing the conveyance losses of canals by lining the canal systems
- Volumetric supply of water in canal commands

- Charging water rates on volumetric basis which will enforce the farmers to use right amount of water in the crop fields.

Surface and Sub-Surface Drainage System

Out of different drainage systems, surface drainage is the simplest and cheapest drainage system. Figure4 shows a surface drainage system for evacuation of excess water from crop field.

Figure 4. An open surface drain used to evacuate excess surface water

Parallel field surface drains are the widely adopted surface drain systems. In the design of parallel field surface drains, one of the most important design parameter is deciding the optimum drain spacing. The drain spacing would be optimum when it lowers down the groundwater table to the maximum amount and thereby facilitating to grow non-rice crops and at the same time it is economically viable. Experiments in the loamy soil at Regional Research and Technology Transfer Station, Chiplima in the command reveal that out of various drainage spacing, 10 m drain spacing works better in lowering down the water table and enables the farmers to grow rice based cropping systems like rice-wheat-mung and rice-mustard-sesamum in chronically waterlogged ecosystem. The six years experiments in the field revealed that the ground water level could be lowered down by 35.3, 32.6 and 29.4 cm below the ground level with 10, 15 and 20 m drain spacings, respectively (Panigrahi and Behera, 2008; Panigrahi, et al., 2007)). Figure 5 shows the fluctuation of groundwater table by different drain spacings by parallel filed surface drains. From the experimental data, it is recommended that in chronically waterlogged ecosystem, excess water from the soil surface as well as the groundwater from the soil sub surface should be evacuated by constructing 10 m parallel field surface drains. Groundwater table in the sub soil region can also be reduced by installing sub surface drains like tile and mole drains at suitable spacing and at suitable depth below the ground level. However, installation of sub surface drains is more costly than the surface drain methods but it has several advantages also. It does not hamper in conveyance of machineries and in farm operation. The costly agricultural lands are also not wasted towards construction of the drains.

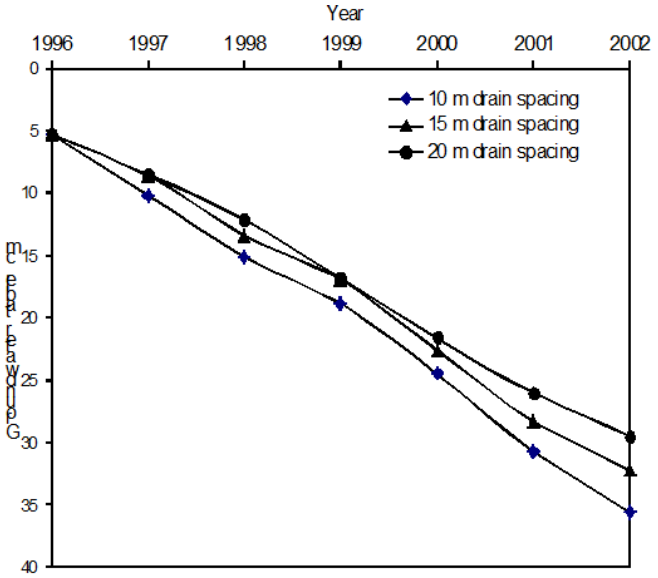

Figure 5. Fluctuation of groundwater table below ground surface

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© 2015 IJSRST | Volume 1 | Issue 2 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Engineering and Technology

Approaches for Efficient Workflow Planning and Execution of Scientific Application with Cloud Resources to Maximize Throughput within a Limited Time Limit

Bakul Panchal
Department of Computer Engineering L. D. College of Engineering, Ahmedabad, Gujarat, India

ABSTRACT

In Cloud Environment, Resources available to the client on demand with pay per usage. Higher throughput with minimal execution time can reduce the budget cost for client as well as can never violate Service Level Agreement (SLA). For scientific application like weather forecasting maximum calculation within a limited time scope must be requirement. Prediction of incoming future work and its parallel execution with unlimited cloud resources can fulfil our requirement. Various techniques should be developed for this strategy. Usage Pattern [1] scheme use knowledge base for predicting future jobs by pattern matching which help to reduce start-up overhead. Bag of Task [2] scheme provide concept of simultaneous execution of scientific tasks with variable resources on available cloud. Resources can be increased or decreased on demand which can reduce the overall cloud rent cost. Our approach suggests a technique to combine usage pattern with bag of task which can provide efficient result with higher throughput in minimum time. Predict the future work, estimate execution time, divide jobs in small tasks and execute them parallel with on-demand variable resources can provide good results.

Keywords : Cloud Computing, Bag of Task, Usage Pattern, eScience Application on Cloud, SLA, Higher Throughput.

I. INTRODUCTION

Cloud computing is a technology which provides internet based on demand pay per usage of various services like Infrastructure as a service, Software as a service and Platform as a service. Cloud computing create an illusion of an infinite resources by creating an instance of resource which can be helpful for very heavy large computing application like eScience application - weather forecasting. This type of application contains list of different task that may be independently executed. By executing them parallel we can reduce the execution time. Science Lab requires very large computation which cannot be done using their limited resources. They are using Grid infrastructure for large computation. The problem with grid infrastructure is that it works on batch processing system and maintains queue for various tasks. Due to this a task which require little execution time also take longer processing time due to long queue in Grid environment. Cloud provide on-demand resource instance which reduce the queue processing time and fast response time. Proper scheduling should be required to utilize the available cloud resource to minimize the rent cost of cloud services. Various approaches are designed for efficient usage of cloud resources to reduce the cost and get fast response time. In Greedy approach, as many cloud resources as possible are acquired at the beginning of an application execution. This approach will provide faster response time but resources are not efficiently utilized. Some resources are idle for most of the time during total application execution which increase the cloud rent cost because heavy eScience application take so many hours to finish application execution. Another approach is online scheduling in which scheduler make decision when resources should be required and for that moment resource should be acquired on demand base which can reduce the cloud rent cost. Cloud does not have queue problem so using this approach we can also get faster output within deadline. Bag of Task approach use Work Queue [3]with Replication using online scheduling technique. Here replicas of task are available to grid infrastructure and provide parallel execution but do not duplicate execution of same task. Another approach for eScience application is predication of future task. Prediction can be done by the scheduler using heuristic approach. Prediction algorithm using historical data are available to scheduler to predict the execution time of current eScience application [4]. In cloud environment historical data of an application also depends on factor of non-uniformity of available hardware resources. The goal of this various approaches to achieve low cost execution that minimizes total turnaround time and cloud rent cost within a deadline. Proper workflow with available cloud resource using discussed approaches can solve it.

II. METHODS AND MATERIAL

We identify relationships between Cloud Computing, Service-Oriented Computing (SOC) and Grid Computing.

2.1 Bag of Task Approach

In this approach independent tasks of an application are ready for execution. Initially scheduler starts parallel execution of task on available cloud resources. At the end of time period t, scheduler revaluates its decision by calculating throughput and estimating task behaviour for next turn. Cloudburst scheduler revaluates its initial decision throughout the application execution time. Once the heuristic information for tasks is available scheduler calculate the number of cloud instances required to complete application. Using this approach scheduler can acquire the cloud resources whenever they required and reduce the application execution cost.

Here the approach of Work Queue with Replica of tasks for available grid and cloud resources is used for task execution. It avoids running the same task once it is finished. When the application is finished, scheduler has complete information about tc (task completion time) and nc (number of resources) application acquired for execution. Now using the equation $p(t) = u(t) – c(nc(t))$ profit can be calculated where $u(t)$ is a utility function for an application. Online scheduler uses the feedback mechanism. It uses the heuristic information of executed task and makes decision to acquire resources for next available tasks.

Online scheduler use three different type of heuristic: (i) Conservative (ii) Derivative and (iii) Predictive. Conservative heuristic believes that grid has reached to a maximum required resources and it is fair enough for future task execution and cannot be change. Derivative Heuristic use difference of throughput value of last two turns $\Delta S=St-St-1$. At first startup schedulers has no information about St and St-1. As the first turn it consider as warm up turn and calculate the throughput of available grid and cloud resources. Using predictive approach scheduler can also predict initial throughput from user defined resources and from available historical data of same type of application.

2.2 Usage Pattern Approach

Pattern matching with Knowledgebase in Prediction algorithm can predict task execution time [5], job startup time [6], queue waiting time [7] and resource requirement [8]. Prediction algorithm to find task characteristics using pattern matching with available historical data can work fine on Grid Infrastructure but with cloud it also add factor of different heterogeneous hardware resources execution capability. This approach includes (i) Meta scheduler which draws from AppleS [9] and (ii) GRADS [10] to maintain and use historical data for pattern matching of future activity. Using this approach we can predict future jobs by extracting user pattern for historical data. It reduces high startup overhead for a heavy and time critical application like eScience application. Knowledge-based should be created from zero or pre populated job information and updated after successful completion of an application. Knowledge-based heuristic should be very useful to predict the future job for similar type of application or job. Prediction algorithm classify in two models: (i) Statistical technique and (ii) Artificial Intelligence knowledge base technique. AppleS include good scheduler with application prediction using statistical technique. Ganapathi et also [11] propose good statistical model to predict the resource requirement and execution time of application on Cloud Environment. This model use Map Reduce [12] technique for tasks by using pre execution features an post execution performance metrics. In Artificial Intelligence technique Knowledge base heuristic should be created and maintain by the system itself by learning from past job execution experience. It includes instance based learning, genetic algorithms, case based learning together with heuristic for searching an optimization.

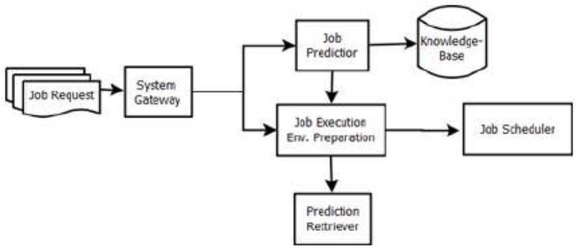

Figure 1: System Architecture

As per given figure1 System work as a middle ware or Meta scheduler. When Job request arrives, Job execution environment prepare environment and job predictor predict for next future job by extracting user patterns information in knowledgebase for same type of application. If next job is predicted then relevant required cloud resources should be prepared. If job is not predicted System prepare the environment and execute job with startup overhead and try to find reason why system is not able to predict job. During this execution cycle system maintains its knowledge base using self-learning approach.

