Online ISSN : 0975-4172
Print ISSN : 0975-4350

Global Journal of Computer Science and Technology : E

Network, Web & Security

DISCOVERING THOUGHTS AND INVENTING FUTURE

HIGHLIGHTS

- Wireless Cellular Networks
- MultiRate Signal Processing
- Routing Protocols for Mobile
- Advanced Packet Inspection

Computer Server Farm

Volume 12 | Issue 13 | Version 1.0

ENG

Global Journal of Computer Science and Technology: E
Network, Web & Security

Global Journal of Computer Science and Technology: E
Network, Web & Security

Volume 12 Issue 13 (Ver. 1.0)

Open Association of Research Society

Incorporation No.: 0423089
License No.: 42125/022010/1186
Registration No.: 430374
Import-Export Code: 1109007027
Employer Identification Number (EIN):
USA Tax ID: 98-0673427

Global Journals Inc.

(A Delaware USA Incorporation with "Good Standing"; Reg. Number: 0423089)

Sponsors:Global Association of Research

Open Scientific Standards

Publisher's Headquarters office

Global Journals Inc., Headquarters Corporate Office, Cambridge Office Center, II Canal Park, Floor No. 5th, ***Cambridge (Massachusetts)***, Pin: MA 02141 United States

USA Toll Free: +001-888-839-7392

USA Toll Free Fax: +001-888-839-7392

Offset Typesetting

Global Association of Research, Marsh Road, Rainham, Essex, London RM13 8EU United Kingdom.

Packaging & Continental Dispatching

Global Journals, India

Find a correspondence nodal officer near you

To find nodal officer of your country, please email us at *local@globaljournals.org*

eContacts

Press Inquiries: *press@globaljournals.org*
Investor Inquiries: *investers@globaljournals.org*
Technical Support: *technology@globaljournals.org*
Media & Releases: *media@globaljournals.org*

Pricing (Including by Air Parcel Charges):

For Authors:
22 USD (B/W) & 50 USD (Color)
Yearly Subscription (Personal & Institutional):
200 USD (B/W) & 250 USD (Color)

Editorial Board Members (HON.)

Dr. Bart Lambrecht
Director of Research in Accounting and FinanceProfessor of Finance
Lancaster University Management School
BA (Antwerp); MPhil, MA, PhD (Cambridge)

Dr. Carlos García Pont
Associate Professor of Marketing
IESE Business School, University of Navarra
Doctor of Philosophy (Management), Massachusetts Institute of Technology (MIT)
Master in Business Administration, IESE, University of Navarra
Degree in Industrial Engineering, Universitat Politècnica de Catalunya

Dr. Fotini Labropulu
Mathematics - Luther College
University of ReginaPh.D., M.Sc. in Mathematics
B.A. (Honors) in Mathematics
University of Windso

Dr. Lynn Lim
Reader in Business and Marketing
Roehampton University, London
BCom, PGDip, MBA (Distinction), PhD, FHEA

Dr. Mihaly Mezei
ASSOCIATE PROFESSOR
Department of Structural and Chemical Biology, Mount Sinai School of Medical Center
Ph.D., Etvs Lornd University
Postdoctoral Training,
New York University

Dr. Söhnke M. Bartram
Department of Accounting and FinanceLancaster University Management SchoolPh.D. (WHU Koblenz)
MBA/BBA (University of Saarbrücken)

Dr. Miguel Angel Ariño
Professor of Decision Sciences
IESE Business School
Barcelona, Spain (Universidad de Navarra)
CEIBS (China Europe International Business School).
Beijing, Shanghai and Shenzhen
Ph.D. in Mathematics
University of Barcelona
BA in Mathematics (Licenciatura)
University of Barcelona

Philip G. Moscoso
Technology and Operations Management
IESE Business School, University of Navarra
Ph.D in Industrial Engineering and Management, ETH Zurich
M.Sc. in Chemical Engineering, ETH Zurich

Dr. Sanjay Dixit, M.D.
Director, EP Laboratories, Philadelphia VA Medical Center
Cardiovascular Medicine - Cardiac Arrhythmia
Univ of Penn School of Medicine

Dr. Han-Xiang Deng
MD., Ph.D
Associate Professor and Research
Department Division of Neuromuscular Medicine
Davee Department of Neurology and Clinical NeuroscienceNorthwestern University
Feinberg School of Medicine

Dr. Pina C. Sanelli
Associate Professor of Public Health
Weill Cornell Medical College
Associate Attending Radiologist
NewYork-Presbyterian Hospital
MRI, MRA, CT, and CTA
Neuroradiology and Diagnostic Radiology
M.D., State University of New York at Buffalo,School of Medicine and Biomedical Sciences

Dr. Roberto Sanchez
Associate Professor
Department of Structural and Chemical Biology
Mount Sinai School of Medicine
Ph.D., The Rockefeller University

Dr. Wen-Yih Sun
Professor of Earth and Atmospheric SciencesPurdue University Director
National Center for Typhoon and Flooding Research, Taiwan
University Chair Professor
Department of Atmospheric Sciences, National Central University, Chung-Li, TaiwanUniversity Chair Professor
Institute of Environmental Engineering, National Chiao Tung University, Hsin-chu, Taiwan.Ph.D., MS The University of Chicago, Geophysical Sciences
BS National Taiwan University, Atmospheric Sciences
Associate Professor of Radiology

Dr. Michael R. Rudnick
M.D., FACP
Associate Professor of Medicine
Chief, Renal Electrolyte and Hypertension Division (PMC)
Penn Medicine, University of Pennsylvania
Presbyterian Medical Center, Philadelphia
Nephrology and Internal Medicine
Certified by the American Board of Internal Medicine

Dr. Bassey Benjamin Esu
B.Sc. Marketing; MBA Marketing; Ph.D Marketing
Lecturer, Department of Marketing, University of Calabar
Tourism Consultant, Cross River State Tourism Development Department
Co-ordinator , Sustainable Tourism Initiative, Calabar, Nigeria

Dr. Aziz M. Barbar, Ph.D.
IEEE Senior Member
Chairperson, Department of Computer Science
AUST - American University of Science & Technology
Alfred Naccash Avenue – Ashrafieh

Contents of the Volume

Global Journal of Computer Science and Technology
Network, Web & Security
Volume 12 Issue 13 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Multilevel Downlink Relay Queue Aware and Loss Recovery Scheduling for Media Transmission in Wireless Cellular Networks

By A.Veerabhadra Reddy & Dr. D. Sreenivasa Rao
Jawaharlal Nehru University - Anantapur

Abstract - In this document, we study the result of multi hop relaying on the throughput of the downstream channel in cellular networks. In particular, we contrast the throughput of the multi hop method through that of the conventional cellular system, representing the feasible throughput development by the multi hop relaying under transitive transmission considerations. We moreover propose a hybrid control plan for the multi hop communicate, in which we activist the use of in cooperation, the straight transmission and the transitive multi hop relaying. Our study illustrates that the majority of the throughput gain can be obtained with the related of a transitive relaying scheme. Important throughput improvement could be moreover obtained by operating the simultaneous relaying transmission in conjunction with the non simultaneous transmission. We also disagree here that the multi hop relaying technology can be developed for mitigating injustice in quality-of-service (QoS), which arrive due to the location-dependent signal quality. Our outcomes demonstrate that the multi hop system can provide more even QoS over the cell district. The multi hop cellular system design can also be used as a self-configuring network mechanism that efficiently contains variability of traffic distribution. We have studied the throughput development for the consistent, as well as for the non uniform traffic distribution, and we conclude that the utilization of transitive relaying in cellular networks would be relatively robust to alter in the actual traffic distribution.

Keywords : *Mobility prediction, mobile positioning, location tracking, handoff prioritization, dynamic, resource reservation.*

GJCST-E Classification: *C.2.1*

Strictly as per the compliance and regulations of:

Multilevel Downlink Relay Queue Aware and Loss Recovery Scheduling for Media Transmission in Wireless Cellular Networks

A.Veerabhadra Reddy[α] & Dr. D. Sreenivasa Rao[σ]

Abstract - In this document, we study the result of multi hop relaying on the throughput of the downstream channel in cellular networks. In particular, we contrast the throughput of the multi hop method through that of the conventional cellular system, representing the feasible throughput development by the multi hop relaying under transitive transmission considerations. We moreover propose a hybrid control plan for the multi hop communicate, in which we activist the use of in cooperation, the straight transmission and the transitive multi hop relaying. Our study illustrates that the majority of the throughput gain can be obtained with the related of a transitive relaying scheme. Important throughput improvement could be moreover obtained by operating the simultaneous relaying transmission in conjunction with the non simultaneous transmission. We also disagree here that the multi hop relaying technology can be developed for mitigating injustice in quality-of-service (QoS), which arrive due to the location-dependent signal quality. Our outcomes demonstrate that the multi hop system can provide more even QoS over the cell district. The multi hop cellular system design can also be used as a self-configuring network mechanism that efficiently contains variability of traffic distribution. We have studied the throughput development for the consistent, as well as for the non uniform traffic distribution, and we conclude that the utilization of transitive relaying in cellular networks would be relatively robust to alter in the actual traffic distribution.

Keywords : Mobility prediction, mobile positioning, location tracking, handoff prioritization, dynamic, resource reservation.

I. Introduction

MULTI HOP cellular networks have been proposed as an addition to the conventional single-hop cellular network by joining the fixed cellular infrastructure with the multi hop relaying technology that is frequently used in ad hoc networks. Due to the potential of the multi hop relaying to enhance coverage, ability and flexibility, the multi hop cellular networks have been drawing considerable notice. This approach of augmenting cellular communication with multi hop relaying was also used in the consistency effort to include the multi hop relaying into the third-generation (3G) mobile communication systems [1]. The main advantage of the multi hop relaying arrives from the reduction in the overall path loss among a base station (BS) and a mobile station (MS) [2].

However, the penalty for using multi hop relaying is in the necessitating for extra radio channels. Another advantage of the multi hop relaying is the path diversity increase that can be achieved by picking the mainly favorable multi hop path in the shadowed environment. This diversity increase can increase with the quantity of MSs, as then the quantity of potentially transmit candidates raise and the likelihood of finding a relay with lesser path loss increases as well.

In addition, the system's ability can additionally increase by permitting concurrency among the multi hop broadcast. However, such concurrency also raises the interference. So, the overall result is not instantly clear.

As we saw above, the performance of the multi hop cellular networks is ruled by different tradeoffs. Thus, to get advantage from the multi hop relaying, the different tradeoffs must be comprehensively studied. However, the study of such tradeoffs in the literature is extremely limited. In scrupulous, the analysis of the transaction caused by the simultaneous transmissions among the interference and the channel reuse efficiency is of very importance. Toumpis and Goldsmith [3] showed that the simultaneous transmission can improve the system capacity of the multi hop cellular networks. However, their outcomes were obtained for a single cell system and in just two cases of complex topology, i.e., a linear topology and a single comprehension of a haphazard topology. Hence, those outcomes are inadequate to demonstrate, in common, the concurrency exchange. Moreover, numerous studies account that it is not easy to improve the capacity of code-division multiple-access (CDMA) systems by utilize of the multi hop relaying [5] –[9]. This is mostly due to the interference increase resulting from the simultaneous transmissions. Such interference may be the most significant factor limiting the network capacity. Hence, the collision of the concurrent transmission must be carefully investigated. The multi hop relaying technology can give a significant flexibility in the design and the operation of the cellular system. On the multi hop cellular system, MS preserve decide to utilize the multi hop relaying instead of the single-hop direct transmission. Such a hybrid operation can be exploited for different purposes; one of which is to mitigate the

Author α : Lecturer, Department of ECE Government Polytechnic for Women, Hindupur. E-mail : bhadrareddy47@gmail.com
Author σ : Professor, Department of ECE , JNTU CE, Hyderabad

unfairness in the quality of service (QoS) between the users. In cellular networks, there is a tradeoff difficulty between system throughput and QoS fairness [4]. Since the established signal excellence depends on the user location, it is not easy to give an even QoS over the entire cell service region and to maximize the system throughput at the similar time. On the other hand, the use of multi hop relaying, instead of a direct link, can develop the QoS of the users with poor direct links who are situated near the cell boundary or in a deep shadowed district. Therefore, the equation, as well as scheme throughput in the cellular network can be better through the use of the multi hop relaying.

An additional application exploiting the flexibility of the multi hop relaying technology is to mitigate the inefficiency due to the temporal changes in traffic demand in cellular scheme. To optimize the appearance of a cellular scheme, discover the optimum positions of the cell sites is a fundamental problem with interference-imperfect systems, such as the CDMA category scheme. However, due to the ever-changing traffic demand patterns, optimal placement of cell site is a complex problem. Even if the traffic allocation could be predictable, it would still be complex to optimally plan the radio network, as the fixed cell sites cannot be relocated whenever the traffic allocation changes. Hence, there is a requirement for a self-configuring network, which would be capable of automatically coping with the alteration in traffic distribution. In the multi hop cellular system, the unusual collection of the multi hop path can allow flexible design of the cell site, which is mainly important in the case of non regular traffic allocation. Thus, the multi hop cellular system design can be utilized as a self-configuring network method that can efficiently accommodate the spatial and temporal inconsistency of traffic patterns.

Although the multi hop relaying technology has been future as one of the key technologies of the self-configuring cellular networks [10], [11], there have been merely little numerical results clarifying how the self-configuring feature achieved during the multi hop relaying can develop the system's ability for non consistently distributed traffic case. Although Wu et al. [12] evaluated the capacity of the multi hop system with non consistent traffic, such that when the traffic among adjacent cells is unstable, that paper focused only on the channel borrowing among adjacent cells through multi hop relaying. Moreover, a few features of the multi hop transmit, such as path-loss diminution and path variety, were not measured in their study. Hence, their outcome may not be able to completely explain the behavior of the self-configuring capability of multi hop relaying itself.

The problem studied here is to plan a scheduling algorithm for multi-hop relay wireless cellular networks, so that it can correctly position the concurrent transmission scenarios for multi-hop relay links, and the overall network throughput can be improved.