2.3 Proposed Approach

We are using the combine approach of Usage pattern with Bag of Task execution on cloud environment. System structure use a heuristic knowledge base for various jobs - tasks of an application. Self-learning system always updates this knowledge base. Using this algorithm we can predict the future job and find out required execution time and cloud resources. So whenever cloud resources should be required they are rented which reduce the cost. Bag of Task provide an environment to execute available task in parallel with available cloud resources and efficiently utilize it. Conservative, Derivative and Predictive technique is used to predict the job as discussed in Bag of Task Scheduling. System work as Meta scheduler and provide efficient resource allocation and utilization for heavy application like eScience application. This reduces the total cost of execution of an application.

III. CONCLUSION

Using heuristic usage pattern with bag of task scheduling technique predict the future job, cloud resource requirement and task execution time. Advance knowledge of these characteristics can help to efficiently create an execution environment using efficient resource utilization. Resource can be rented only whenever they require which reduce the overall execution cost. Generally, this approach works fine for eScience application because it requires high computation power. Most of eScience application has similar type of characteristics so prediction using available Knowledgebase produces good accuracy. These reduce cost and provide fast response time within a deadline. Overall Service Level Agreement should be maintained because of fast response with good performance on cloud resources.

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© 2015 IJSRST | Volume 1 | Issue 2 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Science

An Application of the Generalized Bernoulli Equation Method to the Fractional Nonlinear Kawahara Equation

OJO M.O. [1], IJILA P.O. [1], OMOLIKI A.J. [2], KOLEBAJE O.T. [1]*

[1]Department of Physics, Adeyemi College of Education, Ondo, Nigeria
[2]Department of Physics and Solar, Bowen University, Iwo, Nigeria

ABSTRACT

An application of the generalized Bernoulli equation method to the fractional nonlinear fifth order Kawahara equation is presented in this paper. We applied this method to solve the fractional nonlinear Kawahara equation by using the generalized Bernoulli equation which has 13 different known solutions as the auxiliary equation. This method is a simple, reliable and powerful tool for solving the fifth order nonlinear Kawahara equation as it produces an interesting range of solutions.

Keywords: generalized Bernoulli equation method, nonlinear differential equations, travelling wave solutions, Kawahara equation.

I. INTRODUCTION

In Soliton theory, the study of exact solutions to these nonlinear equations plays a very germane role, as they provide much information about the physical models they describe. In recent times, it has been found that many physical, chemical and biological processes are governed by nonlinear partial differential equations of non-integer or fractional order [1-4].

Computer algebraic systems such as Mathematica, Matlab, Maple, and Scilab have made research into methods of obtaining exact solution to NLPDEs an interesting area of research in the last decade. These methods include the Hirota bilinear method,[5] the inverse scattering transform,[6] the Backlund transform,[7-8] the Darboux transform,[9] the sine-cosine method,[10] the tanh-function method,[11-12] the exp-function method,[13] the Homogenous balance method,[14] (G'/G) expansion method, [15] etc.

In this paper, we apply the Generalized Bernoulli equation method for finding exact solution to the fractional nonlinear fifth order Kawahara equation defined in the sense of Jumarie's modified Riemann-Liouville derivatives. The method utilizes the Generalized Bernoulli equation with 13 different solutions as an auxiliary equation.

II. METHODS AND MATERIAL

Description of the Generalized Bernoulli Equation Method

The proposed method can be described as follows: consider a nonlinear PDE with the independent variables x, y, z and t of the form

$$F\left(u, D_t^{\delta} u,\ D_x^{\eta} u,\ D_y^{\sigma} u,\ D_z^{\gamma} u, \ldots\right) = 0 \qquad 0 < \alpha, \eta, \sigma, \gamma \leq 1 \qquad (2)$$

F is a polynomial in u and its partial derivatives (integer and fractional) with respect to x, y, z and t, in which the highest order derivatives and the nonlinear terms are also involved.

Step 1: We begin by transforming Eq. (2) into a nonlinear ordinary differential equation (ODE) of integer order by applying a fractional complex transformation proposed by Li and He: [16]

$$u(x, y, z, t) = U(\xi)$$

$$\xi = \frac{x^\eta}{\Gamma(1+\eta)} + \frac{y^\sigma}{\Gamma(1+\sigma)} + \frac{z^\gamma}{\Gamma(1+\gamma)} - \frac{ct^\delta}{\Gamma(1+\delta)} \quad (3)$$

Where c is an arbitrary constant and Eq. (2) reduces to a nonlinear integer order ODE of the form

$$G(u, u', u'', u''', \dots) = 0 \quad (4)$$

If possible, we integrate term by term one or more times with the integration constants set to zero for simplicity.

Step 2: We assume that the solution to Eq. (2) can be expressed as a polynomial in V

$$U(\xi) = \sum_{i=0}^{m} \alpha_i V^i \qquad \alpha_m \neq 0 \qquad (5)$$

Where $\alpha_0, \alpha_1, \dots, \alpha_m$ are constants to be determined and V satisfies the generalized Bernoulli equation of the form

$$V' = rV + sV^2 \qquad s \neq 0 \qquad (6)$$

Where r and s are arbitrary constants. To determine m, we consider the homogenous balance between the highest order derivative and the highest order nonlinear term(s).

Step 3: Substitute Eq. (5) with the determined value of m into Eq. (4) using Eq. (6), and collect all terms with the same order of V^i for $i = 0, 1, 2, 3, \dots$ together. If the coefficients of V^i vanish separately, we have a set of algebraic equations in $\alpha_0, \alpha_1, \dots, \alpha_m, c, r$ and s that is solved with the aid of Mathematica.

Step 4: Finally, substituting $\alpha_0, \alpha_1, \dots, \alpha_m$, c and the general solutions to Eq. (6) into Eq. (5) yield the exact travelling wave solutions of Eq. (2). The 13 different solutions of the generalized Bernoulli equation under four different classes are presented below with the solutions depending on the nature of r :

For a real and non-zero r, i.e. $r^2 > 0$ and $s \neq 0$, the solutions to Eq. (6) are:

$$V_1 = -\frac{r}{2s}\left[1 + \tanh\left(\frac{r}{2}\xi\right)\right]$$

$$V_2 = -\frac{r}{2s}\left[1 + \coth\left(\frac{r}{2}\xi\right)\right]$$

$$V_3 = -\frac{r}{2s}[1 + \tanh(r\xi) \pm i\,\mathrm{sech}(r\xi)]$$

$$V_4 = -\frac{r}{2s}[1 + \coth(r\xi) \pm \mathrm{csch}(r\xi)]$$

$$V_5 = -\frac{r}{4s}\left[2 + \tanh\left(\frac{r}{4}\xi\right) + \coth\left(\frac{r}{4}\xi\right)\right]$$

$$V_6 = \frac{r}{2s}\left[\frac{\sqrt{J^2+K^2} - J\cosh(r\xi)}{J\sinh(r\xi) + K} - 1\right]$$

$$V_7 = -\frac{r}{2s}\left[\frac{\sqrt{K^2-J^2} + J\sinh(r\xi)}{J\cosh(r\xi) + K} + 1\right]$$

J and K are two non-zero real constants that satisfy $K^2 - J^2 > 0$.

$$V_8 = \frac{\pm re^{r\xi}}{s(1 \mp e^{r\xi})}$$

$$V_9 = \frac{\pm re^{r\xi}}{s(i \mp e^{r\xi})}$$

$$V_{10} = \frac{r\left[\sqrt{J^2-K^2} \pm \left(Je^{r\xi} - iK\right)\right]}{\mp s[J(e^{r\xi} - e^{-r\xi}) - 2iK]}$$

J and K are two non-zero real constants that satisfy $J^2 - K^2 > 0$.

$$V_{11} = \frac{-r\varphi e^{r\xi}}{s(1 + \varphi e^{r\xi})}$$

$$V_{12} = \frac{-re^{r\xi}}{s(\varphi + e^{r\xi})}$$

where φ is an arbitrary constant.

For $r = 0$, $s \neq 0$ and an arbitrary constant μ, the solution to Eq. (5) is:

$$V_{13} = \frac{-1}{s\xi + \mu}$$

III. RESULTS AND DISCUSSION

Application

Consider the space and time fractional fifth order Kawahara equation given by

$$\frac{\partial^\gamma u(x,t)}{\partial t} + u(x,t)\frac{\partial^\sigma u(x,t)}{\partial x} + \frac{\partial^{3\sigma} u(x,t)}{\partial x^3} - \frac{\partial^{5\sigma} u(x,t)}{\partial x^5} = 0 \qquad (7)$$

We apply the fractional complex transformation given by

$$u(x,t) = U(\xi) \qquad \xi = \frac{x^\eta}{\Gamma(1+\eta)} - \frac{ct^\delta}{\Gamma(1+\delta)} \qquad (8)$$

where c is an arbitrary constant. By using Eq. (8), Eq. (7) can be reduced into the following integer order ODE:

$$-cU' + UU' + U''' - U''''' = 0 \qquad (9)$$

Integrating Eq. (10) once with respect to ξ and setting the integration constant to zero yields

$$-cU + {U^2}/{2} + U'' - U'''' = 0 \qquad (10)$$

By considering the homogenous balance between the highest order derivative U'''' and the highest order nonlinear term U^2, we deduce that $m = 4$.

Then the solution to Eq. (10) can be written as

$$U(\xi) = \alpha_4 V^4 + \alpha_3 V^3 + \alpha_2 V^2 + \alpha_1 V + \alpha_0 \quad \text{where } \alpha_4 \neq 0 \qquad (11)$$

where α_0, α_1, α_2, α_3 and α_4 are arbitrary constants to be determined by algebraic calculations. Substituting Eq. (11) and its derivatives into Eq. (10) and collecting all terms with the same power of V together yields a system of algebraic equation presented below

V^0: $\alpha_0{}^2 - 2c\alpha_0 = 0$

V^1: $-c\alpha_1 + r^2\alpha_1 - r^4\alpha_1 + \alpha_0\alpha_1 = 0$

V^2: $6rs\alpha_1 - 30r^3s\alpha_1 + \alpha_1{}^2 - 2c\alpha_2 + 8r^2\alpha_2 - 32r^4\alpha_2 + 2\alpha_0\alpha_2 = 0$

V^3: $2s^2\alpha_1 - 50r^2s^2\alpha_1 + 10rs\alpha_2 - 130r^3s\alpha_2 + \alpha_1\alpha_2 - c\alpha_3 + 9r^2\alpha_3 - 81r^4\alpha_3 + \alpha_0\alpha_3 = 0$

V^4: $-120rs^3\alpha_1 + 12s^2\alpha_2 - 660r^2s^2\alpha_2 + \alpha_2{}^2 + 42rs\alpha_3 - 1050r^3s\alpha_3 + 2\alpha_1\alpha_3 - 2c\alpha_4 + 32r^2\alpha_4 - 512r^4\alpha_4 + 2\alpha_0\alpha_4 = 0$

V^5: $-24s^4\alpha_1 - 336rs^3\alpha_2 + 12s^2\alpha_3 - 1164r^2s^2\alpha_3 + \alpha_2\alpha_3 + 36rs\alpha_4 - 1476r^3s\alpha_4 + \alpha_1\alpha_4 = 0$

V^6: $-240s^4\alpha_2 - 2160rs^3\alpha_3 + \alpha_3{}^2 + 40s^2\alpha_4 - 6040r^2s^2\alpha_4 + \alpha_2\alpha_4 = 0$

V^7: $-360s^4\alpha_3 - 2640rs^3\alpha_4 + \alpha_3\alpha_4 = 0$

V^8: $-1680s^4\alpha_4 + \alpha_4{}^2 = 0$

Case 1 $\alpha_4 = 1680s^4$ $\alpha_3 = 3360rs^3$ $\alpha_2 = 1680s^2/13$ $\alpha_1 = 0$ $\alpha_0 = {-72}/{169}$ $c = {-36}/{169}$ $r = \pm 1/\sqrt{13}$

Case 2 $\alpha_4 = 1680s^4$ $\alpha_3 = 3360rs^3$ $\alpha_2 = 1680s^2/13$ $\alpha_1 = 0$ $\alpha_0 = 0$ $c = 36/169$ $r = \pm 1/\sqrt{13}$

Case 3
$\alpha_4 = 1680s^4$ $\alpha_3 = 3360rs^3$ $\alpha_2 = 280/13\,(-s^2 + 91r^2s^2)$
$\alpha_1 = 280/13\,(-rs + 13r^3s)$ $\alpha_0 = 0$ $c = \dfrac{(31 + 2093r^2)}{1690}$ $r = \pm\sqrt{\dfrac{-31 \pm 3i\sqrt{31}}{260}}$

Case 4 $\alpha_4 = 1680s^4$ $\alpha_3 = 3360rs^3$ $\alpha_2 = 280/13\,(-s^2 + 91r^2s^2)$
$\alpha_1 = \dfrac{280(-rs + 13r^3s)}{13}$ $\alpha_0 = \dfrac{(-31 - 2093r^2)}{845}$ $c = -\dfrac{(31 + 2093r^2)}{1690}$ $r = \pm\sqrt{\dfrac{-31 \pm 3i\sqrt{31}}{260}}$

Substituting the different sets of solution to the algebraic equation and the general solutions to Eq. (6) into Eq. (11), we obtain 13 different travelling wave solutions of the space and time fractional nonlinear Kawahara equation for each of the sets of solutions. From case 1, we obtain the following exact solutions:

$$U(\xi) = \alpha_4 V^4 + \alpha_3 V^3 + \alpha_2 V^2 + \alpha_1 V + \alpha_0$$

For a real r, the solutions to Eq. (7) are

$$U_1 = \frac{3}{169}\left[-24 + 35\,\mathrm{sech}^4\left(\frac{\xi}{2\sqrt{13}}\right)\right]$$

$$U_2 = \frac{3}{169}\left[-24 + 35\,\mathrm{csch}^4\left(\frac{\xi}{2\sqrt{13}}\right)\right]$$

$$U_3 = \frac{24}{169}\left[-3 - \frac{70e^{\frac{2\xi}{\sqrt{13}}}}{\left(\mp i + e^{\frac{\xi}{\sqrt{13}}}\right)^4}\right]$$

$$U_4 = -24 + 35\left(\frac{e^{\frac{\xi}{\sqrt{13}}}J + K - \sqrt{J^2 + K^2}}{K + J\sinh\left(\frac{\xi}{\sqrt{13}}\right)}\right)^4 + 140\left(\frac{e^{\frac{\xi}{\sqrt{13}}}J + K - \sqrt{J^2 + K^2}}{K + J\sinh\left(\frac{\xi}{\sqrt{13}}\right)}\right)^2 + 140\left(-1 + \frac{\sqrt{J^2 + K^2} - J\cosh\left(\frac{\xi}{\sqrt{13}}\right)}{K + J\sinh\left(\frac{\xi}{\sqrt{13}}\right)}\right)^3$$

$$U_5=\frac{3}{169}\left[-24+140\left(-1+\frac{\sqrt{J^2+K^2}-J\cosh\left(\frac{\xi}{\sqrt{13}}\right)}{K-J\sinh\left(\frac{\xi}{\sqrt{13}}\right)}\right)^2+140\left(-1+\frac{\sqrt{J^2+K^2}-J\cosh\left(\frac{\xi}{\sqrt{13}}\right)}{K-J\sinh\left(\frac{\xi}{\sqrt{13}}\right)}\right)^3+35\left(-1+\frac{\sqrt{J^2+K^2}-J\cosh\left(\frac{\xi}{\sqrt{13}}\right)}{K-J\sinh\left(\frac{\xi}{\sqrt{13}}\right)}\right)^4\right]$$

$$U_6=\frac{3}{169}\left[-24-\frac{70J^2}{\left(K+J\cosh\left(\frac{\xi}{\sqrt{13}}\right)\right)^4}\left(-3J^2-4JK\cosh\left(\frac{\xi}{\sqrt{13}}\right)+(J^2-2K^2)\cosh\left(\frac{2\xi}{\sqrt{13}}\right)+4\sqrt{K^2-J^2}\sinh\left(\frac{\xi}{\sqrt{13}}\right)\left(J+K\cosh\left(\frac{\xi}{\sqrt{13}}\right)\right)\right)\right]$$

$$U_7=\frac{3}{169}\left[-24+\frac{70J^2}{\left(K+J\cosh\left(\frac{\xi}{\sqrt{13}}\right)\right)^4}\left(3J^2-4JK\cosh\left(\frac{\xi}{\sqrt{13}}\right)+(J^2-2K^2)\cosh\left(\frac{2\xi}{\sqrt{13}}\right)+4\sqrt{K^2-J^2}\sinh\left(\frac{\xi}{\sqrt{13}}\right)\left(J+K\cosh\left(\frac{\xi}{\sqrt{13}}\right)\right)\right)\right]$$

J and K are two non-zero real constants that satisfy $K^2-J^2>0$.

$$U_8=-\frac{48\,e^{\frac{2\xi}{\sqrt{13}}}\left(26+3\cosh\left(\frac{2\xi}{\sqrt{13}}\right)-12i\sinh\left(\frac{\xi}{\sqrt{13}}\right)\right)}{169\left(-i+e^{\frac{\xi}{\sqrt{13}}}\right)^4}$$

$$U_9=-\frac{48\,e^{\frac{2\xi}{\sqrt{13}}}\left(26+3\cosh\left(\frac{2\xi}{\sqrt{13}}\right)+12i\sinh\left(\frac{\xi}{\sqrt{13}}\right)\right)}{169\left(i+e^{\frac{\xi}{\sqrt{13}}}\right)^4}$$

$$U_{10}=\frac{1}{169\left(K+i\,J\sinh\left(\frac{\xi}{\sqrt{13}}\right)\right)^4}\left[840J^2\sqrt{J^2-K^2}\cosh\left(\frac{\xi}{\sqrt{13}}\right)+6J^2(41J^2-34K^2)\cosh\left(\frac{2\xi}{\sqrt{13}}\right)+48iJK\,(13J^2-6K^2)\sinh\left(\frac{\xi}{\sqrt{13}}\right)+420iJ^2K\sqrt{J^2-K^2}\sinh\left(\frac{2\xi}{\sqrt{13}}\right)-9\left(-67J^4+24J^2K^2+8K^4+J^4\cosh\left(\frac{4\xi}{\sqrt{13}}\right)-8iJ^3K\sinh\left(\frac{3\xi}{\sqrt{13}}\right)\right)\right]$$

$$U_{11}=-\frac{48e^{\frac{4\xi}{\sqrt{13}}}}{169\left(J-e^{\frac{2\xi}{\sqrt{13}}}J+2i\,e^{\frac{\xi}{\sqrt{13}}}K\right)^4}\Bigg[3\Bigg(-67J^4+24J^2K^2+8K^4+J^4\cosh\left(\frac{4\xi}{\sqrt{13}}\right)\Bigg)-8iJK\sinh\left(\frac{\xi}{\sqrt{13}}\right)(29J^2-12K^2)+280J^2\sqrt{J^2-K^2}\cosh\left(\frac{\xi}{\sqrt{13}}\right)\left(J+i\,K\sinh\left(\frac{\xi}{\sqrt{13}}\right)\right)+2J^2\cosh\left(\frac{2\xi}{\sqrt{13}}\right)\left(-41J^2+34K^2-24iJK\sinh\left(\frac{\xi}{\sqrt{13}}\right)\right)\Bigg]$$

$$U_{12}=-\frac{48e^{\frac{4\xi}{\sqrt{13}}}}{169\left(-J+e^{\frac{2\xi}{\sqrt{13}}}J+2i\,e^{\frac{\xi}{\sqrt{13}}}K\right)^4}\Bigg[3\Bigg(-67J^4+24J^2K^2+8K^4+J^4\cosh\left(\frac{4\xi}{\sqrt{13}}\right)\Bigg)+8iJK\sinh\left(\frac{\xi}{\sqrt{13}}\right)(29J^2-12K^2)-280J^2\sqrt{J^2-K^2}\cosh\left(\frac{\xi}{\sqrt{13}}\right)\left(J-i\,K\sinh\left(\frac{\xi}{\sqrt{13}}\right)\right)+2J^2\cosh\left(\frac{2\xi}{\sqrt{13}}\right)\left(-41J^2+34K^2+24iJK\sinh\left(\frac{\xi}{\sqrt{13}}\right)\right)\Bigg]$$