II. Related Work

The study of combining relay networks with cellular networks has been going on for quite a while. In [12], an RS is equipped with together WLAN and cellular network interfaces to help with cellular traffic forwarding with WLAN links, aiming to achieve throughput development and load balancing. In [13], the MS is assumed to contain both WLAN and 3G interfaces for traffic communicates. On-demand direction-finding protocols are urbanized to discover relay paths, and incentive schemes are designed to encourage the MS to transmit traffic for other MS. In [14], a clique discovery algorithm is proposed to place the concurrent transmissions in a multi-hop relay cellular system, and relay nodes contain WLAN or WPAN edge in addition to the cellular network interface. The authors believe that the MS is presented all over in the relay path and can serve as a communicate node. Dissimilar from the over loom where a separate relay interface is required, other approaches illustrate below let the relay path share the identical physical interface of the cellular system. In [15], multiple portable stations appearance multi-hop ad hoc network inside cellular system and ad hoc steering is oppressed to extend system throughput. In [16], the MS is used to communicate traffic, while simultaneous transmissions are investigated with an easy network topology, though the source is based on account and hence is not appropriate for practical purpose. In [17], a distributed scheduling algorithm is developed to schedule concurrent transmissions in a cellular relay network aiming at maximizing throughput while avoiding data collision in the communicate links. As a consequence, each mobile knob has to pay for the signaling and bandwidth overhead for the distributed algorithm. The over approaches have one thing in general, which is the ad hoc implementation of a relay network within cellular network architecture. One benefit of the ad hoc implementation is the abundance of ad hoc routing protocols that can provide in communicates routing. Besides, the ad hoc steering protocol consequences in flexibility in the selection of relay routes. However, the ad hoc implementation has a few drawbacks. The first drawback is that ad hoc routing needs every node in the relay network to contribute in the route discovery process that involves distribution, feedback, and onward of routing communication, and this participation need significant modifications of the signaling protocols of wireless cellular system. These momentous modifications in the indication protocols of the BS and the MS make the present cellular network operator reluctant to deploy relay network. Second, the algorithm for discovery ad hoc routing occupies a definite amount of bandwidth from every mobile node,

and additional bandwidth expenditure is anticipated in order to continue the routing bench up to date, since nodes are movable in the scheme. Third, the recurrent alter in the routing table decrease the consistency of the data delivery and authority the total complex throughput. Therefore, the ad hoc implementation is unattractive to the network machinist in manufacturing, since the BS, the RS, and the MS all embrace to correct for the architecture changes of the cellular network, and the additional signaling overhead and bandwidth consumption incurred for each MS is significant. Observing the disadvantage of the ad hoc implementation of a relay network, we prefer an approach that involves least network architecture changes and still can enjoy the advantages of multi-hop simultaneous transmissions. A desirable solution must be able to incorporate a relay network into the existing cellular network with unimportant architecture modification and little realization slide, and the new network construction is still handy from the point view of the network operator.

When designing a relay network within the cellular network, there are several optional factors, such as whether or not the relay networks accepts the ad hoc implementation as converse over, and whether or not the RS must use the identical cellular spectrum to relay traffic, referred to as in-band relay. Other option include whether or not the MS can provide as the RS and whether or not the scheduling algorithm for simultaneous transmissions should be centralized. How to wisely select among these options to form an adaptive relay network is a difficult task. With such effort is the development of a WiMAX draft standard, 802.16j [20], which is a revision of WiMAX with the aim of incorporating relay network into WiMAX network. This 802.16j draft standard has the subsequent characteristics. The RS in 802.16j is for relay traffic simply, and the forecast algorithm is federal and run in the BS. The RS uses the identical spectrum as the BS and the MS, and no ad hoc steering is suitable in the relay paths. The approach in 802.16j permit WiMAX network to incorporate relay network without sacrificing WiMAX network architecture, and the WiMAX BS is still able to control the RS. One research work [18] study the scheduling algorithm in 802.16j, and it utilizes directional antennas to exploit the space use again of frequency resources in multi-hop relay cellular network under a Manhattan-like environment. Although scheduling algorithm is given to improve network throughput, but how to decide the simultaneous transmissions on the relay network is not addressed.

What inspires our research is the work in [19], which suppose a multi-hop wireless mesh backhaul network with in-band communicate. Each RS cumulates the traffic from the close MS. A linear programming model is then developed to evaluate the minimum time to transmit a fixed data load from the BS to every RS above likely multiple hops. Since the transmission time is reduced for the fixed information load, throughput is exploiting. However, it does not in use into reflection the varying line size of each relay station; neither does it relate the frame boundary of cellular network into the transmission. Since wireless cellular networks are mainly frame-based, it is non-trivial to study the scheduling algorithm for multi-hop relay network under frame-based statements.

III. Network Architecture and Challenges

In a cellular network with frame-based transmissions, base Station attach to relay station and/or mobile station, and every relay station can attach further to additional relay station and/or mobile position. Relay position only ahead traffic to/from mobile station and produce no traffic on its own. Relay station is visible to a mobile station, and mobile station does not engage in routing packets for additional mobile station. Base station, relay station, and mobile station all share the similar spectrum, thus no additional hardware such as a second physical interface is required. Base station needs to meet the downlink real time queue range of its related relay station and this queue information is sent to the base station with uplink bandwidth. The resulting signaling change due to uplink queue status report is unimportant, and the matching uplink bandwidth consumption is neglect able. After gathering relay station queue.

Queue information, base station runs the scheduling algorithm to get the downlink scheduling results and broadcasts the outcome to relay station and mobile station.

As the input for the scheduling algorithm, simultaneous transmission scenarios need to be resolved in a capable way. When adding a link candidate into a simultaneous transmission scenario, it must be sure that adding this link will not decrease the total throughput of this scenario. However, it is not practical to cross all possible links searching for simultaneous scenarios due to the nonlinear development of links with respect to number of MS and RS.

The challenge is due to information that wireless cellular networks are mainly frame-based, and the equivalent scheduling algorithm must take this factor into consideration. In each frame, different simultaneous scenarios must share this frame period. Thus arises the matter of a fair share of time resources between different MS who share one frame, while still achieving the goal of achieving max network throughput.

The third challenge is to let the scheduling algorithm regulate to the real time queue size change in RS. Implementation of Scheduling Algorithm under Linear Programming:

We there a linear programming model to implement the scheduling algorithm for wireless cellular multi hop relay network. The main advantages of this algorithm are

Constraint 1: Derives the throughput for Mobile Station node in the border, informative the simultaneous broadcast nature of the multi hops cellular networks.

Constraint 2: Indicates the queue consciousness of the proposed preparation algorithm by monitoring

Constraint 3: The dynamic RS queue status, and this queue consciousness are not addressed by the associated work, the capacity restraint of a link in situation SK.

Constraint 4: Applies Shannon's Theorem to compute the upper bound of link data rate with the thought of the interference caused by simultaneous transmissions.

Constraint 5: States the time restraint of all simultaneous scenarios in a frame, suggestive of the frame-based characteristic of this approach.

Constraint 6: Transitive relative among BS and RS will be careful and this restraint power the real delay calculated at RS that connected directly to the BS.

Block Diagram:

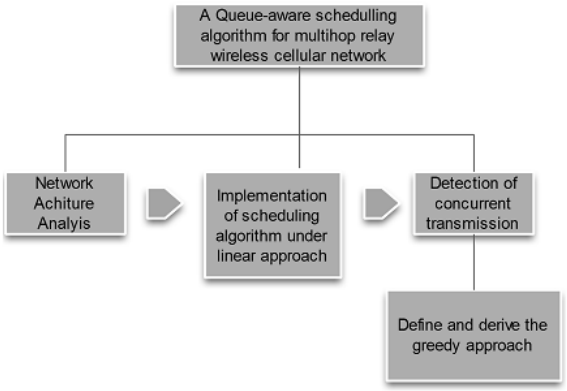


Figure 1 : Scheduling Algorithm under Linear Programming

a) Detection of Concurrent Transmission Scenarios

The number of links grows non-linearly with the number of nodes in the network; it is impractical to use a comprehensive algorithm to search for all probable scenarios. We use a linear programming model confirmed to compute the transmission schedules for all simultaneous transmission scenarios, aiming at maximizing the throughput in each frame. Here we consider the transmission schedules those subjective by the transitive relations between BS and RS.

b) Structure of Greedy effect

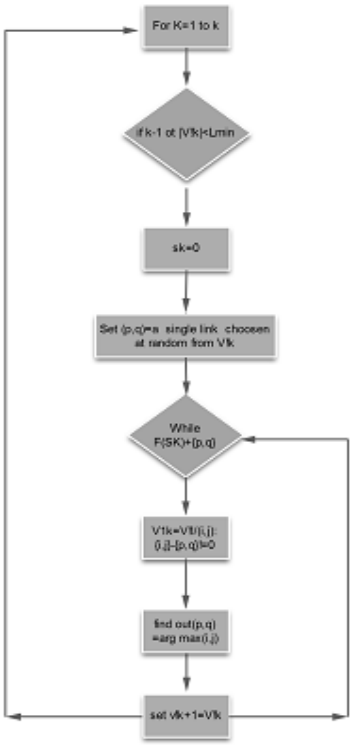
In this Greedy Approach we apply the back force flow control mechanism. This mechanism states that in order to maximize the end to- end throughput in multi hop wireless network, the chosen simultaneous transmissions must be able to get the most out of the object function. We use a greedy algorithm to get a set of simultaneous transmission scenarios, with the back force flow control mechanism included in the greedy algorithm.

Which are defined as: $F(S) = \sum_{(i,j)\in S} w_{ij} R_{ij},$

IV. Implementation Methodology and Results

The Queue aware scheduling under transitive connection considerations has been implemented using mxml and action script. The accomplishment is based on multi-hop relay based wireless cellular network routing functions that are added. In additional to building QoS routes, the protocol also establishes a best schedule plan when it learns such obligation. The best-effort scheduling is used to enhance the throughput. A distributed protocol which dynamically generates and updates broadcast schedules between the nodes has been used. Assumed transmission rate is 1 Mbps. The proposed model detects all simultaneous transmissions, and responds by invoking scheduling behavior as suitable. The relay station queues that are transitively associated with BS also be measured to end the Queue capacity of the relay station that relies on the middle between BS and transitive relay station. We apply greedy search techniques to recognize simultaneous relations of the replication. And finally end the scheduling strategy using the linear program technique proposed. These greedy searches and linear approach we implemented using action script. The linear approach considers the 6 different constraints explored above.

Process flow:



LP model for arrangement in cellular relay networks under transitive relation considerations.

OBJECTIVE: maximizes $\sum_m a_m(t)$

INPUT VARIABLES:

1: MS index m;

2: frame index t;

3: frame duration T;

4: Under transitive situation the calculation of relay stations r;

5: RS node i's queue status $Q_i^m(t)$;

6: RS node i's queue status under transitivity

$$\sum_{r=1}^{tc} Q_{i_r}^m(t)$$

7: a set of simultaneous transmission scenarios Sk, 1 ≤ k ≤ K;

8: power used from node i to j, Pij ;

9: distance between node I to j, dij ;

OUTPUT VARIABLES:

1: $x_{ij}^m(k,t)$, scheduled packets transmitted from node i to j in Sk at frame t, which are destined for MS node m;

2: Tk(t), scheduled time portion for scenario Sk

Constraints

$$S_{sm} = \sum_{s,k=1}^{K} x_{sm}(k,t)$$

$$a_m(t) = \sum_{k=1}^{K} S_{sm(k)}$$

1. where s is MS node m's upstream node' index;
2.

$$\sum_{r=1}^{tc} Q_{i_r}^m(t) + \sum_{k=1,s}^{K} x_{si}^m(k,t) = \sum_{w,k=1}^{K} x_{iw}^m(k,t) + \sum_{r=1}^{tc} Q_{i_r}^m(t+1)$$

Where 'i' is RS index and r is transitive RS index and tc is transitively associated relay station count. 's' and 'w' stands for node i's upstream and downstream node, correspondingly;

3. $$\sum_{m} x_{ij}^m(k,t) \le w_{ij}(k,t) \times T_k(t)$$

4. $$w_{ij}(k,t) = \omega \log_{\partial 2}\left(1 + \frac{P_{ij} / d_{ij}^{\alpha}}{N_0 + \sum (x,y) \in S_k, (x,y) \neq (i,j) \; P_{xy} / d_{xj}^{\alpha}}\right)$$ where α is the path defeat advocate, and N0 is sound power;

5. $$\sum_{k=1}^{K} T_k(t) = T$$

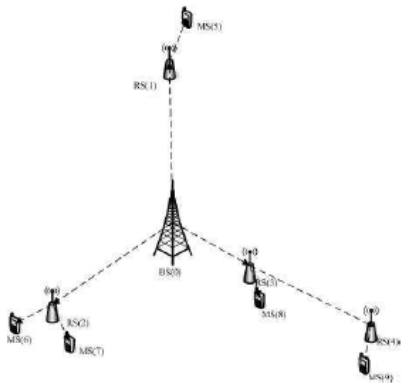


Fig. 1 : Cellular network with Transitive relay topology for simulation

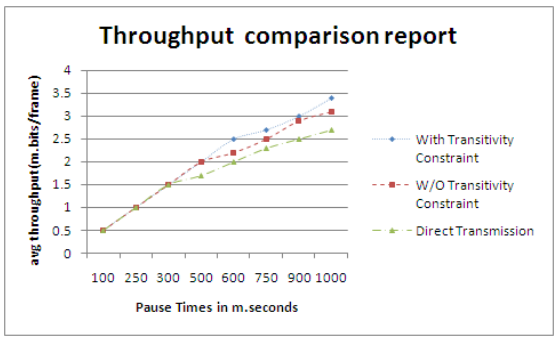


Fig. 2 : Throughput Comparison report

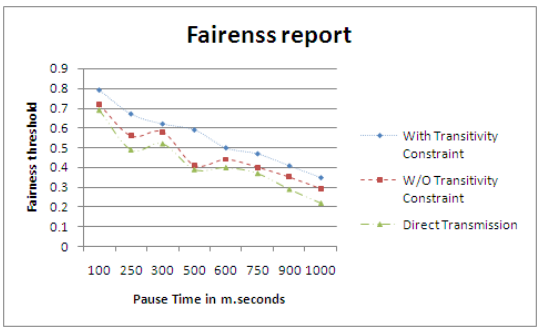


Fig. 3 : Fairness Comparison report

V. Conclusion and Future Work

We have offered a Transitive relation aware scheduling algorithm for multi-hop relay wireless cellular networks. Through our analysis, we dispute that following a centralized approach for building cellular relay networks best reflects the interest of the cellular networks. This central approach implies that relay stations and mobile stations do not form ad hoc networks and they are under the control of bottom station. Another selection of building communicates cellular networks we follow include using in-band spectrum of relay stations, not permit mobile stations to provide as relay position, and relate centralized preparation algorithm. An essential scheduling algorithm is developed and base stations will run this preparation

algorithm. In the preparation algorithm, initial a locate of simultaneous transmission scenarios is the result and then it is used as input for a linear programming model that decide the transmission schedules for the multi-hop communicate network. The linear encoding model aims at exploiting the overall throughput of the all the mobile stations, while taking into attention the frame-based environment of cellular networks and the dynamic queue modify in the relay position The skin of frame-based and queue-awareness of the preparation algorithm are the single assistance that have not been addressed by earlier work. Simulations calculate performance metrics such as throughput and equality of the proposed scheduling algorithm. Two extra scheduling algorithms are evaluated with our approach via simulations. One is scheduled for straight transmission only, and the other is scheduled with no buffer in the communicate nodes. The effectiveness of our loom is authenticated by the replication results.

References Références Referencias

1. 3GPP TR25.924, "Opportunity driven multiple access," 3GPP, ver. 1.0.0, Dec. 1999.
2. TR 101 146, "UMTS; UTRA; Concept evaluation (UMTS 30.06)," ETSI, ver. 3.0.0, Dec. 1997.
3. S. Toumpis and A. Goldsmith, "Capacity regions for wireless ad hoc networks," in Proc. IEEE ICC 2002, New York, Apr. 2002, pp. 3168–3173.
4. M. Airy and K. Rohani, "QoS and fairness for CDMA packer data," in Proc. IEEE Vehicular Technology Conf. 2000 Spring, Tokyo, Japan, May 2000, pp. 450–454.
5. A. Fujiwara et al., "Area coverage and capacity enhancement by multi hop connection of CDMA cellular network," in Proc. IEEE Vehicular Technology Conf. 2002 Fall, Vancouver, BC, Canada, Sept. 2002, pp. 2371–2374.
6. A. N. Zadeh and B. Jabbari, "Performance analysis of multi hop packet CDMA cellular networks," in Proc. IEEE GLOBECOM 2001, San Antonio, TX, Nov. 2001, pp. 2875–2879.
7. T. J. Harrold and A. R. Nix, "Performance analysis of intelligent relaying in UTRA TDD," in Proc. IEEE Vehicular Technology Conf. 2002 Fall, Vancouver, BC, Canada, Sept. 2002, pp. 1374–1378.
8. T. Rouse, S. McLaughlin, and H. Haas, "Coverage-capacity analysis of opportunity driven multiple access (ODMA) in UTRA TDD," in Proc. IEE 3G Mobile Communication Technologies, Mar. 2001, pp. 252–256.
9. T. Rouse, I. Band, and S. McLaughlin, "Capacity and power investigation of opportunity driven multiple access (ODMA) networks in TDDCDMA based systems," in Proc. IEEE ICC 2002, New York, Apr. 2002, pp. 3202–3206.
10. A. G. Spilling, A. R. Nix, M. A. Beach, and T. J. Harrold, "Self-organization in future mobile communications," Electron. Commun. Eng. J., pp. 133–147, June 2000
11. R. Becher,M. Dillinger,M. Haardt, andW. Mohr, "Broad-band wireless access and future communication networks," Proc. IEEE, vol. 89, pp. 58–75, Jan. 2001
12. H.Wu, C. Qiao, S. De, and O. Tonguz, "Integrated Cellular and Ad-hoc Relay Systems: iCAR," IEEE J. Sel. Areas Commun., vol. 19, no. 10, pp. 2105–2115, Oct. 2001.
13. H. Luo, X. Meng, R. Ramjee, P. Sinha, and L. Li, "The Design and Evaluation of Unified Cellular and Ad Hoc Networks," IEEE Trans. Mobile Comp., vol. 6, no. 9, pp. 1060–1074, Jun. 2007.
14. B. Radunovic and A. Proutiere, "On Downlink Capacity of Cellular Data Networks with WLAN/WPAN Relays," in Proc. 3rd IEEE RAWNET, 2007, pp. 1–7.
15. Y. D. Lin and Y. C. Hsu, "Multi hop Cellular: A New Architecture for Wireless Communication," in Proc. IEEE INFOCOM, 2000, pp. 1273–1282.
16. J. Cho and Z. J. Hass, "On the Throughput Enhancement of the Downstream Channel in Cellular Radio Networks Through Multi hop Relaying," IEEE J. Sel. Areas Commun., vol. 22, no. 7, pp. 1206–1219, Sept. 2004.
17. Y.-N. Lee, J.-C. Chen, Y.-C. Wang, and J.-T. Chen, "A Novel Distributed Scheduling Alorithm for Downlink Relay Networks," IEEE Trans. Wireless Commun., vol. 6, no. 6, pp. 1985–1991, Jun. 2007.
18. S.-J. Lin, W. H. Sheen, I.-K. Fu, and C.-C. Huang, "Resource Schduling with Directional Antennas for Multi hop Relay Networks in Manhattan-linke Environment," in Proc. IEEE Mobile WiMAX Symp., 2007, pp. 108–113
19. H. Viswanathan and S. Mukherjee, "Throughput-Range Tradeoff of Wireless Mesh Backhaul Networks," IEEE J. Sel. Areas Commun., vol. 24, no. 3, pp. 593–602, Mar. 2006.
20. H. Viswanathan and S. Mukherjee, "Throughput-Range Tradeoff of Wireless Mesh Backhaul Networks," IEEE J. Sel. Areas Commun., vol. 24, no. 3, pp. 593–602, Mar. 2006.

This page is intentionally left blank

Global Journal of Computer Science and Technology
Network, Web & Security
Volume 12 Issue 13 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Advancements of Multirate Signal Processing for Wireless Communication Networks: Current State of the Art

By D V Srihari Babu & Dr. P Chandrashekhar Reddy
ECE SKTRM College of Engineering Hyderabad

Abstract - With the hasty growth of internet contact and voice and information centric communications, many contact technologies have been urbanized to meet the stringent insist of high speed information transmission and viaduct the wide bandwidth gap among ever-increasing high-data-rate core system and bandwidth-hungry end-user complex. To make efficient consumption of the limited bandwidth of obtainable access routes and cope with the difficult channel environment, several standards have been projected for a variety of broadband access scheme over different access situation (twisted pairs, coaxial cables, optical fibers, and unchanging or mobile wireless admittance). These access situations may create dissimilar channel impairments and utter unique sets of signal dispensation algorithms and techniques to combat precise impairments. In the intended and implementation sphere of those systems, many research issues arise. In this paper we present advancements of multi-rate indication processing methodologies that are aggravated by this design trend. The thesis covers the contemporary confirmation of the current literature on intrusion suppression using multi-rate indication in wireless communiqué networks.

Keywords : *Acoustic signal processing, audio reconstruction, autoregressive (AR) models, blocking, cyclic spectrum, cyclostationarity, filterbanks.*

GJCST-E Classification: *C.2.1*

Strictly as per the compliance and regulations of:

Advancements of Multirate Signal Processing for Wireless Communication Networks: Current State of the Art

D V Srihari Babu [α] & Dr. P Chandrashekhar Reddy [σ]

Abstract - With the hasty growth of internet contact and voice and information centric communications, many contact technologies have been urbanized to meet the stringent insist of high speed information transmission and viaduct the wide bandwidth gap among ever-increasing high-data-rate core system and bandwidth-hungry end-user complex. To make efficient consumption of the limited bandwidth of obtainable access routes and cope with the difficult channel environment, several standards have been projected for a variety of broadband access scheme over different access situation (twisted pairs, coaxial cables, optical fibers, and unchanging or mobile wireless admittance). These access situations may create dissimilar channel impairments and utter unique sets of signal dispensation algorithms and techniques to combat precise impairments. In the intended and implementation sphere of those systems, many research issues arise. In this paper we present advancements of multi-rate indication processing methodologies that are aggravated by this design trend. The thesis covers the contemporary confirmation of the current literature on intrusion suppression using multi-rate indication in wireless communiqué networks.

Keywords : Acoustic signal processing, audio reconstruction, autoregressive (AR) models, blocking, cyclic spectrum, cyclostationarity, filterbanks.

I. Introduction

Multi-rate signal dispensation techniques are extensively used in several areas of contemporary engineering such as interactions, image processing, digital audio, and multimedia. The major benefit of a Multi-rate system is the considerable decrease of computational density, and consequently, the inferior power utilization in real-time operations, slighter chip area pursue by the cost diminution. The computational competence of Multi-rate algorithms is pedestal on the ability to use concurrently dissimilar example rates in the dissimilar parts of the scheme. Moreover, the Multi-rate-based algorithms are worn to solve a few of the composite signal processing errands that could not be resolve otherwise, such as illustration rate conversions, signal disintegration and reconstruction, multiplexing and de-multiplexing, totaling of DSP transforms. Multi-rate systems are structure blocks frequently used in digital signal processing (DSP). Their purpose is to alter the tempo of the discrete-time signals, which is realize by adding or erase a portion of the signal illustration. Multi-rate systems play a inner role in a lot of areas of signal processing, such as strain bank theory and multi declaration theory. They are necessary in various typical signal processing techniques such as signal analysis, de-noising, density and so forth. During the previous decade, however, they have progressively more found submission in new and emerging region of signal processing, as well as in some neighboring regulation such as digital infrastructure.

Rate alter filters, wavelets and sift banks have conventionally been used in a amount of digital communications region like timing management, digital modems, pre-coding for conduit equalization, wideband infrastructure, pulse form filter design [1] etc. They have established recent and growing usage in extend spectrum CDMA infrastructure, fractal modulation [2] as well as distinct multi-tone intonation systems [3].

In (some) subsequent and (most of) third cohort digital recipient architectures [4], Analog to Digital Converters (ADC) illustrates a wideband indication instantly after first spectrum conversion to IF. Digital oscillators transfer the range to baseband; personages channels are then pull out by low pass FIR filters. The baseband strait are extremely oversampled and thus decimation is necessary to bring the illustration rate down in agreement with the bandwidth of the indication. Since computations of short pass strain have an circumlocutory share in the power expenditure of the radio terminal, particular multiplication gratis filters, merge filtering and decimation are worn to perform these process professionally.

These Multi-rate filters also propose a simple and programmable plan process that makes them suitable for third cohort wireless scheme. [5]. Symbol timing association is necessary in digital recipient every time the broadcast signal has accepted through a linear-phase declaration channel. If the recipient has no in succession about the channel section response, the inward cryptogram will experience an unidentified time change. For finest potential exposure, the recipient needs to illustration the cryptogram at the accurate moment. Most recipient, consequently, achieve

Author α : Assoc. Professor, Dept of ECE SKTRM College of Engineering. E-mail : srihari2k1@gmail.com
Author σ : Professor, Department of ECE JNTUH, Hyderabad.

representation timing management ahead of recognition. A class of Multi-rate twist namely polynomial intermission filters has been damaged for an efficient success with digital process to correct symbol timings in the declaration receivers [6]. Another effect of band-limited communiqué conduit is the Inter depiction Interference (ISI) at the recipient. To mitigate ISI, the transmit symbols are pulse fashioned usually by a heave cosine filter that restrictions the frequency inside of the basis symbols. Before pulse determining, the transmitted cryptogram are oversampled as well. A number of Multi-rate comprehension help to merge pulse shaping and interruption at a fraction of the charge compared to the difficulty of traditional interpolation procedure [1]. The use of poly-phase DFT strain banks in wideband satellite infrastructure systems has been description in the past[7]. Poly-phase strain bank channelizers also perform a crucial role in together cognitive and software radio troubles addressed in this proposal.

Equalizers reimburse the effects of occurrence selective channels. Some communiqué systems also utilize a cyclic prefix method at the receiver. This assist in frequency field equalization at the recipient where DFT filter bank plays an important position in verdict the inverse of the conduit response. Pre-coding is completed using filter banks to append redundancy to the broadcast signal. This, in turn, facilitate the equalizer to be considered in such a way that the possessions of communication conduit can be cancelled out in accumulation to noise containment in the received signal [8]. There are various emerging announcement applications for which wavelets and strain banks seem preferably suited [2].Among these are, extend spectrum multiuser connections, in which up sampling and strain operations are worn to assign a undo signature to each user at the bringer. Corresponding Multi-rate procedure are performed at recipient to separate every user channel. In more universal terms, strain bank design with paraunitary restraint is shown to be adequate to derive orthogonal accent and spread signatures for multiuser CDMA. Lastly, wavelets have been projected as ideal contender for fractal modulation. This is a modulation approach for a individual channel of unknown time extent and bandwidth to the spreader. The main scheme is embedding the information in a homogeneous indication that has wavelet representation.