J and K are two non-zero real constants that satisfy $J^2-K^2>0$.

$$U_{13}=\frac{3}{169\left(1+e^{\frac{\xi}{\sqrt{13}}}\varphi\right)^4}\left[35s^4\left(-1+e^{\frac{\xi}{\sqrt{13}}}\varphi\right)^4\pm140s^3\left(-1+e^{\frac{\xi}{\sqrt{13}}}\varphi\right)^3\left(1+e^{\frac{\xi}{\sqrt{13}}}\varphi\right)-24\left(1+e^{\frac{\xi}{\sqrt{13}}}\varphi\right)^4+140s^2\left(-1+e^{\frac{2\xi}{\sqrt{13}}}\varphi\right)^2\right]$$

$$U_{14}=\frac{3}{169\left(e^{\frac{\xi}{\sqrt{13}}}+\varphi\right)^4}\Big[e^{\frac{4\xi}{\sqrt{13}}}(-24+35s^2(2+s)^2)-4e^{\frac{3\xi}{\sqrt{13}}}(24+35s^3(2+s))\varphi+2e^{\frac{2\xi}{\sqrt{13}}}(-72+35s^2(-4+3s^2))\varphi^2-4e^{\frac{\xi}{\sqrt{13}}}(24+35s^3(-2+s))\varphi^3+(-24+35s^2(-2+s)^2)\varphi^4\Big]$$

$$U_{15}=\frac{3}{169\left(1+e^{\frac{\xi}{\sqrt{13}}}\varphi\right)^4}\left[35s^4\left(-1+e^{\frac{\xi}{\sqrt{13}}}\varphi\right)^4-140s^3\left(-1+e^{\frac{\xi}{\sqrt{13}}}\varphi\right)^3\left(1+e^{\frac{\xi}{\sqrt{13}}}\varphi\right)-24\left(1+e^{\frac{\xi}{\sqrt{13}}}\varphi\right)^4+140s^2\left(-1+e^{\frac{2\xi}{\sqrt{13}}}\varphi^2\right)^2\right]$$

where $\xi=x^\eta/\Gamma(1+\eta)+36t^\delta/169\,\Gamma(1+\delta)$

Remark 1 The exact travelling wave solutions of the fractional nonlinear Kawahara equation obtained using the generalized Bernoulli equation method for the first set of solution (Case 1) are presented in U_1-U_{15}. The corresponding exact solutions to the fractional nonlinear Kawahara equation for Cases 2-4 can be constructed in a similar way as Case 1. The travelling wave solutions to the fractional nonlinear Kawahara equation obtained were checked by putting them back into Eq. (7) with the aid of Mathematica.

IV. CONCLUSION

With the aid of fractional complex transformation which converts nonlinear fractional partial differential equations into ordinary differential equations of integer order, the fractional nonlinear Kawahara equation was converted into an integer order equivalent. The generalized Bernoulli equation method was then applied to solve the ensuing Kawahara equation. The generalized Bernoulli method is a reliable and efficient method for solving the nonlinear fractional Kawahara equation as it has the ability of producing about 60 different solutions.

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© 2015 IJSRST | Volume 1 | Issue 2 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Engineering and Technology

PERFORMANCE COMPARISON OF AODV/DSR ON-DEMAND ROUTING PROTOCOLS FOR AD HOC NETWORKS

Jethva Harikrishna
Department of Computer Engineering L. D. College of Engineering, Ahmedabad (Gujarat-India)

ABSTRACT

Ad hoc networks are characterized by multihop wireless connectivity, frequently changing network topology and the need for efficient dynamic routing protocols. I compare the performance of two prominent on demand routing protocols for mobile ad hoc networks—Dynamic Source Routing (DSR) and Ad Hoc On-Demand Distance Vector Routing (AODV). We demonstrate that even though DSR and AODV share similar on-demand behaviour, the differences in the protocol mechanics can lead to significant performance differentials. The AODV out-perform DSR in the normal situation but in the constrained situation DSR out-performs AODV, the degradation is as severe as (30%) in AODV whereas DSR degrades marginally (10%) as observed through simulation [7].
Keywords : Ad hoc networks, routing protocols, mobile networks, wireless networks, simulation, performance evaluation, AODV, DSR

I. INTRODUCTION

Wireless cellular systems have been in use since 1980s. We have seen their evolutions to first, second and third generation's wireless systems. These systems work with the support of a centralized supporting structure such as an access point. The wireless users can be connected with the wireless system by the help of these access points, when they roam from one place to the other.

The adaptability of wireless systems is limited by the presence of a fixed supporting coordinate. It means that the technology cannot work efficiently in that places where there is no permanent infrastructure. Easy and fast deployment of wireless networks will be expected by the future generation wireless systems. This fast network deployment is not possible with the existing structure of present wireless systems.

Recent advancements such as Bluetooth introduced a fresh type of wireless systems which is frequently known as mobile ad-hoc networks. Mobile ad-hoc networks or "short live" networks control in the nonexistence of permanent infrastructure. Mobile ad hoc network offers quick and horizontal network deployment in conditions where it is not possible otherwise. Ad-hoc is a Latin word, which means "for this or for this only."

Mobile ad hoc network is an autonomous system of mobile nodes connected by wireless links; each node operates as an end system and a router for all other nodes in the network. A wireless network is a growing new technology that will allow users to access services and information electronically, irrespective of their geographic position.

Wireless networks can be classified in two types: - infrastructure network and infrastructure less (ad hoc) networks. Infrastructure network consists of a network with fixed and wired gateways. A mobile host interacts with a bridge in the network (called base station) within its communication radius. The mobile unit can move geographically while it is communicating. When it goes out of range of one base station, it connects with new base station and starts communicating through it. This is called handoff. In this approach the base stations are fixed.

A Mobile ad hoc network is a group of wireless mobile computers (or nodes); in which nodes collaborate by forwarding packets for each other to allow them to communicate outside range of direct wireless transmission. Ad hoc networks require no centralized administration or fixed network infrastructure such as base stations or access points, and can be quickly and inexpensively set up as needed.

A MANET is an autonomous group of mobile users that communicate over reasonably slow wireless links. The network topology may vary rapidly and unpredictably over time, because the nodes are mobile. The network is decentralized, where all network activity, including discovering the topology and delivering messages must be executed by the nodes themselves. Hence routing functionality will have to be incorporated into the mobile nodes.

MANET is a kind of wireless ad-hoc network and it is a self-configuring network of mobile routers (and associated hosts) connected by wireless link the union of which forms an arbitrary topology. The routers, the participating nodes act as router, are free to move randomly and manage themselves arbitrarily; thus, the network's wireless topology may change rapidly and unpredictably. Such a network may operate in a standalone fashion, or may be connected to the larger Internet.

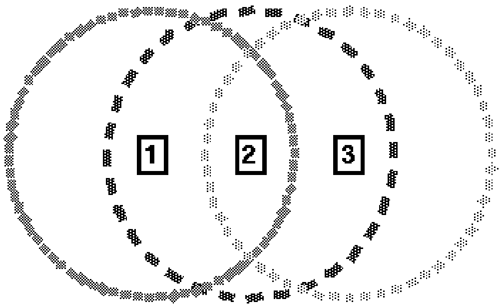


Figure1: Example of a simple ad-hoc network with three participating nodes

Mobile ad hoc network is a collection of independent mobile nodes that can communicate to each other via radio waves. The mobile nodes can directly communicate to those nodes that are in radio range of each other, whereas others nodes need the help of intermediate nodes to route their packets. These networks are fully distributed, and can work at any place without the aid of any infrastructure. This property makes these networks highly robust.

In Figure 1 nodes A and C must discover the route through B in order to communicate. are not in direct transmission range of each other, since A‘s circle does not cover C.

1.1. Characteristics of MANET

Mobile ad hoc network nodes are furnished with wireless transmitters and receivers using antennas, which may be highly directional (point-to-point), omnidirectional (broadcast), probably steerable, or some combination thereof. At a given point in time, depending on positions of nodes, their transmitter and receiver coverage patterns, communication power levels and co-channel interference levels, a wireless connectivity in the form of a random, multihop graph or "ad hoc" network exists among the nodes. This ad hoc topology may modify with time as the nodes move or adjust their transmission and reception parameters.

The characteristics of these networks are summarized as follows:

- Communication via wireless means.
- Nodes can perform the roles of both hosts and routers.
- Bandwidth-constrained, variable capacity links.
- Energy-constrained Operation.
- Limited Physical Security.
- Dynamic network topology.
- Frequent routing updates.

1.2. Advantages of MANET

The following are the advantages of MANET:

- They provide access to information and services regardless of geographic position.
- These networks can be set up at any place and time.

1.3. Disadvantages of MANET

Some of the disadvantages of MANETs are as follows:

- Limited resources and physical security.
- Intrinsic mutual trust vulnerable to attacks.
- Lack of authorization facilities.
- Volatile network topology makes it hard to detect malicious nodes.
- Security protocols for wired networks cannot work for ad hoc networks.

1.4. Applications of MANET

Some of the applications of MANETs are as follows:

- Military or police exercises.
- Disaster relief operations.
- Mine cite operations.
- Urgent Business meetings.

2. Routing in MANETs

A routing protocol is the mechanism by which user traffic is directed and transported through the network from the source node to the destination node. Objectives include maximizing network performance from the application point of view - application requirements- while minimizing the cost of network itself in accordance with its capacity. The application requirements are hop count, delay, throughput, loss rate, stability, jitter, cost; and the network capacity is a function of available resources that reside at each node and number of nodes in the network as well as its density, frequency of end-to-end connection (i.e. number of communication), frequency of topology changes (mobility rate). The four core basic routing functionalities for mobile ad hoc networks are:

Path generation: This generates paths according to the assembled and distributed state information of the network and of the application; assembling and distributing network and user traffic state information

Path selection: This selects appropriate paths based on network and application state information.

Data Forwarding: This forwards user traffic along the select route forwarding user traffic along the selected route.