II. Multi Rate Systems

a) *Basic building blocks*

The signals of attention in digital signal dispensation are discrete succession of real or complex information denoted by x(n), y(n), etc. The succession x(n) is often obtained by sample a continuous-time signal xc(t). The preponderance of accepted signals (like the audio signal accomplishment our ears or the visual signal reaching our eyes) are continuous-time. However, in regulate to facilitate their dispensation using DSP procedure; they need to be model and converted to digital indication. These conversions also contain signal quantization, i.e., discretization in amplitude; though in practice it is safe to assume that the amplitude of x (n) can be any real or composite number. Signal allowance analysis is often simplified by bearing in mind the frequency sphere representation of sign and systems.

$$\xrightarrow[X(z)]{x(n)} \boxed{H(z)} \xrightarrow[Y(z)=H(z)X(z)]{y(n)=\sum_{k=-\infty}^{\infty} x(k)h(n-k)}$$

Figure 1 : Filtering process: linear time invariant system

Commonly used choice representations of x(n) are its z-transform X(z) and the discrete-time Fourier convert X(e^{jw}). The z-transform is distinct as X (z) = $\sum_{n=-\infty}^{\infty} x(n)z^{-n}$ and X(e^{jw}) is nothing but X(z) assess on the component circle z = e^{jw}

Multi rate DSP systems are typically collected of three basic construction blocks, operating on a discrete-time indication x(n). Those are the linear time invariant (LTI) strain, the decimator and the expander. An LTI filter, like the single shown in Fig.1.1, is describe by its desire response h (n), or equivalently by its z-transform (also identify the transfer purpose) H (z). The rate of the indication at the output of an expander is M times superior to the rate at its contribution, while the communication is true for decimators. That is why the scheme containing expanders and decimators are describe systems.

The addition to the case of vector signals are quite straightforward: the decimation and the growth are achieved on each element discretely. The corresponding vector succession decimators/expanders are denoting within quadrangle boxes in wedge diagrams. The LTI systems in service on vector indication are called various inputs. Multiple output(MIMO) scheme and they are describe by a (possibly rectangular) medium transfer purpose H(z).

b) *Some multi rate definitions and identities*

The vector signals are occasionally obtained from the equivalent scalar signals by overcrowding. Conversely, the scalar indication can be improved from the vector signals by unblocking. The overcrowding/unblocking procedure can be defined with the delay or the proceed chains [9], thus leading to two comparable definitions. One way of crucial these operations, while the additional is obtained irrelevantly by switching the holdup and the advance machinist. Instead of illustration the complete delay/advance sequence structure, we frequently use the basic block

notation. It is frequently clear from the circumstance which of the two descriptions of the unblocking and blocking process is employed.

A very constructive tool in multi rate indication processing is the so-called poly segment representation of signals and scheme. It facilitates substantial simplifications of hypothetical results as well as competent implementation of multi tempo systems. Since poly phase depiction will play an significant role in the respite of the thesis, here we take a instant to formally describe it. Consider an LTI system with a transport function H(z) $= \sum_{n=-\infty}^{\infty} h(n) z^{-n}$ and assume we are given an digit M. We can molder H(z) as

$$H(z) = \sum_{m=0}^{M-1} z^{-m} \sum_{n=-\infty}^{\infty} h(nM+m) z^{-nM} = \sum_{m=0}^{M-1} z^{-m} H_m(z^M)$$

(Type1 decomposition) (1)

Note that this is corresponding to dividing the whim response *h*(*n*) into *M* non overlie groups of samples hm(n), gain from h(n) by M-fold decimation opening from sample m. In other expressions, h(n) can be obtained by merge sequences hm(n) through the unblocking configuration. Subsequences (n) and the equivalent z-transforms are called the Type 1 poly segment mechanism of H(z) with respect to M. A dissimilarity of z-transforms is gain if we decimate h(n) opening from sample -m, for 0≤ m ≤M - 1. This gives climb to Type 2 poly segment components Hm(z):

$$H(z) = \sum_{m=0}^{M-1} z^{m} \overline{H_m}(z^M)$$

(Type2 decomposition) (2)

III. Bi-Orthogonal Partners

a) Generalized inverse

Consider the scheme shown in the primary part of Fig. 2(a), namely, the scheme for generating y(n) from x(n).Traditionally, this arrangement has been describe the scheme for digital exclamation since the charge of y(n) is M times superior than that of x(n). Filter H(z) is frequently referred to as the exclamation filter [9]. Suppose the purpose is to recover the indication x(n) from y(n). Conceptually the simplest way to attain this is shown in Fig.2(a). Namely, y(n) is primary passed during the inverse of the exclamation filter 1/H(z). This recovers the indication at the input of the M-fold expander. The M-fold decimator that chase simply rejects the zeros introduce by the expander and the revival of x(n) is complete. Notice, though, that this is not the simply way to renovate x(n), simply because the converse filter forces the redundant samples to be zero, while they can take random values. Indeed, any strain F(z) with the possessions that its output conserve the desired samples of x(n) in the suitable locations, with arbitrary principles in between [see Fig.2(b)] yields a suitable reconstruction system.

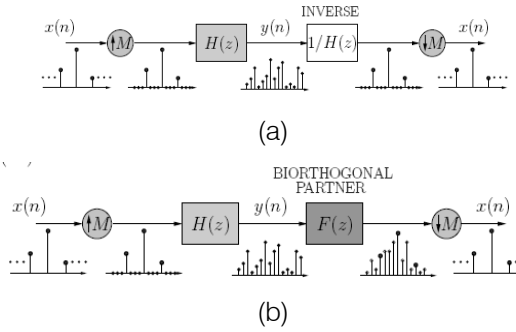


Figure 2 : Signal recovery after interpolation: (a) using filter inverses, and (b) using 'generalized inverses

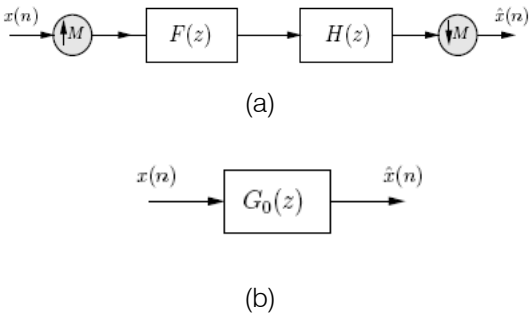


Figure 3 : Bi-orthogonal partners: (a) definition and (b) equivalent LTI system

Filters F(z) with the explain property are identify bi-orthogonal partners of H(z)and were primary initiate in [10]. Notice that the opposite filter is a valid bi-orthogonal associate. Therefore bi-orthogonal associates can be thought of as comprehensive inverses. Before we offer the formal description of bi-orthogonal associates let us answer a possible question: why would we even trouble to use the additional general reconstruction arrangement from Fig.2(b) if the one in Fig.2(a)previously works fine? In most sensible applications where the exclamation structure begin (e.g.,[11], [12],[10]) filter H(z) has restricted impulse reaction (FIR). Therefore the explanation in Fig.2(a) involves IIR (endless impulse answer) filtering which is often period unstable or no fundamental. In dissimilarity to this, bi-orthogonal associates often display many attractive properties. Under some gentle conditions on H(z) and M there survive stable and even FIR bi-orthogonal associates [10]. Moreover, when FIR solutions survive they are not unique. This possessions will be of special significance in the study of numerous input—multiple output (MIMO) and incomplete bi-orthogonal associates in Chapters 2 and 3, respectively, where we utilize this non-uniqueness to locate the optimal bi-orthogonal associate for the application at hand.1.2.2 description and relative to filter banks believe the system in Fig.3(a). We say [10] that the strain F(z) and H(z) are bi-

orthogonal associates with admiration to an integer M if an random input x(n) to the scheme produces x(n) = x(n) as the production, in other terms if the system in the shape is the individuality.

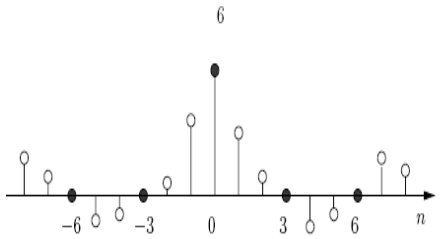


Figure 4 : Nyquist(*M*) property demonstrated for $M = 3$

It is a effortless exercise to demonstrate that the system in query is indeed an LTI system. If we indicate the product F(z)· H(z) = G(z), then scheme fromFig.3(a) is corresponding to the one in Fig.3(b), where G0(z) indicate the 0^{th} poly segment component of G(z) with admiration to M. Therefore, F(z) and H(z) are said to appearance a bi-orthogonal pair (bi-orthogonal associate relationship is symmetric) with admiration to M if

$$G_0(z) = [F(z)H(z)] \downarrow M = 1 \tag{3}$$

In the time province (3) implies that g(n), the desire response of G(z), convince the Nyquist(M) condition established in Fig.4. In other words, the succession g(n) has zero-crossings at all multiples of M excluding when n = 0. Notice that if M is distorted the two strain might not stay partners; though, the term 'with deference to M' is usually omitted every time no perplexity is anticipated. As mentioned formerly, the expression 'bi-orthogonal partners' was first initiate in [10]. In the subsequent we stimulate this terminology. Consider the ideal reconstruction (PR) or bi-orthogonal strain bank [9]. Such scheme is by explanation the identity, i.e., for any contribution x(n), the production is x(n). Each pair of filters {Hk(z), Fk(z)} in such filter store forms a bi-orthogonal match up. To see this, attach the analysis depository at the production of the PR filter depository. The outputs are perceptibly given by the identical ui(n) that emerge in the associate bands of the PR filter depository. This is accurate for any x(n) and thus for any alternative of ui(n). Without loss of simplification, let us focus on the first channel. We monitor that the marked scheme among u1(n) and u1(n) is equal to the one in Fig.3(a)and is nothing but the individuality scheme. Therefore H1(z) and F1(z) are certainly bi-orthogonal associates with deference to M. For a more complete treatment of bi-orthogonal acquaintances, the reader is referred to [10]. The objective in this segment was presently to provide some fundamentals that will inspire develop addition based on modern affirmation of the new literature.

IV. Contemporary Affirmation of Recent Literature

Several multiuser detectors initially projected for single-rate direct- succession CDMA (DS/CDMA) [14] have been explore for their use in multi-rate scheme, counting the linear and nonlinear multiuser detectors [15,16,17,18,19,20,21,22]. The characteristic instance of multi-rate linear detectors are low-rate de-correlation (LRD) and high-rate de-correlation (HRD) for synchronous dual-rate scheme with lone receive transmitter [15], [16], which are pedestal on bit period of low-rate (LR) consumer and high-rate (HR) users, correspondingly. It has been established that the LRD is not substandard to the HRD in conditions of probability of fault, and the dual-rate consequences are further comprehensive to multi-rate situation where more than two information rates exist [15]. To defeat their requirements of the preceding knowledge of the intrusive users, LR and HR blind least mean-squared error (MMSE) detectors were projected in [23] and [24]. Though, HR blind MMSE detector in [23] and [24] is not firmly blind. This is since for the sake of sense an LR user, the signal-to-interference-plus-noise ratio (SINR) of this LR consumer within each subinterval, which engages the information of the noise level and the intrusive users, is requisite for decision-making. Also, the presentation of LR and HR blind MMSE detectors in [23] and [24] were evaluate only by numerical replication. Note that the over dual-rate unsighted MMSE detectors do not function in indication subspace. Blind adaptive multiuser detection and antenna array processing have been viewed as powerful methods for mitigating co-channel interfering inherent to the non-orthogonal CDMA systems. For occurrence, Chkeif et al[25]. presented the subspace-based space–time (ST) blind de-correlation and blind MMSE detector for synchronous single-rate organization [25]. Adaptive accomplishment for ST blind MMSE uncovering based on the ortho-normal protuberance estimate subspace tracking (PAST) algorithm [26] has also been urbanized. However, so far little has been statement on ST multiuser uncovering for multi-rate DS/CDMA.

In the same background Lei Huang et al[13] comprehensive the results in [15] and [25]to suggest two-stage ST dual-rate blind detectors, which coalesce the adaptive purely sequential dual-rate blind MMSE detectors with the non-adaptive MVDR beam previous. Lei Huang et al[13] projected the ST-LR and ST-HR blind linear detectors, i.e., unsighted de-correlations and unsighted MMSE detectors, for synchronous DS/CDMA.

Observation: *In the comprehensive view of synchronous multi-rate scheme, we can conclude that*

1. *ST-LR blind linear detectors would bear no less users than their HR opponent as long as the preferred spatial signature is particular (assuming*

that all the additional system limitation are the same);

2. *ST-LR blind de-correlation wouldn't be substandard to its HR complement in terms of probability of mistake.*

The adaptive phase with parallel arrangement converge is worn in projected two-stage ST dual-rate unsighted detectors. Hence it can execute much faster than the equivalent adaptive ST dual-rate sightless MMSE detectors, as having the similar computational difficulty to the final.

Early effort of Nyquist [28] served to identify the maximum acceptable sampling interval, afterward dubbed the "Nyquist interval," which holds complete signal in sequence. Thus, it is not astounding that the most essential form of sampling, the standardized sampling theorem, had subsist well established within the meadow prior to its enclosure in Shannon's classic manuscript roughly two decades soon [29]. Alternative variety techniques are only vaguely more modern; with Shannon initiate the idea of derivative variety in his same classic manuscript. Additional premature work [30] examined several dissimilar classes of inconsistent variety including the case of intermittent inconsistent sampling. Such intermittent cases, including Shannon's imitative sampling, fall under the widespread sampling expansion (GSE) of Papoulis [31], which demonstrate that a band-limited indication passed through L dissimilar linear time-invariant systems can be modernize from the L outputs consistently sampled at a least of 1=Lth the Nyquist rate. Subsequent bear of the GSE with further analysis was recognized in [32]. These past mechanism provide an establishment for the development of achievable periodic inconsistent variety schemes.

More lately, some techniques have been initiated, which rely on multi-rate filter banks to rebuild a continuous-time or consistently sampled discrete-time indication from its periodic conflicting samples. Initial purpose of multi-rate filter banks for widespread sampling function, including inconsistent sampling, was obtainable in [33]. Follow up work by the similar authors [34] established a additional reliable technique of determining a discrete-time filter bank for rebuilding of a signal from its conflicting samples. A technique support on a continuous-time rebuilding filter bank, along with a technique for conversion to discrete-time, was urbanized in [35]. Discrete-time incomplete delay filters were employed in a strain bank structure [36] to rebuild a class of oversampled signals. One formulation [37] outlook the design of the rebuilding filters as a communications equalization trouble through a least-squares explanation. The multi-rate filter bank configuration was also used in [38], [39] to utilize a inconsistent technique for finest sampling of multiband indication.