Path Maintenance: Maintaining of the selected route. Consequently routing is bounded by traffic requirements, network capacity and the security requirements, as illustrated in Figure. 2

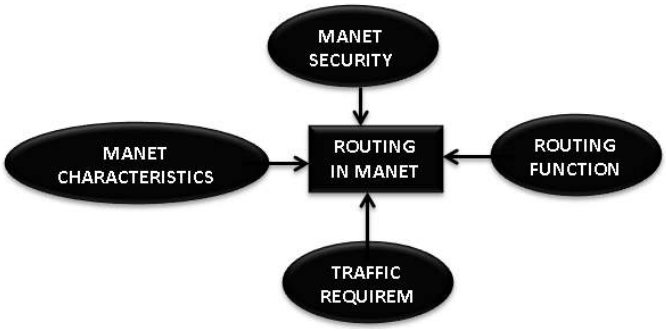


Figure 2: Routing in MANET

Due to its characteristics, other desirable features of ad hoc routing protocol include- fast route establishment, multiple routes selection, energy/bandwidth efficiency and fast adaptability to link changes. Almost all routing systems respond in some way to the changes in network and user traffic state. However, routing systems vary widely in the types of state changes to which they respond and the speed of their response. Routing states can be divided into three categories - Static, Quasi Static and Dynamic. Further, each of the three basic routing functions may be implemented in three ways- Centralized, Decentralized and Distributed.

On-Demand Routing (Reactive Protocols)

In reactive protocols, routes are determined when they are required by the source using a route discovery process. These protocols were designed to reduce the overhead encountered in proactive protocols by maintaining information for active routes only. This means that the routes are determined and maintained for the nodes that are required to send data to a particular destination. Route discovery usually occurs by flooding route request packets through the network. When a node with a route to the destination (or the destination itself) is reached a route reply is sent back to the source node using link reversal if the route request has traveled through the bi-directional links or by piggy-backing the route in a route reply packet via flooding. Therefore, the route discovery overhead (in the worst case scenario) will grow by O(N+M) when link reversal is possible and O(2N) for unidirectional links (where, N represents the total number of nodes and M represents the total number of nodes in the localized region).

II. METHODS AND MATERIAL

Reactive protocols can be classified into two categories:

- Source routing, and
- Hop-by-Hop routing

In Source routed on-demand protocols, each data packets carry the complete source to destination address. Therefore, each intermediate node forwards these packets according to the information kept in the header of each packet. This means that the intermediate nodes do not need to maintain up-to-date routing information for each active route in order to forward the packet towards the destination. Furthermore, nodes do not need to maintain neighbor's connectivity through periodic beaconing messages. The major drawback with source routing protocols is that in large networks they do not perform well.

In hop-by-hop routing (also known as point-to-point routing), each data packet only carries the destination address and the next hop address. Therefore, each intermediate node in the path to the destination uses its routing table to forward each data packet towards the destination. The advantage of this strategy is that routes are adaptable to the dynamically changing environment of MANETs, since each node can update its routing table when they receiver fresher topology information and hence forward the data packets over fresher and better routes. The disadvantage of this strategy is that each intermediate node must store and maintain routing information for each active route and each node may require being aware of their surrounding neighbors through the use of beaconing messages. This following section describes the three protocols along with their performance comparison. The performance metrics represent the worst-case scenario.

1) Ad hoc On-demand Distance Vector (AODV)

The AODV routing protocol is based on DSDV and DSR algorithm. It uses the periodic beaconing and sequence numbering procedure of DSDV and a similar route discovery procedure as in DSR. However, there are two major differences between DSR and AODV. The most distinguishing difference is that in DSR each packet carries full routing information, whereas in AODV the packets carry the destination address. This means that AODV has potentially less routing overheads than DSR. The other difference is that the route replies in DSR carry the address of every node along the route, whereas in AODV the route replies only carry the destination IP address and the sequence number. The advantage of AODV is that it is adaptable to highly dynamic networks. However, node may experience large delays during route construction, and link failure may initiate another route discovery, which introduces extra delays and consumes more bandwidth as the size of the network increases.

Ad hoc On-Demand Distance Vector (AODV) routing is a routing protocol for mobile ad hoc networks and other wireless ad-hoc networks. It is jointly developed in Nokia Research Centre of University of California, Santa Barbara and University of Cincinnati by C. Perkins and S. Das. It is an on-demand and distance-vector routing protocol, meaning that a route is established by AODV from a destination only on demand[1,4].

AODV is capable of both unicast and multicast routing. It keeps these routes as long as they are desirable by the sources. Additionally, AODV creates trees which connect multicast group members. The trees are composed of the group members and the nodes needed to connect the members. The sequence numbers are used by AODV to ensure the freshness of routes. It is loop-free, self-starting, and scales to large numbers of mobile nodes. AODV defines three types of control messages for route maintenance:

RREQ-A route request message is transmitted by a node requiring a route to a node. As an optimization AODV uses an expanding ring technique when flooding these messages. Every RREQ carries a time to live (TTL) value that states for how many hops this message should be forwarded. This value is set to a predefined value at the first transmission and increased at retransmissions. Retransmissions occur if no replies are received. Data packets waiting to be transmitted (i.e. the packets that initiated the RREQ). Every node maintains two separate counters: a node sequence number and a broadcast_ id. The RREQ contains the following fields:-
Source address, broadcast ID, source sequence number, destination address, destination sequence number and hop count[2,3].

The pair < source address, broadcast ID> uniquely identifies a RREQ. Broadcast_id is incremented whenever the source issues a new RREQ.

RREP- A route reply message is unicasted back to the originator of a RREQ if the receiver is either the node using the requested address, or it has a valid route to the requested address. The reason one can unicast the message back, is that every route forwarding a RREQ caches a route back to the originator[2].

RERR- Nodes monitor the link status of next hops in active routes. When a link breakage in an active route is detected, a RERR message is used to notify other nodes of the loss of the link. In order to enable this reporting mechanism, each node keeps a ―precursor list", containing the IP address for each its neighbors that are likely to use it as a next hop towards each destination[3].

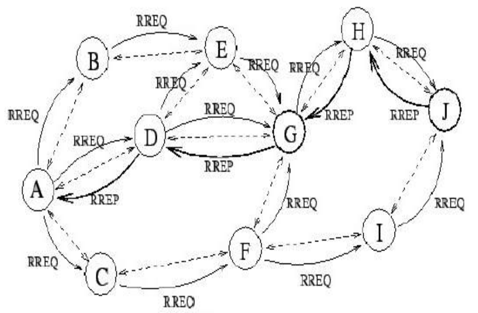


Figure 3: A possible path for a route replies if A wishes to find a route to J

The above Figure 3 illustrates an AODV route lookup session. Node A wants to initiate traffic to node J for which it has no route. A transmit of a RREQ has been done, which is flooded to all nodes in the network. When this request is forwarded to J from H, J generates a RREP. This RREP is then unicasted back to A using the cached entries in nodes H, G and D.

AODV builds routes using a route request/route reply query cycle. When a source node desires a route to a destination for which it does not already have a route, it broadcasts a route request (RREQ) packet across the network. Nodes receiving this packet update their information for the source node and set up backwards pointers to the source node in the route tables. In addition to the source node's IP address, current sequence number, and broadcast ID, the RREQ also contains the most recent sequence number for the destination of which the source node is aware. A node getting the RREQ may send a route reply (RREP) if it is either the destination or if it has a route to the destination with corresponding sequence number greater than or equal to that contained in the RREQ. If this is the case, it unicast a RREP back to the source. Otherwise, it rebroadcasts the RREQ. Nodes keep track of the RREQ's source IP address and broadcast ID. If they receive a RREQ which they have already processed, they discard the RREQ and do not forward it.

As the RREP propagates back to the source, nodes set up forward pointers to the destination. Once the source node receives the RREP, it may begin to forward data packets to the destination. If the source later receives a RREP containing a greater sequence number or contains the same sequence number with a smaller hop count, it may update its routing information for that destination and begin using the better route.

As long as the route remains active, it will continue to be maintained. A route is considered active as long as there are data packets periodically travelling from the source to the destination along that path. Once the source stops sending data packets, the links will time out and eventually be deleted from the intermediate node routing tables. If a link break occurs while the route is active, the node upstream of the break propagates a route error (RERR) message to the source node to inform it of the now unreachable destinations. After receiving the RERR, if the source node still desires the route, it can reinitiate route discovery[2].

Multicast routes are set up in a similar manner. A node wishing to join a multicast group broadcasts a RREQ with the destination IP address set to that of the multicast group and with the 'J'(join) flag set to indicate that it would like to join the group. Any node receiving this RREQ that is a member of the multicast tree that has a fresh enough sequence number for the multicast group may send a RREP. As the RREPs propagate back to the source, the nodes forwarding the message set up pointers in their multicast route tables. As the source node receives the RREPs, it keeps track of the route with the freshest sequence number, and beyond that the smallest hop count to the next multicast group member. After the specified discovery period, the source nodes will unicast a Multicast Activation (MACT) message to its selected next hop. This message serves the purpose of activating the route. A node that does not receive this message that had set up a multicast route pointer will timeout and delete the pointer. If the node receiving the MACT was not already a part of the multicast tree, it will also have been keeping track of the best route from the RREPs it received. Hence it must also unicast a MACT to its next hop, and so on until a node that was previously a member of the multicast tree is reached. AODV maintains routes for as long as the route is active. This includes maintaining a multicast tree for the life of the multicast group. Because the network nodes are mobile, it is likely that many link breakages along a route will occur during the lifetime of that route.

The counting to infinity‖ problem is avoided by AODV from the classical distance vector algorithm by using sequence numbers for every route. The counting to infinity problem is the situation where nodes update each other in a loop.

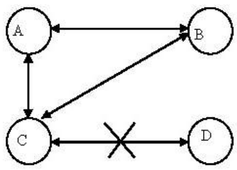


Figure 4: Counting to infinity problem

Consider nodes A, B, C and D making up a MANET as illustrated in Figure 4. A is not updated on the fact that its route to D via C is broken. This means that A has a registered route, with a metric of 2, to D. C has registered that the link to D is down, so once node B is updated on the link breakage between C and D, it will calculate the shortest path to D to be via A using a metric of 3.C receives information that B can reach D in 3 hops and updates its metric to 4 hops. A then registers an update in hop-count for its route to D via C and updates the metric to 5. So they continue to increment the metric in a loop.

The way this is avoided in AODV, for the example described, is by B noticing that as route to D is old based on a sequence number. B will then discard the route and C will be the node with the most recent routing information by which B will update its routing table.