Alternate reconstruction techniques that do not use a filter bank arrangement exist for various modules of inconsistently model signals. In cases where the variety pattern is constant, the filter bank arrangement cannot be functional as in the periodic container. Techniques for the revival of non-periodically sampled indication are typically more computationally composite than a filter bank, and frequently require iterative technique. An example interchange technique urbanized for the periodic case is [40], which recuperate the spectral pleased of a uniformly sampled signal bottom on points in the erratically sampled spectrum. Requiring a matrix development for each spectral point improved, the computational cost is significantly greater than revival through a filter bank. This thesis will deal only with the subclass of occasionally sampled signals, and a multi-rate strain bank structure will be worn for recovery. The broader group of inconsistently sampled indication along with purpose is examining in [41].

In the same circumstance Ryan Prendergast et al[27] accessible a purely discrete-time filter bank accomplishment for reconstruction of a intermittent inconsistently sampled indication. While equivalent in structure to preceding methods, a new loom introduced to conclude reconstruction filter bank. Reconstruction filters are restricted impulse response (FIR), assurance a realizable system. As mentioned above, this accomplishment is only relevant to cases where the variety is periodic.

Observation: This projected model seems to be aggravated by the area of analog-to-digital converters (ADCs). Correction of tiny periodic timing mistake in a time-interleaved ADC was the incentive in [36], [37], [40]. Earlier effort by the authors of this thesis [42] developed a solution for a effortless case of bunched sampling for the idea of noise reduction in mixed-signal included circuits (ICs). The solution urbanized in this thesis will be applied to mutually of these cases. Overall system presentation is dependent on two factors: the precision of signal replica through the analysis bank, and the accuracy of signal reconstruction through the fusion bank. The effects can be scrutinized separately. Synthesis filters can be considered that produce a PR or near PR scheme, but if the analysis filter modeling was imprecise the reconstructed signal will hold significant errors.

A discrete-time indication is said to be cyclo-stationary, or firmly speaking cyclo--wide-sense-stationary, if it's signify and/or autocorrelation are occasionally time-varying sequences [44], [45], [46]. Discrete-time cyclo-stationary indication often occur due to the time-varying scenery of physical phenomena, e.g., the endure [47], and certain man-made procedure, e.g., the amplitude accent, fractional sampling, and multi-rate scheme filtering [48], [44]. The ethereal theory of cyclo-stationary indication has applications in dissimilar areas, e.g., blind channel recognition and

equalization by incomplete sampling received indication [49], [50], filter-bank optimization by reduce averaged variances of modernization errors [51], [52], and system recognition by introducing cyclo-stationary peripheral excitation [53], [54] and by fast variety system outputs [55], [56].

The spectral assumption of discrete-time cyclo-stationary indication mainly consists of two parts, namely, the cyclo-spectrum illustration and the cyclo-spectrum conversion by linear systems. Here, the cyclo-spectrum is the equivalent of the power spectrum distinct for discrete-time motionless or strictly speaking wide-sense-stationary indication. The theory was first urbanized by Gladyshev [57]; a complex purpose that is currently referred to as the cyclic band was defined as the spectrum of a -periodically associated sequence; the spectral relationship among the original sequence and a superior dimensional sequence that is really the blocked signal was converse. Motivated by the sampling action, the cyclic band of discrete-time cyclo-stationary signals was distinct, but only a very imperfect study has been specified in Gardner's books [58], [59]; as a balance, linear time-invariant (LTI) and linear occasionally time-varying (LPTV) filtering of cyclo-stationary indication was discussed briefly in [48]. Via the Gardner's notation (e.g., that in [59]), Ohno and Sakai [51] consequent the output cyclic spectrum of a filter-bank (an LPTV system) frequently from definitions and worn it in the optimal filter-bank propose. To avoid the cumbersome source in [51], Sakai and Ohno [52] studied the cyclic range relationships among the unique, the modulated, and the blocked indication, and obtained the same expression of the cyclic range in [51] via these relationships. In an outstanding overview [44], Giannakis presented some consequences in terms of the cyclic range on the LPTV filtering, incomplete sampling, and multi-rate dispensation. Besides the cyclic range, there are some other cyclo-spectra, explicitly, the time-frequency illustration (TFR), the bispectrum, and the two-dimensional (2-D) range. After giving an surveillance that the cyclic range is not "very illustrative" (a personality actually caused by origin without a systematic approach), Lall et al. [60] analyzed the production of a filter-bank in conditions of the TFR. Akkarakaran and Vaidyanathan [61] used the bispectrum as a instrument to simplify most results in [62] (studying possessions of multi-rate blocks on scalar cyclo-stationary indication) into the vector case; they also provide the bispectrum of the production of a single-input and single-output (SISO) LPTV scheme and found the conditions below which a SISO LPTV scheme would produce motionless outputs for all stationary inputs. The 2-D spectrum, certainly a coordinate convert of the bispectrum, was projected in the context of episodic random processes in [63,64,65], where it was connected to the cyclic range and the TFR.

These four types of cyclo-spectra must have some interrelationships, while they all illustrate second-order statistical possessions of cyclo-stationary indication. The first input of this thesis, which is also of some seminar value, is to abridge these cyclo-spectra and discover their interrelationships.

Blocking in signal dispensation [66], [67] or lifting in organize [68], [69] has been shown to be a influential technique in commerce with multi-rate scheme and cyclo-stationary signals; by the overcrowding technique, one can correlate the multi-rate system with an corresponding multi-input and multi-output LTI system [69], [70]; overcrowding the cyclo-stationary signal can consequence in a higher dimensional motionless signal [57], [52], [62].

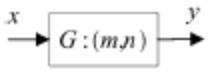


Fig. 1 : Linear SISO multi-rate system

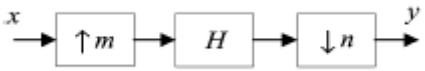


Fig. 2 : Cascade of up-sampler, LTI system (H), and down-sampler $(\downarrow n)$

Based on this dispute Jiandong Wang et al[43] proposed a combined frame work that referred as incorporated model, which is a universal multi-rate scheme that encompasses most frequent systems—linear, time-invariant scheme and linear periodically time changeable systems. The main scheme of this integrated replica is to block multi-rate scheme and cyclo-stationary signals correctly and convert the unique problem into one involving LTI scheme and stationary signals only, which can be readily, explain using some well-known consequences. More specifically, the kernel difficulty is separated into the subsequent two sub questions.

- Given a linear SISO multi-rate scheme in Fig. 1 and that the contribution is cyclo--wide-sense-stationary with phase and abbreviated as CWSS, is the production still or cyclo-stationary? If it is cyclo-stationary, what is its era?
- What is the cyclo-spectrum alteration in Fig. 1, i.e., how do we symbolize the cyclo-spectrum of in conditions of that of?

Observation: *The cyclo-spectrum revolution by linear systems is solving in a methodical manner by using multi-rate scheme as the unifying framework and the overcrowding technique as the major tool. The effects of the overcrowding operator on cyclo-stationary indication are investigated. The cyclo-stationarity of the production of the multi-rate scheme is studied and the*

cyclo-spectrum of the output is connected with that of the contribution in the form of matrix development.

The need for localized signal renovation in audio may emerge in several situations. For instance, signal drop-outs due to broadcast errors in digital channels [72] and extensive localized signal degradations in elderly gramophone recordings [73] are characteristic cases.

Signal renovation across gaps of missing model in audio signals has been loom through several means, between them band-limited exclamation [74], [75]; waveform switch schemes [76], [77]; interpolators based on sinusoidal replica [78], [79]; sub-band methods [80,81,82]; and autoregressive- bottom interpolators [79], [83], [84]. A comprehensive exposure of interpolation procedure can be found in [85]. Interpolators based on autoregressive (AR) replica are a suitable choice for renovate relatively short fragments of acoustic signals. The span of the gaps that can be significantly filled in is upper-limited by the unspecified short-term stationarity of the indication segment at hand. For common audio signals, stationarity can be predictable within frames of regarding 20 to 50ms. Therefore, extreme belongings correspond to interpolating crosswise missing portions whose durations are similar to or longer than the short-term stationarity unspecified for a given indication.

A straightforward way to condense the energy fading occurrence is to increase the order of the AR replica used in the interpolation system. This resource tends to yield AR replica with poles closer to the unit loop, thus favoring the interpolation process. Other alternatives consist of affix a sinusoidal basis symbol to AR-based interpolators [79]; employing exclamation schemes that oblige a lower limit to the minimization of modeling fault variance [87], [88]; and via random sampling interpolators [86], [89], [90]. When the breach becomes too extended it may happen that the ethereal characteristics of the gesture before and after the gap diverge substantially. In those belongings, it is preferable to utilize two separate AR models, one for instead of the fragment that instantly precedes the gap and a different for the portion that thrive the gap. Such a scheme has been projected in [91], which presents a prejudiced Least-Squares (LS) solution for the absent samples given the two dissimilar AR models. The resource of employing two dissimilar AR models for interpolation of extended gaps is also originated in [92, 93, 94].

Paulo A et al[71] presented an capable model-based interpolator for recreate long portions of missing illustration in audio signals, which is a adjustment to the interpolation proposal proposed in [92,93,94].

Instead of the stage pure extrapolation, which consists essentially of setting an initial situation for the AR synthesis sieve and computing its unforced reaction [94], an artificially created indication is employed to excite the combination filter. This resource allows organization the interpolation technique for AR models of considerably lower orders, without considerable degradations of its qualitative presentation. However, some bend on the low-frequency range can be apparent in the restored signals. To conquer this side-effect a post-processing period is then introduced. It essentially entails decomposing the indication into sub-bands and re-applying the conservative interpolation technique to the lowest-frequency sub-bands simply.

Observation: *The projected scheme is based on an earlier suggestion, which employs auto regressive based indication extrapolation. The key idea consisted in moving the synthesis filter with a synthetically created excitation; instead of calculate its unforced response, as in the unique method. The devised excitation is preferred as the time-reversed modeling error progression associated with the section used to estimate the AR synthesis filter. Moreover, a post-processing phase was devised to condense the low-frequency distortions shaped by the modified interpolation algorithm. This phase first decomposes the indication into six sub-bands through a CQF maximally decimated filter bank. Then, the predictable interpolation technique is applied to the two buck frequency sub-band signals, previous to the final synthesis.*

As an effect of the present commutation process in the thyristor undergrowth and the finite system impedance (symbolize by inductances L), line voltages at the contribution of the converter hold a notch-type commotion. The corrupted line voltage is not appropriate as a synchronization indication since various zero crossings can arise. These multiple zero passage is known to generate control instabilities [96].

In this circumstance Stjepan Pavljasevi et al[95] projected a digital-signal-processing scheme suitable for organization in applications where the organization signal is severely concerned, and where the signal occurrence and amplitude are changeable. The scheme is based on a multi-rate phase-locked sphere. The main compensation of the multi-rate loom are that it relaxes the execution of the antialiasing filter, and it facilitate one to accommodate the unstable amplitude of the contribution signal. The antialiasing filter, which is in this container a high-order band-pass filter, is realize in the digital part of the scheme. This feature is accomplished by applying the oversampling procedure to the input signal. The antialiasing filter mechanically adapts to the input-signal-frequency dissimilarity through the system's erratic sample-rate action. In cases where the contribution signal is tainted with strong disturbances, concert of an ordinary PLL may be substandard. The PLL output signal can hold jitter, or it even may occur that the PLL cannot path the input signal at all. In the aspire overcoming these complicatedness, Stjepan Pavljasevi et al[95] introduced a organization method based on a multi-rate PLL. The disorder rejection in the

projected system is mainly firm by the frequency reaction of the antialiasing filter. The antialiasing filter measured provides additional disturbance rejection evaluate to other approaches [97]. All scheme blocks, together with the antialiasing filter, in the proposed scheme are implemented in digital appearance.

Observation: *Stjepan Pavljasevi et al[95] discussed mutually theoretical and sensible aspects of the projected system. With respect to the conjectural aspects the scheme operation was analyzed and consequent system models. The consequent transfer-function replica is key to solve the question of the scheme control. For the scheme considered, the fastest potential response is about eight-sampling era long. This response is attaining with the MRT (deadbeat) control. The retort with the PI control is around six times slower evaluated to the MRT control.*

In several applications of radars and infrastructure systems, it is desirable to rebuild a multiband sparse indication from its samples. When the shipper frequencies of the signal group are high evaluated to the overall signal measurement, it is not cost effectual and often it is not feasible to trial at the Nyquist rate. It is therefore attractive to reconstruct the indication from samples taken at tariff lower than the Nyquist rate. Recent progress in electro–optical systems enables undersampling of multiband sparse signals with transporter frequencies that can be situated in a very broad frequency district (0–20 GHz) [99]. Such an extensive bandwidth cannot be attain in the current electronic skill.

To exploit the compensation of optical sampling scheme the under sampling should be execute using a small number of channels in use at high sampling charge. Moreover, there is an intrinsic advantage to sampling, in every channel, near the most sampling rate allowed by expenditure and technology. This is since sampling at higher rates increases the signal-to-noise proportion in the sampled signals [100].

There is a huge literature on reconstructing multiband indication from under sampled data [101,102,103,104,105]. Most of the techniques are based on a multi coset variety scheme. In a multi-coset variety scheme m, low-rate cosets are selected out of L cosets of samples, gain from time uniformly dispersed samples taken at a rate F ,which is superior than or equal to the Nyquist rate F_{Nyq} [103]. In each strait, the sampling is offset by a dissimilar predetermined integer several of the reciprocal of the rate F. The information from the different variety channels are then used to rebuild a signal by solving a system of linear equations.

In [102], the difficulty of blind multiband signal renovation was first presented and solved by using a multi-coset variety scheme. In a blind signal rebuilding, the frequency hold of the signal is not recognized a priori. Under certain circumstances on the sampling rate and the amount of channels, a proper option of the time offsets among the sampling channels guarantee a unique reconstruction in casing that the signal bands position are known a priori [103], or unidentified a priori [102,104,105].

The main benefit of a multi-coset sampling scheme is the capability to construct a universal variety pattern [103], [105]. The algorithms for blind indication recovery of [105] and the adequate conditions for their success rely on these possessions. However, in order to gain a high achievement rate, the sampling should be performing using elevated number of sampling channels. Moreover, in organize to obtain the theoretical least sampling rate; the bandwidth of the indication bands should be equal.

In the same rivulet of context Michael Fleyer et al[98]projected a new scheme for sampling and rebuild of a multiband sparse signals that reside in a small part of a given wide frequency range under the limitation of a small number of variety channels. The locations of the signal group are not known a priori. The method that referred as synchronous multi-rate sampling (SMRS), entails assembly samples synchronously at few dissimilar rates whose sum is significantly inferior than the Nyquist sampling rate. The indication are reconstructed by verdict a solution of an underdetermined scheme of linear equations by applying a chase algorithm and assuming that the clarification is composed of a least number of bands.

The sampling outline of the SMRS scheme can also be obtained by using an corresponding multi-coset sampling proposal. However, since the necessary time shifts between dissimilar sampling channels is very small, such a proposal cannot be practically apply. Moreover, the number of channels in the corresponding multi-coset sampling method is very high (on the order of 55 in one of our realistic examples). The equivalent multi-coset proposal enabled us to evaluate the empirical reconstruction achievement rate of SMRS to the rebuilding methods in [105] for the practical difficulty studied in this manuscript. In [105], two algorithms indicate by SBR4 and SBR2 are given for a blind rebuilding of sparse multiband signal. Since the variety pattern in the equivalent multi-coset proposal was not a universal pattern, we might not implement the algorithm illustrate in SBR2 that enables a faultless reconstruction by using less sampling channels than necessary in SBR4 algorithm. We have realized the SBR4 algorithm and evaluate its performance to our rebuilding method. The rebuilding method described in this manuscript gives a superior empirical reconstruction achievement rate than obtained by using SBR4 algorithm for four group complex-valued signals and for genuine signals with a total bandwidth that is a smaller amount than one fifth of the entirety sampling rate. The higher achievement rate is obtained since when the variety rate

in each channel is high, the prospect that a sparse signal aliases concurrently in all sampling channels turn into very low in the SMRS scheme. It is inferior than a multi-coset sampling proposal in which, because all channels sample at the similar frequency, an alias in one conduit is equivalent to an pseudonym in all channels. A universal variety pattern that ensures a ideal reconstruction in a multi-coset sampling proposal [103] can be obtained with a lesser total sampling rate than essential by the SMRS scheme. However, such a proposal requires a superior number of channels than is necessary in the SMRS scheme to attain comparable empirical rebuilding success rate. This number can be prohibitively elevated, rendering such a sampling scheme unrealistic when implemented with electro–optical scheme.

Observation: *The described multi-rate synchronous variety scheme is destined for blind reconstruction of thin multiband signals using a little number of sampling channels whose entirety sampling rate is considerably lower than the Nyquist rate. This proposal is an alternative approach to a multi-coset variety scheme appropriate when the number of sampling channel is inadequate. It also yields a important improvement evaluate to the previously published multi-rate asynchronous proposal. The scheme is especially successful when the sampling rate of every sampling conduit is high. The reconstruction technique introduced is associated with a decline procedure and a band-sparsest alteration of a common pursuit algorithm. If the illustration signals acquire some reasonable properties, then projected model is auspicious to grow high empirical reconstruction accomplishment rate.*

Multi-rate fir filter banks are linear occasionally shift variant (LPSV) scheme [107,108,109], where the shift variance is origin by non-ideal anti-aliasing filtering in the decimation phase. In a similar way, non-ideal anti-imaging filtering in the exclamation stage implies that ephemeral a wide sense stationary (WSS) casual signal through a channel of a multi-rate filter bank usually introduces cyclic nonstationarities into the indication, making the output indication wide sense cyclostationary (WSCS) slightly than WSS (see, e.g., [110]). For multi-rate filter banks, interrupted shift variance and the cohort of cyclo-stationarity are intimately related [111], [112]. Moreover, they are matching in the sense that, while transfer variance is generally analyzed using deterministic contribution signals [113,114,115,116] the scrutiny of cyclo-stationarity by description pertains to random signals.

In this circumstance Til Aach et al[106] provided a unified framework to calculate both shift variance of the LPSV scheme and the amount of cyclo-stationarity it generates. In this deference, the key concept is the covariance machinist associated to an arbitrary variable. Cyclo-stationarity of the erratic translates to LPSV properties of the machinist, and vice versa. An analysis was manner on the effects of an LPSV scheme on deterministic and statistical indication within a unified structure by quantifying shift variance of machinist [117]. For this reason, initially considered a Hilbert space norm that quantifies the episodic shift variance of an LPSV machinist T via the expanse to its nearest shift invariant machinist, as previously recommended in [118], and then turned to arbitrary signals.

To measure the quantity of (wide sense) cyclo-stationarity in an arbitrary signal in a manner consistent with projected treatment of shift variance and distinct the covariance operator C connected to the random signal. The covariance machinist C regards the covariance matrix or autocorrelation purpose of the random signal as a description of a linear scheme. The key observation is that this scheme is LPSV if and only if (iff) the random indication is WSCS. In exacting, the system is shift invariant iff the arbitrary signal is WSS. Hence, pertain the shift variance measure distinct above for deterministic signals to the covariance machinist of a WSCS random signal offer a measure of its cyclo-stationarity implicit as the distance to the adjacent stationary autocorrelation, or consistently, as the distance from C to its adjacent shift invariant operator. The covariance machinist associated to the output indication of an LPSV operator is known by the concatenation of the covariance machinist of its input with the LPSV machinist and its ad joint. Hence, applying the shift discrepancy measure to the covariance machinist of the WSCS output signal of an LPSV machinist with WSS input provides determine for the amount of cyclo-stationarity produce by the LPSV scheme. The effects of LPSV system on WSS random signals are, yet, only partly captured by probing the cyclo-stationarity generated. For an inclusive analysis of LPSV possessions on random signals which go outside their covariance structure, the research aimed to examine the dissimilarity caused in the output indication when system operator and shift machinist are interchanged. For WSS or WSCS input signals, this dissimilarity process is WSCS, and can be enumerate by the expected shift variance over one sequence, and then resultant analytical Fourier domain terminology of these measures for multi-rate strain banks. Finally functional these to evaluate various seriously sampled two-channel perfect renovation (PR) filter banks with arbitrary input signals, and rank the filter banks with deference to generation of cyclo-stationarity and probable shift variance.

Observation: *Starting from custom in Hilbert-space (originally initiate in [118]), Til Aach et al[106] first urbanized a coherent framework for enumerate the shift-variant effects of LPSV scheme on deterministic signals as well as their cyclostationary possessions on WSS random signals. The link between the deterministic and the statistical loom was formed by the covariance*

machinist. The framework combine criteria urbanized in our previous analyses of shift variant [113] and cyclo-stationary [112] possessions, while at the same time given that a unified view by connect Greens functions to the covariance structures of random signals at the production of LPSV systems. The WS-cyclo-stationary perspective is, however, limited to an assessment of the said covariance configuration, and does not permit a genuine evaluation of shift conflict on random signals going past their covariance structure. The extension projected by Til Aach et al[106] gain a new measure, namely projected shift variance that is justified by logical spectral-domain similes of the various criteria, consequent invariance properties and sharp higher estimates.

V. Conclusion

Overall seven papers [13, 27, 43, 71, 95, 98, 106] published in IEEE transactions on Signal Processing of tenure 2004 to 2012 discussed in this contemporary affirmation of the recent literature. These papers covered different aspects of advanced multi-rate signal processing techniques and low-complexity/reconfigurable/programmable DSP implementations for wireless communication systems. In this review context, we can conclude that there is much scope for research in advanced multi-rate signaling models. Due to magnitude changes in multimedia transmission methodologies in wireless communication networks, transmission channel sharing is in particular, the QoS factors such as bandwidth utilization and signal noise reduction become key factors. Hence the driving future research in this context will be auspicious to device multi-rate signaling models, which can effective in QoS factors without compromising at computational scalability and infrastructure adaptability.

References Références Referencias

1. Harris, F. (2005). Multirate Signal Processing for Communication Systems. Prentice Hall.
2. Wornell, G. (1996). Emerging applications of multirate signal processing and wavelets in digital communications. Proceedings of the IEEE, 84(4):586603.
3. Akansu, A., Tazebay, M., and Medley, M.J.and Das, P. (1997). Wavelet and subband trans- forms: fundamentals and communication applications. IEEE Communications Magazine, 35(12):10411
4. Mirabbasi, S. and Martin, K. (2000). Classical and modern receiver architectures. IEEE Communication Magazine, pages 132139.
5. Chester, D. B. (1999). Digital IF Iter technology for 3G systems: An introduction. IEE E Communications Magazine, 35(2):102107
6. Erup, L., Gardner, F.M., and Harris, R. (1993). Interpolation in digital modems-part II: Implementation and performance. IEEE Transactions On Communications, 41(6):296 311
7. Kumar, R., Nguyen, T., Wang, C., and Goo, G. (1999). Signal processing techniques for wideband communications systems. IEEE Military Communications Conference Proceed- ings, 1:452457
8. Bojan, V. (2003). Multirate signal processing concepts in digital communications. PhD the- sis, California Institute of Technology, http://etd. caltech. edu/etd/available/etd-06252003- 115639/.
9. P. P. Vaidyanathan, Multirate Systems and Filter Banks. Englewood Cliffs, NJ: Prentice-Hall, 1993.
10. P. P. Vaidyanathan and B. Vrcelj, “Bi-orthogonal partners and applications,” IEEE Trans. Signal Processing, vol. 49(5), pp. 1013–1027, May 2001.
11. M. Unser, A. Aldroubi, and M. Eden, “B-spline signal processing: Part I—Theory,” IEEE Trans. Signal Processing, vol. 41(2), pp. 821–833, Feb. 1993.
12. B. Vrcelj and P. P. Vaidyanathan, “Efficient implementation of all-digital interpolation,” IEEE Trans. Image Processing, vol. 10(11), pp. 1639–46, Nov. 2001.
13. Lei Huang; Fu-Chun Zheng; , "Space-time blind multiuser detection for multi-rate DS/CDMA signals," Vehicular Technology, IEEE Transactions on , vol.53, no.6, pp. 1746- 1755, Nov. 2004; doi: 10.1109/TVT.2004.836954
14. S. Verdú, Multiuser Detection, U.K.: Cambridge Univ. Press, 1998
15. J. X. Chen and U. Mitra, “Analysis of decorrelator-based detectors formultirate DS/CDMA communications,” IEEE Trans. Veh. Technol., vol.48, pp. 1966–1983, 1999.
16. M. Saquib, R. Yates, and N. Mandayam, “Decorrelating detectors fora dual-rate synchronous DS/CDMA system,” Wireless Pers. Commun.,vol. 9, pp. 197–216, 1998.
17. M. Saquib, R. D. Yates, and A. Ganti, “An asynchronous multiratedecorrelator,” IEEE Trans. Commun., vol. 48, pp. 739–742, 2000
18. J. Choi and S. R. Kim, “Adaptive MMSE receiver for multirate CDMAsystems,” IEEE Trans. Signal Processing, vol. 50, pp. 3098–3106, 2002.
19. A. Sabharwal, U. Mitra, and R. Moses, “MMSE receiver for multirateDS-CDMA systems,” IEEE Trans. Commun., vol. 40, pp. 2184–2197,2001.
20. M. J. Juntti, “Performance of multiuser detection in multirate CDMA systems,” Wireless Pers. Commun., vol. 11, pp. 293–311, 1999.
21. U. Mitra, “Comparison of maximum-likelihood-based detection for two multirate access schemes for CDMA signals,” IEEE Trans. Commun., vol. 47, pp. 64–77, 1999.
22. M. Saquib, R. Yates, and N. Mandayam, “Decision feedback detection for a dual-rate CDMA system,”