Characteristics of AODV

- Unicast, Broadcast, and Multicast communication.
- On-demand route establishment with small delay.
- Multicast trees connecting group members maintained for lifetime group.
- Link breakages in active routes efficiently repaired.
- All routes are loop-free through use of sequence numbers.
- Use of Sequence numbers to track accuracy of information.
- Only keeps track of next hop for a route instead of the entire route.
- Use of periodic HELLO messages to track neighbors.

Advantages and Disadvantages

The main advantage of AODV protocol is that routes are established on demand and destination sequence numbers are used to find the latest route to the destination. The connection setup delay is less. The HELLO messages supporting the routes maintenance are range-limited, so they do not cause unnecessary overhead in the network.

One of the disadvantages of this protocol is that intermediate nodes can lead to inconsistent routes if the source sequence number is very old and the intermediate nodes have a higher but not the latest destination sequence number, thereby having stale entries. Also multiple Route Reply packets in response to a single Route Request packet can lead to heavy control overhead. Another disadvantage of AODV is that the periodic beaconing leads to unnecessary bandwidth consumption.

2) Dynamic State Routing (DSR)

The DSR protocol requires each packet to carry the full address every hop in the route, from source to the destination. This means that the protocol will not be very effective in large networks, as the amount of overhead carried in the packet will continue to increase as the network diameter increases.

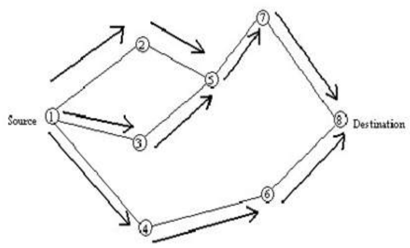
Therefore, in highly dynamic and large networks the overhead may consume most of the bandwidth. However, this protocol has a number of advantages over other routing protocols, and in small to moderately size networks (perhaps up to a few hundred nodes), this protocol performs better. An advantage of DSR is that nodes can store multiple routes in their route cache, which means that the source node can check its route cache for a valid route before initiating route discovery, and if a valid route is found there is no need for route discovery. This is very beneficial in network with low mobility, because the routes stored in the route cache will be valid for a longer period of time. Another advantage of DSR is that it does not require any periodic beaconing (or hello message exchanges), therefore nodes can enter sleep node to conserve their power. This also saves a considerable amount of bandwidth in the network. A full description of this protocol appears in later text.

Dynamic Source Routing (DSR) is a routing protocol for wireless mesh networks.[5] It is similar to AODV in that it establishes a route on-demand when a transmitting mobile node requests one. However, it uses source routing instead of relying on the routing table at each intermediate device.

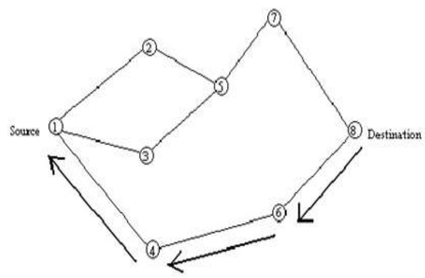
Dynamic source routing protocol (DSR) is an on-demand, source routing protocol, whereby all the routing information is maintained at mobile nodes. DSR allows the network to be completely self-organizing and self-configuring, without the need for any existing network infrastructure or administration. The protocol is composed of the two main mechanisms of "Route Discovery" and "Route Maintenance", which work together to allow nodes to discover and maintain routes to arbitrary destinations in the ad hoc network[5]. An optimum path for a communication between a source node and target node is determined by Route Discovery process. Route Maintenance ensures that the communication path remains optimum and loop-free according the change in network conditions, even if this requires altering the route during a transmission. Route Reply would only be generated if the message has reached the projected destination node, route record which is firstly contained in Route Request would be inserted into the Route Reply.

To return the Route Reply, the destination node must have a route to the source node. If the route is in the route cache of target node, the route would be used. Otherwise, the node will reverse the route based on the route record in the Route Reply message header - symmetric links. In the event of fatal transmission, the Route Maintenance Phase is initiated whereby the Route Error packets are generated at a node. The incorrect hop will be detached from the node's route cache; all routes containing the hop are reduced at that point. Again, the Route Discovery Phase is initiated to determine the most viable route.

The major dissimilarity between this and the other on-demand routing protocols is that it is beacon-less and hence it does not have need of periodic hello packet transmissions, which are used by a node to inform its neighbors of its presence. The fundamental approach of this protocol during the route creation phase is to launch a route by flooding RouteRequest packets in the network. The destination node, on getting a RouteRequest packet, responds by transferring a RouteReply packet back to the source, which carries the route traversed by the RouteRequest packet received.



(a). Propagation of request (PREQ) packet



(b). Path taken by the Route Reply (RREP) packet

Figure 5: Creation of route in DSR

A destination node, after receiving the first RouteRequest packet, replies to the source node through the reverse path the RouteRequest packet had traversed. Nodes can also be trained about the neighbouring routes traversed by data packets if operated in the promiscuous mode. This route cache is also used during the route construction phase. If an intermediary node receiving a RouteRequest has a route to the destination node in its route cache, then it replies to the source node by sending a RouteReply with the entire route information from the source node to the destination node.

Advantages and Disadvantages

DSR uses a reactive approach which eliminates the need to periodically flood the network with table update messages which are required in a table-driven approach. The intermediate nodes also utilize the route cache information efficiently to reduce the control overhead.

The disadvantage of DSR is that the route maintenance mechanism does not locally repair a broken down link[5]. The connection setup delay is higher than in table driven protocols. Even though the protocol performs well in static and low-mobility environments, the performance degrades rapidly with increasing mobility. Also, considerable routing overhead is involved due to the source-routing mechanism employed in DSR. This routing overhead is directly proportional to the path length.

3) Related Work

The performance differentials are analyzed using varying network load, mobility and network size. The internet connectivity may frequently create scenarios of multiple sources with constant bit rate traffic leading to common destination. In this paper, the performance of AODV and DSR are compared in normal and constrained scenarios for getting conclusions[7].

4) Simulation Environment

We simulated on Network Simulator [6], an event driven network simulator developed at UC Berkeley that simulates variety of IP networks.

To setup a simulation network, an OTCL script is written and to simulate it the script is executed which initiates an event scheduler and the network topology is setup using the network objects, controlling the traffic sources and the time to start and stop the transmitting of packets.

NAM and Xgraph are used for running the simulations. The biggest advantage of network animator (NAM) is that it provides a graphical user interface (GUI) for the different simulation environment according to the parameters specified by the user. The Xgraph utility generates the graphical output of the input data (or trace files).

To evaluate the performance of protocol in MANET, the protocol should be tested under realistic conditions such as – transmission range, data traffic, movement of mobile users etc. The simulations here use the Random Waypoint Mobility Model. It includes pause times between changes in destination and speed. The Random Waypoint model uses the concepts of epoch and pause making it a little bit more similar to realistic user mobility model.

Evaluations based on throughput and Packet delivery fraction comparison.

For all the simulations, the same movement model is used. The maximum speed of the nodes was set to 20m/s.

The number of nodes varied for 10 and 15.

The Simulation time was varied as 10s and 25s.

Table 1: Simulation Scenario for Simulation time as 10s and 25s for 10 nodes

Parameter	Value
Number of nodes	**10**
Simulation Time	10 sec and 25 sec
Pause Time	5ms
Environment Size	800x800
Transmission Range	250 m
Traffic Size	Constant Bit Rate
Packet Size	512 bytes
Packet Rate	5 packets/s
Maximum Speed	20 m/s
Queue Length	50
Simulator	ns-2.34
Mobility Model	Random Waypoint
Antenna Type	Omni directional

Table 2: Simulation Scenario for Simulation time as 10s and 25s for 15 nodes

Parameter	Value
Number of nodes	**15**
Simulation Time	10 sec and 25sec
Pause Time	5ms
Environment Size	800x800
Transmission Range	250 m
Traffic Size	Constant Bit Rate
Packet Size	512 bytes
Packet Rate	5 packets/s
Maximum Speed	20 m/s
Queue Length	50
Simulator	ns-2.34
Mobility Model	Random Waypoint
Antenna Type	Omni directional

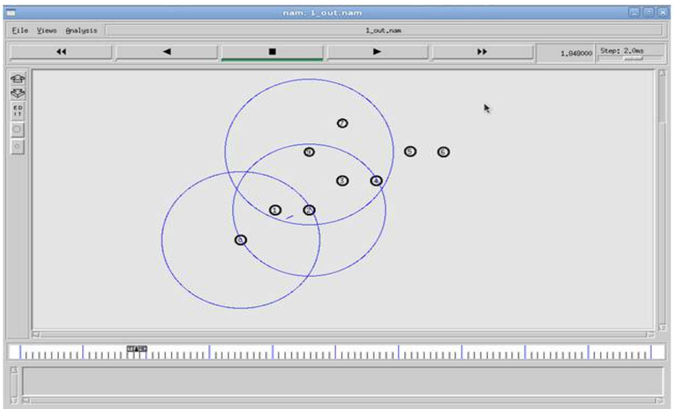
III. RESULT AND DISCUSSION

5) Simulation Results

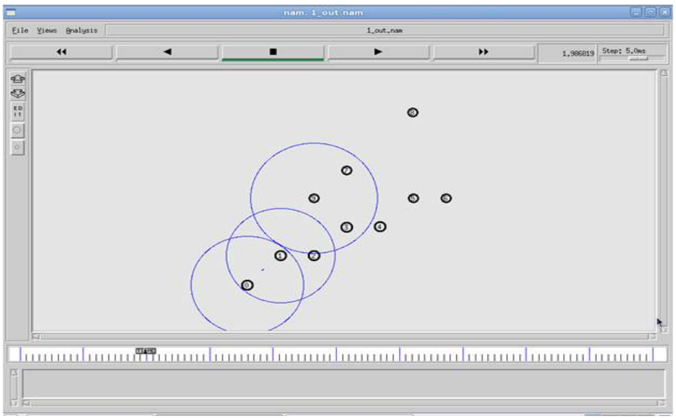
Experiments are conducted with CBR traffic sources sessions between different to common destination using AODV and DSR. The performance metric is Average Packet delivery rate. It was observed that AODV performs better than DSR in normal case. In another experiment four different CBR traffic sources started sessions with a common destination. The performance comparisons reflect that AODV suffers degradation of 30% whereas DSR suffers 10% compared to the normal situation (shown in Graphs)[7,8]. On comparing their performances, it was observed that DSR performs better than AODV under the constrained situation[7].

Simulation Graphs

1) A Screenshot of 10 nodes of AODV NAM – Network animator

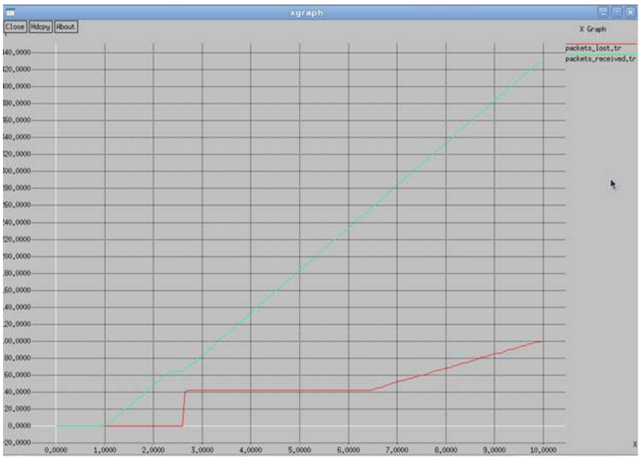


2) A Screenshot of 10 nodes of DSR NAM – Network animator



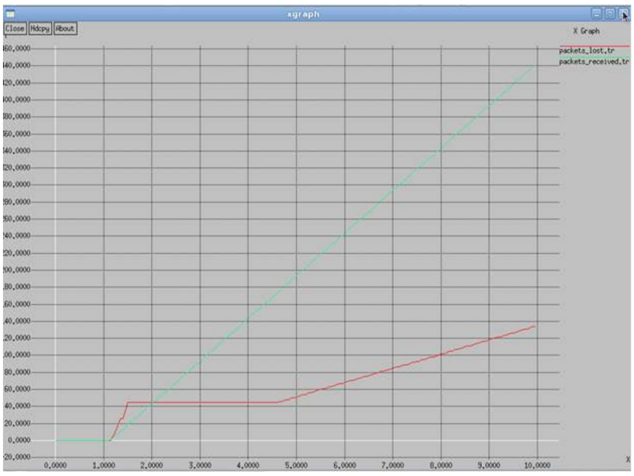
3) X Graph of 10 seconds simulation time of AODV with 10 nodes

From fig, as the simulation start the packet received and packet loss is initially zero, because initially there is no CBR connection and nodes taking their right place. As the CBR connections establish between the nodes the number of packet received increases but no packet loss is there, it means all generated packets are being received by the nodes. But the packet loss increases substantially on the simulation time increases. Finally the packet received is more than the packet loss.

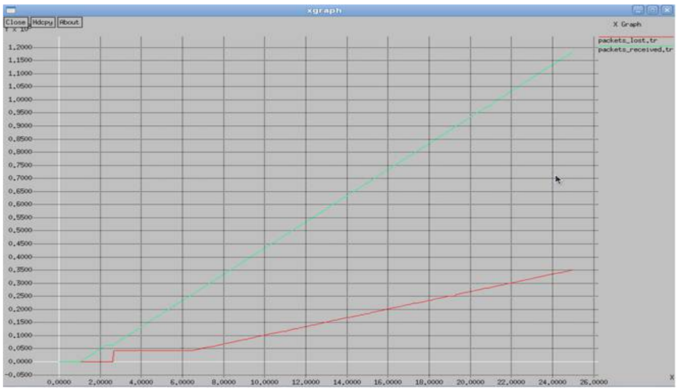


4) X Graph of and 10 seconds simulation time of DSR with 10 nodes

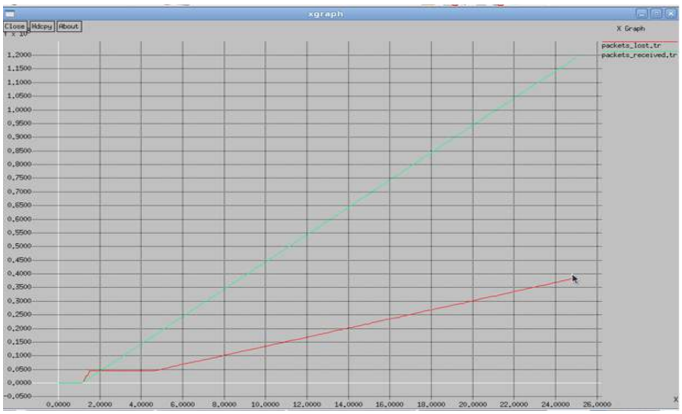
By the Figure we see that as the simulation start the packet received and packet loss is initially zero, because initially there is no CBR connection and nodes taking their right place. As the CBR connections establish the number of packet lost increases very much as compare to packet received. It shows that mostly generated packets are being dropped by the nodes. But the packet loss decreases substantially on the simulation time increases, and number of packet received increases substantially on the simulation time increases.



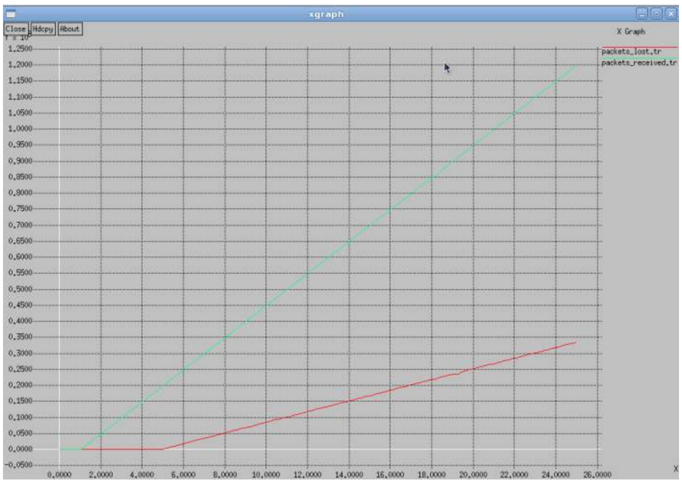
5) X Graph of 25 seconds simulation time of AODV with 10 nodes



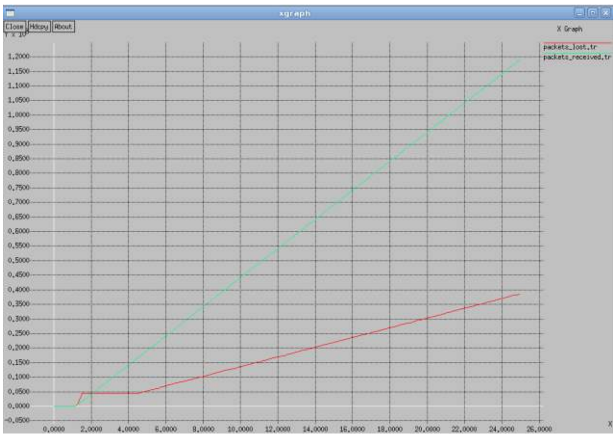
6) X Graph of 25 seconds simulation time of DSR with 10 nodes



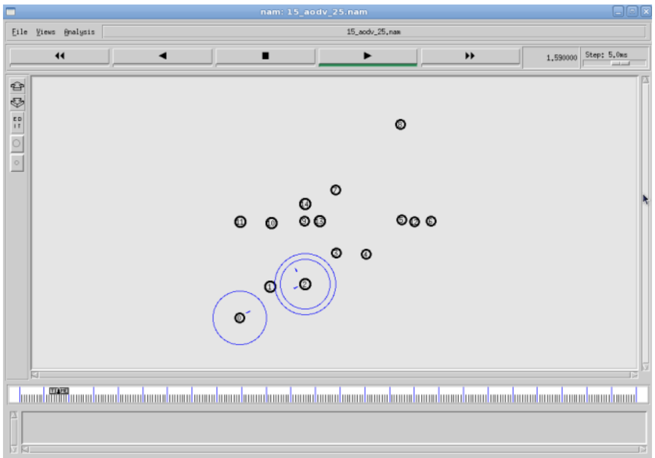
7) X Graph of 25 seconds simulation time of AODV with 15 nodes



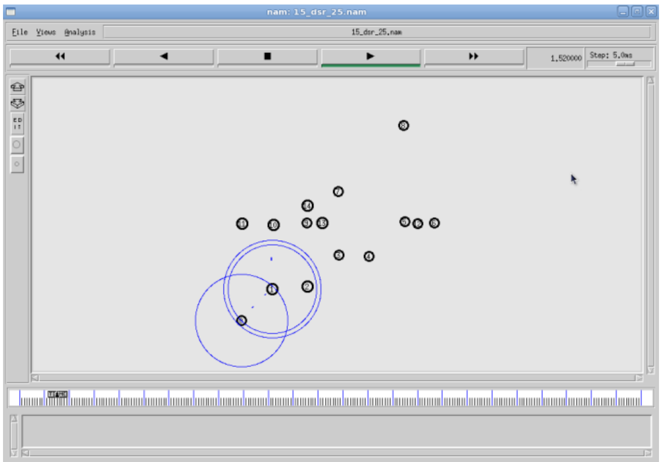
8) X Graph of 25 seconds simulation time of DSR with 15 nodes



9) A Screenshot of 15 nodes of AODV NAM – Network animator



10) A Screenshot of 15 nodes of AODV NAM – Network animator



IV. CONCLUSION

We could observe that the performance of reactive routing protocol depends upon the scenario. In normal cases AODV performs better than DSR using various performance metrics. DSR works better than AODV in constrained situation of several CBR traffic sources leading to same destination in the mobile communicating nodes [7].

We could also see the same behaviour of AODV & DSR in fact of packet receiving and packet loss. Initially there is no packet loss in AODV and a very high packet loss in DSR. But as the simulation time increases, the packet loss decreases and the packet receiving increases [7].

Moreover it can also be seen that AODV performs better with dynamic topology whereas DSR performs over AODV with static topologies.