in ACM Wireless Networks, vol. 4, 1998,pp. 497–506.
23. H. Ge, "Multiuser detection for integrated multi-rate CDMA," in Proc. Int. Conf. Information, Commun., and Signal Processing, Singapore, Sept. 1997, pp. 858–862.
24. H. Ge and J. W. Ma, "Multirate LMMSE detectors for asynchronous multi-rate CDMA systems," in Proc. ICC 1998, June 1998, pp. 714–718.
25. A. Chkeif, K. A. Meraim, G. K. Kaleh, and Y. B. Hua, "Spatio-temporalblind adaptive multiuser detection," IEEE Trans. Commun., vol. 48, pp.729–732, May 2000.
26. K. A. Meraim, A. Chkeif, and Y. Hua, "Fast orthonormal PAST algorithm,"IEEE Signal Processing Lett., vol. 7, pp. 60–62, 2000.
27. Prendergast, R.S.; Levy, B.C.; Hurst, P.J.; , "Reconstruction of band-limited periodic inconsistently sampled signals through multi-rate filter banks," Circuits and Systems I: Regular Papers, IEEE Transactions on , vol.51, no.8, pp. 1612- 1622, Aug. 2004; doi: 10.1109/ TCSI. 2004. 832781
28. H. Nyquist, "Certain Topics in Telegraph Transmission Theory," AIEETrans., pp. 617-644, 1928.
29. C. E. Shannon, "Communication in the presence of noise." Proc. IRE,vol. 37, pp. 10-21, Jan. 1949.
30. J. L. Yen, "On nonuniform sampling of bandwidth-limited signals," IRETrans. Circuit Theory, vol. CT-3, pp. 251-257, Dec. 1956.
31. A. Papoulis, "Generalized sampling expansion," IEEE Trans. Circuits Systems, vol. CAS-24, pp. 652-654, Nov. 1977.
32. J. L. Brown, Jr., "Multi-channel sampling of low-pass signals," IEEET rans. Circuits Systems, vol. CAS-28, pp. 101-106. Feb. 1981.
33. P. P. Vaidyanathan, V. C. Liu, "Classical sampling theorems in the context of multirate and poly-phase digital filter bank structures," IEEE Trans. Acoust., Speech, Signal Processing, vol. 36, pp. 1480-1495, Sept. 1988.
34. P. P. Vaidyanathan, V. C. Liu, "Efficient reconstruction of band-limited sequences from nonuniformly decimated versions by use of poly-phasefilter banks," IEEE Trans. Acoust., Speech, Signal Processing, vol. 38,pp. 1927-1936, Nov. 1990.
35. Y. C. Eldar, A. V. Oppenheim, "Filter-bank reconstruction of band limited signals from non uniform and generalized samples," IEEE Trans. Sig.Proc., vol. 48, pp. 2864-2875, Oct. 2000.
36. H. Johansson, P. L¨owenborg, "Reconstruction of nonuniformly sampled band limited signals by means of digital fractional delay filters," IEEET rans. Sig. Proc., vol. 50, pp. 2757-2767, Nov. 2002.
37. W. Namgoong, "Finite-Length Synthesis Filters for Non-UniformlyTime-Interleaved Analog-to-Digital Converter," IEEE Int. Symposium on Circuits and Systems, vol. 4, pp. 815-818, May 2002.
38. R. Venkataramani, Y. Bresler, "Perfect reconstruction formulas and bounds on aliasing error in sub-Nyquist non uniform sampling of multiband signal," IEEE Trans. Info. Theory, vol. 46, pp. 2173-2183, Sept.2000.
39. R. Venkataramani, Y. Bresler, "Optimal sub-Nyquist non uniform sampling and reconstruction for multiband signals," IEEE Trans. Sig. Proc., vol. 49, pp. 2301-2313, Oct. 2001.
40. Y. -C. Jenq, "Perfect reconstruction of digital spectrum from non uniformly sampled signals," in Proc. Instrumentation and Measurement Technology Conference, Ottowa, Ont., vol. 1, pp. 624-627, 1997.
41. F. Marvasti, Non uniform Sampling, Theory and Practice. Kluwer, 2001.
42. R. S. Prendergast, B. C. Levy, and P. J. Hurst, "Multirate filter banker construction of band limited signals from bunched samples," in Proc.36th Asilomar Conference on Signals, Systems, and Computers, Pacific Grove, CA, vol. 1, pp. 781-785, Nov. 2002.
43. Jiandong Wang; Tongwen Chen; Biao Huang; , "On spectral theory of cyclo-stationary signals in multi-rate systems," Signal Processing, IEEE Transactions on , vol.53, no.7, pp. 2421- 2431, July 2005; doi: 10.1109/TSP.2005.849192
44. "Cyclo stationary signal analysis," in Digital Signal Processing Handbook. Boca Raton, FL: CRC, 1999.
45. E. G. Gladyshev, "Periodically correlated random sequence," Soviet Math., vol. 2, pp. 385–388, 1961.
46. "Cyclo-period estimation for discrete-time cyclo stationary signals, "IEEE Trans. Signal Process., to be published.
47. D. E. K. Martin, "Detection of periodic autocorrelation in time series data via zero-crossing," J. Times Ser. Anal., vol. 20, no. 4, pp. 435–452,1999.
48. "An introduction to cyclo stationary signals," in Cyclo stationarity in Communications and Signal Processing,W. A. Gardner, Ed. Piscataway, NJ: IEEE Press, 1994.
49. L. Tong, G. Xu, and T. Kailath, "Blind identification and equalization based on second-order statistics: A time domain approach," IEEE Trans. Inf. Theory, vol. 40, no. 2, pp. 340–349, Mar. 1994.
50. L. Tong, G. Xu, B. Hassibi, and T. Kailath, "Blind identification and equalization based on second-order statistics: A frequency-domain approach, "IEEE Trans. Inf. Theory, vol. 41, no. 1, pp. 329–334, Jan.1995.
51. S. Ohno and H. Sakai, "Optimization of filter-banks using cyclo stationary spectral analysis," IEEE

Trans. Signal Process., vol. 44, no. 11,pp. 2718–2725, Nov. 1996.
52. H. Sakai and S. Ohno, "Theory of cyclo stationary processes andits application," in Statistical Methods in Control and Signal Processing. New York: Marcel Dekker, 1997, pp. 327–354.
53. "Identification of systems with cyclo stationary input and correlated input/output measurement noise," IEEE Trans. Autom. Control, vol. 35, no. 4, pp. 449–452, Apr. 1990.
54. G. B. Giannakis, "Poly spectral and cyclo stationary approaches for identification of closed-loop systems," IEEE Trans. Autom. Control, vol. 40, no. 5, pp. 882–885, May 1995.
55. L. Sun, H. Ohmori, and A. Sano, "Frequency domain approach to closed loop identification based on output inter-sampling scheme," in Proc. Amer. Control Conf., vol. 3, Jun. 2000, pp. 1802–1806.
56. J. Wang, T. Chen, and B. Huang, "Closed-loop identification via output fast sampling," J. Process Control, vol. 14, no. 5, pp. 555–570, 2004.
57. E. G. Gladyshev, "Periodically correlated random sequence," Soviet Math., vol. 2, pp. 385–388, 1961.
58. W. A. Gardner, Statistical Spectral Analysis: A Non probabilistic Theory. Engel wood Cliffs, NJ: Prentice-Hill, 1988.
59. Introduction to Random Processes With Application to Signals and Systems, Second ed. New York: McGraw-Hill, 1990.
60. B. Lall, S. D. Joshi, and R. K. P. Bhatt, "Second-order statistical characterization of the filter-bank and its elements," IEEE Trans. Signal Process., vol. 47, no. 6, pp. 1745–1749, Jun. 1999.
61. S. Akkarakaran and P. P. Vaidyanathan, "Bifrequency and bispectrummaps: A new look at multirate systems with stochastic inputs," IEEE Trans. Signal Process., vol. 48, no. 3, pp. 723–736, Mar. 2000.
62. V. P. Sathe and P. P. Vaidyanathan, "Effects of multirate systems on the statistical properties of random signals," IEEE Trans. Signal Process., vol. 41, no. 1, pp. 131–146, Jan. 1993.
63. "Issues in multirate statistical signal processing," in Proc. Thirty-Fifth Asilomar Conf. Signals, Syst. Comput., vol. 1, Nov. 2001,pp. 573–576.
64. C. W. Therrien and R. Cristi, "Two-dimensional spectral representation of periodic, cyclo stationary, and more general random processes," inProc. IEEE Int. Conf. Acoust., Speech, Signal Process., vol. 4, May 2002,pp. 3561–3563.
65. C. W. Therrien, "Some considerations for statistical characterization of non stationary random processes," in Proc. Thirty-Sixth Asilomar Conf. Signals, Syst., Comput., vol. 2, Nov. 2002, pp. 1554–1558.
66. R. A. Meyer and C. S. Burrus, "A unified analysis of multirate and periodically time-varying digital filters," IEEE Trans. Circuits Syst., vol.CAS-22, no. 3, pp. 162–168, Mar. 1975.
67. P. P. Vaidyanathan, Multirate Systems and Filter-banks. Engle wood Cliffs, NJ: Prentice-Hall, 1993.
68. T. Chen and B. A. Francis, Optimal Sampled-Data Control Systems. London, U.K.: Springer, 1995.
69. P. P. Khargonekar, K. Poolla, and A. Tannenbaum, "Robust control oflinear time-invariant plants using periodic compensation," IEEE Trans. Autom. Control, vol. AC–30, no. 11, pp. 1088–1096, Nov. 1985.
70. R. A. Meyer and C. S. Burrus, "A unified analysis of multirate and periodically time-varying digital filters," IEEE Trans. Circuits Syst., vol.CAS-22, no. 3, pp. 162–168, Mar. 1975.
71. Esquef, P.A.A.; Biscainho, L.W.P.; , "An efficient model-based multi-rate method for reconstruction of audio signals across long gaps," Audio, Speech, and Language Processing, IEEE Transactions on , vol.14, no.4, pp.1391-1400, July 2006; doi: 10.1109/TSA.2005.858018
72. N. S. Jayant and S. W. Christensen, "Effects of packet losses in waveform coded speech and improvements due to an odd-even sample-interpolation procedure," IEEE Trans. Commun., vol. CAM-29, no. 2, pp.101–109, Feb. 1981.
73. P.Wilson, "Record contamination: Causes and cure," J. Audio Eng. Soc.,vol. 13, no. 2, pp. 166–176, Apr. 1965.
74. A. Papoulis, "A new algorithm in spectral analysis and band-limited extrapolation,"
75. P. J. S. G. Ferreira, "Iterative and noniterative recovery of missing samplesfor 1-D band-limited signals," in Nonuniform Sampling—Theoryand Practice, F. Marvasti, Ed. New York: Kluwer, 2001, ch. 5.
76. D. J. Goodman, G. B. Lockhart, O. J. Waen, and W. C. Wong, "Waveform substitution techniques for recovering missing speech segmentsin packet voice communications," IEEE Trans. Acoust., Speech, Signal Processing, vol. ASSP-34, no. 6, pp. 1440–1448, Dec. 1986.
77. M. Niedz´wiecki and K. Cisowski, "Smart copying—a new approach tore construction of audio signals," IEEE Trans. Signal Processing, vol. 49,no. 10, pp. 2272–2282, Oct. 2001.
78. R. C. Maher, "A method for extrapolation of missing digital audio data,"J. Audio Eng. Soc., vol. 42, no. 5, pp. 350–357, May 1994.
79. S. J. Godsill and P. J. W. Rayner, Digital Audio Restoration—A Statistical Model Based Approach. London, U.K.: Springer-Verlag, 1998.
80. S. Montresor, J. C. Valiere, J. F. Allard, and M. Baudry, "Evaluation of two interpolation methods

applied to old recordings restoration," inProc. 90th Convention of the AES, Paris, France, Feb. 1991.
81. B.-S. Chen and Y.-L. Chen, "Multirate modeling of AR/ARMA stochastic signals and its application to the combined estimation-interpolation problem," IEEE Trans. Signal Processing, vol. 43, no. 10, pp.2302–2312, Oct. 1995.
82. G. Cocchi and A. Uncini, "Subbands audio signal recovering using neural nonlinear prediction," in Proc. Int. Conf. Acoustics, Speech, Signal Processing, vol. 2, 2001, pp. 1289–1292.
83. S. V. Vaseghi, "Algorithms for Restoration of Archived Gramophone Recordings," Ph.D. thesis, Engineering Dept., Cambridge Univ., Cambridge, U.K., 1988.
84. A. J. E. M. Janssen, R. N. J. Veldhuis, and L. B. Vries, "Adaptive interpolation of discrete-time signals that can be modeled as autoregressive processes," IEEE Trans. Acoust., Speech, Signal Processing, vol.ASSP-34, no. 2, pp. 317–330, Apr. 1986.
85. R. Veldhuis, Restoration of Lost Samples in Digital Signals. Englewood Cliffs, NJ: Prentice-Hall, 1990.
86. J. J. Ó. Ruanaidh andW. J. Fitzgerald, "Interpolation of missing samples for audio restoration," Electron. Lett., vol. 30, no. 8, pp. 622–623, Apr.1994.
87. P. J. W. Rayner and S. J. Godsill, "The detection and correction of artefacts in degraded gramophone recordings," in Proc. IEEE ASSP Workshop Applications Signal Processing Audio Acoustics, Oct. 1991, pp.151–152.
88. M. Niedz´wiecki, "Statistical reconstruction of multivariate time series,"IEEE Trans. Signal Processing, vol. 41, no. 1, pp. 451–457, Jan. 1993.
89. S. J. Godsill and P. J.W. Rayner, "A bayesian approach to the restoration of degraded audio signals," IEEE Trans. Speech Audio Processing, vol.3, no. 4, pp. 276–278, Jul. 1995.
90. "Statistical reconstruction and analysis of autoregressive signalsin impulsive noise using the Gibbs sampler," IEEE Trans. Speech Audio Processing, vol. 6, no. 4, pp. 352–372, Jul. 1998.
91. W. Etter, "Restoration of a discrete-time signal segment by interpolation based on the left-sided and right-sided autoregressive parameters," IEEETrans. Signal Processing, vol. 44, no. 5, pp. 1124–1135, May 1996.
92. I. Kauppinen, J. Kauppinen, and P. Saarinen, "A method for long extrapolation of audio signals," J. Audio Eng. Soc., vol. 49, no. 12, pp.1167–1180, Dec. 2001.
93. I. Kauppinen and J. Kauppinen, "Reconstruction method for missing or damaged long portions in audio signal," J. Audio Eng. Soc., vol. 50, no.7/8, pp. 594–602, Jul./Aug. 2002.
94. I. Kauppinen and K. Roth, "Audio signal extrapolation—theory and applications, "in Proc. 5th Int. Conf. on Digital Audio Effects, Hamburg, Germany, Sep. 2002, pp. 105–110.
95. Pavljasevic, S.; Dawson, F.; , "Synchronization to Disturbed Utility-Network Signals Using a Multi-rate Phase-Locked Loop," Industrial Electronics, IEEE Transactions on , vol.53, no.5, pp.1410-1417, Oct. 2006; doi: 10.1109/TIE.2006.882002
96. R. Weidenbrüg and F. Dawson, "New synchronization method for thyristor power converters to weak AC-systems," IEEE Trans. Ind. Electron., vol. 40, no. 5, pp. 505–511, Oct. 1993.
97. S. Väliviita and S. J. Ovaska, "Delayless method to generate current reference for active filters," IEEE Trans. Ind. Electron., vol. 45, no. 4,pp. 559–567, Aug. 1998.
98. Fleyer, M.; Linden, A.; Horowitz, M.; Rosenthal, A.; , "Multi-rate Synchronous Sampling of Sparse Multiband Signals," Signal Processing, IEEE Transactions on , vol.58, no.3, pp.1144-1156, March 2010; doi: 10.1109/TSP.2009.2034906
99. A. Zeitouny, A. Feldser, and M. Horowitz, "Optical sampling of narrow band microwave signals using pulses generated by electro absorption modulators," Opt. Commun., vol. 256, pp. 248–255, Dec. 2005.
100. A. Rosenthal, A. Linden, and M. Horowitz, "Multirate asynchronous sampling of sparse multiband signals," J. Opt. Soc. Amer. A, vol. 25,pp. 2320–2330, Aug. 2008.
101. A. Kohlenberg, "Exact interpolation of band-limited functions," Appl. Phys., vol. 24, pp. 1432–1436, 1953.
102. P. Feng and Y. Bresler, "Spectrum-blind minimum-rate sampling andrecon struction of multiband signals," in Proc. IEEE Int. Conf. Acoust. Speech Signal Process., May 1996, vol. 3, pp. 1688–1691.
103. R. Venkantaramani and Y. Bresler, "Optimal sub-Nyquist non uniform sampling and reconstruction for multiband signals," IEEE Trans.Signal Process., vol. 49, no. 10, pp. 2301–2313, Oct. 2001.
104. Y. M. Lu and M. N. Do, "A theory for sampling signals from aunion of sub-spaces," IEEE Trans. Signal Process., vol. 56, no. 6, pp.2334–2345, Jun. 2008.
105. M. Mishali and Y. Eldar, "Blind multiband signal recostruction: Compressed sensing for analog signals," IEEE Trans. Signal Process., vol.57, no. 3, pp. 993–1009, Mar. 2009.
106. Aach, T.; Fuehr, H.; , "Shift Variance Measures for Multi-rate LPSV Filter Banks with Random Input Signals," Signal Processing, IEEE Transactions on , vol.PP, no.99, pp.1, 0; doi: 10.1109/TSP. 2012. 2205683