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© 2015 IJSRST | Volume 1 | Issue 2 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Engineering and Technology

Data Integrity Proof In Cloud Storage

Bhavesh Prajapati
Department of Information Technology, L. D. College of Engineering, Ahmedabad, Gujarat, India

ABSTRACT

Cloud computing has been envisioned as the de-facto solution to the rising storage costs of IT Enterprises. With the high costs of data storage devices as well as the rapid rate at which data is being generated it proves costly for enterprises or individual users to frequently update their hardware. Apart from reduction in storage costs data outsourcing to the cloud also helps in reducing the maintenance. Cloud storage moves the user's data to large data centres, which are remotely located, on which user does not have any control. However, this unique feature of the cloud poses many new security challenges which need to be clearly understood and resolved. We provide a scheme which gives a proof of data integrity in the cloud which the customer can employ to check the correctness of his data in the cloud. This proof can be agreed upon by both the cloud and the customer and can be incorporated in the Service level agreement (SLA).

Keywords: DNS Hacking, QoS Violation, Denial of Service, Man in the Middle Attack, IP Spoofing, Data Sanitization, Data centre Security, Cloud Computing, Proof of irretrievability, Service level agreement, Cloud storage

I. INTRODUCTION

Data outsourcing to cloud storage servers is raising trend among many firms and users owing to its economic advantages. This essentially means that the owner (client) of the data moves its data to a third party cloud storage server which is supposed to - presumably for a fee - faithfully store the data with it and provide it back to the owner whenever required.

As data generation is far outpacing data storage it proves costly for small firms to frequently update their hardware whenever additional data is created. Also maintaining the storages can be a difficult task. Storage outsourcing of data to cloud storage helps such firms by reducing the costs of storage, maintenance and personnel. It can also assure a reliable storage of important data by keeping multiple copies of the data thereby reducing the chance of losing data by hardware failures.

Storing of user data in the cloud despite its advantages has many interesting security concerns which need to be extensively investigated for making it a reliable solution to the problem of avoiding local storage of data. In this paper we deal with the problem of implementing a protocol for obtaining a proof of data possession in the cloud sometimes referred to as Proof of retrievability (POR).This problem tries to obtain and verify a proof that the data that is stored by a user at a remote data storage in the cloud (called cloud storage archives or simply archives) is Not modified by the archive and thereby the integrity of the data is assured.

Such verification systems prevent the cloud storage archives from misrepresenting or modifying the data stored at it without the consent of the data owner by using frequent checks on the storage archives. Such checks must allow the data owner to efficiently, frequently, quickly and securely verify that the cloud archive is not cheating the owner. Cheating, in this context, means that the storage archive might delete some of the data or may modify some of the data.

Purpose

Purpose of developing proofs for data possession at untrusted cloud storage servers we are often limited by the resources at the cloud server as well as at the client. Given that the data sizes are large and are stored at remote servers, accessing the entire file can be expensive in I/O costs to the storage server. Also transmitting the file across the network to the client can consume heavy bandwidths. Since growth in storage capacity has far outpaced the growth in data access as well as network bandwidth, accessing and transmitting the entire archive even occasionally greatly limits the scalability of the network resources. Furthermore, the I/O to establish the data proof interferes with the on-demand bandwidth of the server used for normal storage and retrieving purpose.

Scope

Cloud storing its data file F at the client should process it and create suitable metadata which is used in the later stage of verification the data integrity at the cloud storage. When checking for data integrity the client queries the cloud storage for suitable replies based on which it concludes the integrity of its data stored in the client. our data integrity protocol the verifier needs to store only a single cryptographic key - irrespective of the size of the data file F- and two functions which generate a random sequence. The verifier does not store any data with it. The verifier before storing the file at the archive pre-processes the file and appends some metadata to the file and stores at the archive.

Proposed Product Features

Our scheme was developed to reduce the computational and storage overhead of the client as well also minimizes the computational overhead of the cloud storage server. We also minimized the size of the proof of data integrity so as to reduce the network bandwidth consumption. Hence the storage at the client is very much minimal compared to all other schemes that were developed. Hence this scheme proves advantageous to thin clients like PDAs and mobile phones.

The operation of encryption of data generally consumes a large computational power. In our scheme the encrypting process is very much limited to only a fraction of the whole data thereby saving on the computational time of the client. Many of the schemes proposed earlier require the archive to perform tasks that need a lot of computational power to generate the proof of data integrity. But in our scheme the archive just need to fetch and send few bits of data to the client.

II. METHODS AND MATERIAL

Problem Definition

Storing of user data in the cloud despite its advantages has many interesting security concerns which need to be extensively investigated for making it a reliable solution to the problem of avoiding local storage of data. Many problems like data authentication and integrity (i.e., how to efficiently and securely ensure that the cloud storage server returns correct and complete results in response to its clients' queries, outsourcing encrypted data and associated difficult problems dealing with querying over encrypted domain were discussed in research literature.

Existing System

As data generation is far outpacing data storage it proves costly for small firms to frequently update their hardware whenever additional data is created. Also maintaining the storages can be a difficult task. It transmitting the file across the network to the client can consume heavy bandwidths. The problem is further complicated by the fact that the owner of the data may be a small device, like a PDA (personal digital assist) or a mobile phone, which have limited CPU power, battery power and communication bandwidth.

Limitations of Existing

System

- The main drawback of this scheme is the high resource costs it requires for the implementation.
- Also computing hash value for even a moderately large data files can be computationally burdensome for some clients (PDAs, mobile phones, etc.).
- Data encryption is large so the disadvantage is small users with limited computational power (PDAs, mobile phones etc.).

Proposed System

One of the important concerns that need to be addressed is to assure the customer of the integrity i.e. correctness of his data in the cloud. As the data is physically not accessible to the user the cloud should provide a way for the user to check if the integrity of his data is maintained or is compromised. In this paper we provide a scheme which gives a proof of data integrity in the cloud which the customer can employ to check the correctness of his data in the cloud. This proof can be agreed upon by both the cloud and the customer and can be incorporated in the Service level agreement (SLA). It is important to note that our proof of data integrity protocol just checks the integrity of data i.e. if the data has been illegally modified or deleted.

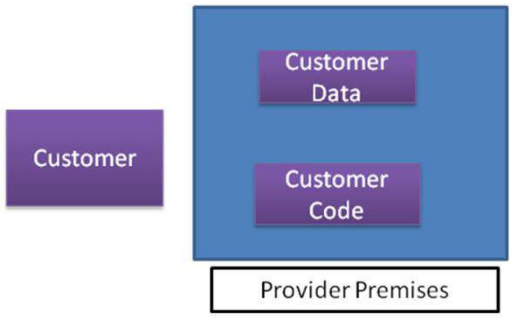
Advantages of Proposed System

- Apart from reduction in storage costs data outsourcing to the cloud also helps in reducing the maintenance.
- Avoiding local storage of data.
- By reducing the costs of storage, maintenance and personnel.
- It reduces the chance of losing data by hardware failures.
- Not cheating the owner.

III. RESULTS AND DISCUSSION

Security a major Concern

- Security concerns arising because both customer data and program are residing in Provider Premises.
- Security is always a major concern in Open System Architectures

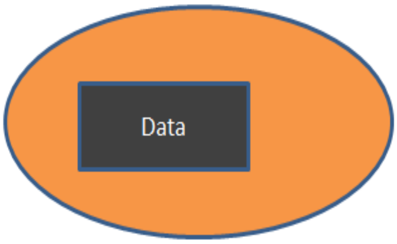


Data centre Security?

- Professional Security staff utilizing video surveillance, state of the art intrusion detection systems, and other electronic means.
- When an employee no longer has a business need to access datacenter his privileges to access datacenter should be immediately revoked.
- All physical and electronic access to data centers by employees should be logged and audited routinely.
- Audit tools so that users can easily determine how their data is stored, protected, used, and verify policy enforcement.

Data Location

- When user uses the cloud, user probably won't know exactly where your data is hosted, what country it will be stored in?
- Data should be stored and processed only in specific jurisdictions as define by user.
- Provider should also make a contractual commitment to obey local privacy requirements on behalf of their customers,
- Data-centered policies that are generated when a user provides personal or sensitive information, that travels with that information throughout its lifetime to ensure that the information is used only in accordance with the policy



Backups of Data

- Data store in database of provider should be redundantly store in multiple physical locations.
- Data that is generated during running of program on instances is all customer data and therefore provider should not perform backups.
- Control of Administrator on Databases.

Data Sanitization

- Sanitization is the process of removing sensitive information from a storage device.
- What happens to data stored in a cloud computing environment once it has passed its user's "use by date"
- What data sanitization practices does the cloud computing service provider propose to implement for redundant and retiring data storage devices as and when these devices are retired or taken out of service.

Network Security

- **Denial of Service**: where servers and networks are brought down by a huge amount of network traffic and users are denied the access to a certain Internet based service.

- **Like DNS Hacking**, Routing Table "Poisoning", XDoS attacks
- **QoS Violation**: through congestion, delaying or dropping packets, or through resource hacking.
- **Man in the Middle Attack**: To overcome it always use SSL
- **IP Spoofing**: Spoofing is the creation of TCP/IP packets using somebody else's IP address.
- **Solution**: Infrastructure will not permit an instance to send traffic with a source IP or MAC address other than its own.

How secure is encryption Scheme:

- Is it possible for all of my data to be fully encrypted?
- What algorithms are used?
- Who holds, maintains and issues the keys? Problem:
- Encryption accidents can make data totally unusable.
- Encryption can complicate availability Solution
- The cloud provider should provide evidence that encryption schemes were designed and tested by experienced specialists.

Information Security

- Security related to the information exchanged between different hosts or between hosts and users.
- This issues pertaining to secure communication, authentication, and issues concerning single sign on and delegation.
- Secure communication issues include those security concerns that arise during the communication between two entities.
- These include confidentiality and integrity issues. Confidentiality indicates that all data sent by users should be accessible to only "legitimate" receivers, and integrity indicates that all data received should only be sent/modified by "legitimate" senders.

Solution: public key encryption, X.509 certificates, and the Secure Sockets Layer (SSL) enables secure authentication and communication over computer networks.

IV. CONCLUSION

In this paper we have worked to facilitate the client in getting a proof of integrity of the data which he wishes to store in the cloud storage servers with bare minimum costs and efforts. Our scheme was developed to reduce the computational and storage overhead of the client as well as to minimize the computational overhead of the cloud storage server. We also minimized the size of the proof of data integrity so as to reduce the network bandwidth consumption. Many of the schemes proposed earlier require the archive to perform tasks that need a lot of computational power to generate the proof of data integrity. But in our scheme the archive just need to fetch and send few bits of data to the client.

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