107. R. E. Crochiere and L. R. Rabiner, Multirate Digital Signal Processing. Englewood Cliffs: Prentice-Hall, 1983.
108. C. M. Loeffler and C. S. Burrus, "Optimal design of periodically time varying and multirate digital filters," IEEE Transactions on Acoustics, Speech, and Signal Processing, vol. 32, no. 5, pp. 991–997, 1984.
109. A. S. Mehr and T. Chen, "Representations of linear periodically time varying and multirate systems," IEEE Transactions on Signal Processing, vol. 50, no. 9, pp. 2221–2229, 2002.
110. J. Wang, T. Chen, and B. Huang, "On spectral theory of cyclo stationary signals in multirate systems," IEEE Transactions on Signal Processing, vol. 53, no. 7, pp. 2421–2431, 2005.
111. U. Petersohn, N. J. Fliege, and H. Unger, "Exact analysis of aliasing effects and non-stationary quantization noise in multirate systems," in Proceedings IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP). Adelaide: IEEE, May 1994, pp. III–173–III–176.
112. T. Aach, "Comparative analysis of shift variance and cyclo stationarity in multirate filter-banks," IEEE Transactions on Circuits and Systems–I:Regular Papers, vol. 54, no. 5, pp. 1077–1087, 2007.
113. T. Aach and H. F¨uhr, "On bounds of shift variance in two-channel multirate filter banks," IEEE Transactions on Signal Processing, vol. 57,no. 11, pp. 4292–4303, 2009.
114. R. Yu, "A new shift-invariance of discrete-time systems and its application to discrete wavelet transform analysis," IEEE Transactions on Signal Processing, vol. 57, no. 7, pp. 2527–2537, 2009.
115. K. Chaudhury and M. Unser, "On the shift ability of dual-tree complex wavelet transforms," IEEE Transactions on Signal Processing, vol. 58,no. 1, pp. 221 –232, 2010.
116. R. Yu, "Shift-variance measure of multichannel multirate systems," IEEE Transactions on Signal Processing, vol. 59, p. to appear, 2011.
117. T. Aach and H. F¨uhr, "Shift variance, cyclo stationarity and expected shift variance in multirate LPSV systems," in 2011 IEEE Statistical Signal Processing Workshop (SSP) (SSP'11). Nice, France: IEEE, June 28-302011, pp. 785–788.
118. T. Chen and L. Qiu, "Linear periodically time-varying discrete time systems: aliasing and LTI approximations," Systems Control Lett., vol. 30, no. 5, pp. 225–235, 1997. [Online]. Available: http://dx.doi.org/10.1016/S0167-6911(97)00006-6

Global Journal of Computer Science and Technology
Network, Web & Security
Volume 12 Issue 13 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

MALMR: Medium Access Level Multicast Routing for Congestion Avoidance in Multicast Mobile Ad Hoc Routing Protocol

By G.S.Sreedhar & Dr.A.Damodaram
Academic Audit Cell, JNTUH, Hyderabad

Abstract - This paper is focused on a new solution for congestion avoidance in ad hoc multicast routing by bearing the congestion situations. As the routing strategy belongs to Medium Access Level, the routing strategy is named Medium Access Level Multicast Routing short MALMR. MALMR is aimed at Congestion Avoidance in Multicast Mobile Ad hoc routing protocol. The present MAC level routing strategy is independent which can work with any multicast routing protocol irrespective of tree or mesh structure. During the study of MALMR performance, the MALMR tested along with On-Demand Multicast Routing Protocol where simulation results proved that MALMR raises the performance of ODMRP in order of magnitude.

Keywords : *Multicast, on-demand routing, congestion control, ad hoc network, MALMR.*

GJCST-E Classification: *C.2.2*

Strictly as per the compliance and regulations of:

MALMR: Medium Access Level Multicast Routing for Congestion Avoidance in Multicast Mobile Ad Hoc Routing Protocol

G.S.Sreedhar [α] & Dr.A.Damodaram [σ]

Abstract - This paper is focused on a new solution for congestion avoidance in ad hoc multicast routing by bearing the congestion situations. As the routing strategy belongs to Medium Access Level, the routing strategy is named Medium Access Level Multicast Routing short MALMR. MALMR is aimed at Congestion Avoidance in Multicast Mobile Ad hoc routing protocol. The present MAC level routing strategy is independent which can work with any multicast routing protocol irrespective of tree or mesh structure. During the study of MALMR performance, the MALMR tested along with On-Demand Multicast Routing Protocol where simulation results proved that MALMR raises the performance of ODMRP in order of magnitude.

Keywords : Multicast, on-demand routing, congestion control, ad hoc network, MALMR.

I. Introduction

Great numbers of routing protocols for Ad Hoc network are presented by classifying from many aspects. Protocols are of three types such as reactive protocols, proactive protocols and composite protocols that integrate the discovering process of the above ones. Depending on the structure of network topology, the protocols are divided in two types. They are plane ones and clustering ones. Depending on load balance mechanism, the protocols are grouped as single path ones and multi-path ones. A great number of routing protocols such as Dynamic Source Routing (DSR), Ad Hoc On-Demand Distance Vector Routing (AODV), Destination-Sequenced Distance-Vector Routing (DSDV), Temporally Ordered Routing Algorithm (TORA) and Zone Routing Protocol (ZRP), are identified but the possibility of using them and their efficiency remained doubt in view of the only min-hop metric as routing selection criterion. MANET has no difference between a host and a router, because all nodes are senders or receivers and also forwarders of traffic where all MANET members can deleted easily. Having high mobility nature, MANETs can be used in the environments, which need robust and reliable capacity like military battlefield, emergency rescue, vehicular communication, mining operations etc. For these applications, multicast is paramount and helpful in holding down network bandwidth and resources, as one message from one source can be sent to multiple receivers at a time. The main risk for multicast routing in MANETs is maintaining of robust capacity even in the condition of frequent, mainly high-speed agility and nodes outages. So mesh-based protocols builds a mesh for forwarding multicast packets for sending even in the presence of links breaking, and reaches robustness and reliability demands with path repetition owing to meshes on networks. Present multicast routing protocols for MANET is divided into two types: tree-based and mesh-based protocols. The tree based ones, i. e. MAODV (Multicast of Ad hoc On Demand Distance Vector) generally have tree-based schemes, unfits high-speed ad hoc networks. Common mesh-based multicast routing protocol is ODMRP (On-Demand Multicast Routing Protocol)[2], that uses the concept of forwarding group, builds multicast mesh that is done in soft state and acquires high performance [3, 4]. In [5], V. Kumar, et al. obtains comparative conclusions about MAODV and ODMRP based on the simulation results. Even though the performance of all multicast protocols degrade in terms of packet sending and group reliability as node mobility and traffic load augments, mesh-based protocol ODMRP do better job than tree-based protocol MAODV. ODMRP can bring forth decent robustness based on its mesh structure. MAODV performs less when compared to other protocols in packet delivery ratio and group reliability.

II. Related Work

Based on the researches on real life Ad Hoc network and references, it is seen that a prodigious of real life Ad Hoc networks works without following rules which are included in our theoretical analysis. In contrast to above, selfish nodes hinder the network process. The selfish nodes are intended in participating of the natural network information exchange procedure like routing discovery, routing maintenance and packets forwarding etc. The reason for selfishness of these nodes comes from the various advantages of various organizations who own the various groups of nodes. Because of the existence of selfish nodes, a few relay nodes remains as "hot spots" which leads to "death" due to power decrease resulting in total disabling of entire network.

Author α : Professor, Department of CSE, K.O.R.M.College of Engineering, Kadapa. E-Mail : gssreedhar9@gmail.com
Author σ : Professor of CSE & Director, Academic Audit Cell, JNTUH, Hyderabad. E-Mail : damodarama@rediffmail.com

Prashant Dewan et al. said in [6] that, particular nodes in an Ad Hoc network might become antagonistic and thus refuse to cooperate with each other. In addition to, Ad hoc network posses semiautonomous nodes owned by different entities may not be distributed with common goal, and thus the nodes may not work together which is supposed to do. In [7], Buttayan et.al; presented "Nuglets" protocol for reducing the impact of nodes selfishness on entire network performance. The effectiveness gets "rewards" and in efficiency will be given "penalties"; In [8],"SPRITE" protocol is designed to control the selfishness by constructing a credit clearing service(CCS) server which provides a credit to every node in the network. The node selection depends on its credit for path. The above mentioned protocols focused on selfishness of nodes and how to overcome this selfishness. Whatever may so, implementation contains complexity in the channel fading, retransmission and collision etc. Thus these protocols remain incompetent.

III. Medium Access Level Multicast Routing (Malmr)

The core point of MALMR is reliability transmission of every packet to every neighbor. The presented MALMR designed using a transmission window structure that influenced by IEEE 802.11 transmission structure, thus a brief operational overview of 802.11 transmissions is as follows.

a) IEEE 802.11 Transmission Overview

IEEE 802.11 used a collision avoidance scheme including RTS/CTS/ACK control frames for transmission of unicast packets. In 802.11, the Distributed Coordination Function (DCF) shows the basic access method that mobile nodes uses for sharing wireless channel. The scheme combines CSMA with Collision Avoidance (CSMA/CA) and acknowledgement (ACK). The mobile nodes based on need they can use the virtual carrier sense mechanism which provided RTS/CTS exchange for channel reservation and fragmentation of packets in situations. The CSMA/CA works in transmission of senses the channel. If the channel is free for a time equal to the DCF Inter Frame Space (DIFS) interval, the node transmits. If the channel is busy, the node enters a state of collision avoidance and backs off from transmitting for a specified interval. In the collision avoidance state, the node sensing the channel busy will suspend its back off timer, only resuming the back off countdown when the channel is again sensed free for a DIFS period. Common sequence of exchanges in 802.11 utilizing the virtual carrier sensing mechanism contains the source node first sensing the channel utilizing CSMA/CA. After the execution of CSMA/CA, RTS is transmitted by the source node, which follows responding of node with CTS, after responding the source node sends the data frame and subsequently with the conformation of destination node with an ACK to the source node. Receiving RTS, CTS or data frame is not real destination of any node but it should complete the data exchange is real destination of node. For broadcast packets, IEEE 802.11 nodes simply execute collision avoidance and then transmit the data frame.

b) MALMR Transmission Window Structure

MALMR, multicast node nm need to manage two lists, target nodes list (TNL), which is hop level destinations, Frames Sent (FS), transmission history. Receptions of frames (RTS/CTS/DATA/ACK/HELLO) are used by nm to maintain track of its targeted nodes. Every nm also maintains a FS. The FS contains copies of the frames which are already transmitted which may be need even later for retransmission. After receiving by neighbor a copy will be removed from the FS. FS size must be larger than targets number for any nm. In addition to the FS, there is possibility of storing yet to be transmitted packets which is called. Every target node maintains a list for frame received which is symbolized as FR. FR stores when a target node receives a new frame, it records the frame's sequence number in FR. When a nm node transmits RTS to a destination node specifying a range of (from and to) sequence numbers, the destination node examines its FR to determine whether it is missing any previous sequence numbers in the specified range. If so, the destination node replies with the missing sequence number in the CTS response. Generally in MALMR, If an "nm" has to transmit a packet, it should first test the channel and then a collision avoidance (CSMA/CA) step like that of 802.11. After the collision avoidance step completion the channel becomes free, the nm sends RTS to its target picked from TNL from particular range of sequence numbers which are already sent where the present sequence number is to be transmitted. All the process will be achieved by pulling the least sequence number from the FS and defining it into the RTS frame with the present sequence number which is expected by the source node. After receiving the RTS, the determine target test its FR and decides the needed sequence numbers. CTS response frame will react if the target node doesn't find precedent sequence number.

Similarly, CTS response frame will also react even in case of present sequence number. All other targets hearing the RTS will yield long enough for the CTS/DATA/ACK transmission. Upon the receiving of the CTS, the "nm"transmits the DATA (packet) according to the sequence number determined in the CTS frame. After receiving the DATA, the target node updates its FR and answer with an ACK. Remaining neighboring nodes which receive the DATA updates their FR. After receiving the ACK, if the DATA sent DATA is wrong but obtain from the buffer, the source node its process with the destination node with another RTS until the present

DATA is sent from the queue. After transmission of the present DATA and acknowledged, the source node then buffers the packet and chooses the next neighbor in its NEIGHBOR LIST and repeats the whole process over again then the collision avoidance step is neglected. In MALMR, ordered first strategy is used that picks a target node from TNL chronologically. During this process target nodes order changes depending on their current ingress ability status. The ordered first strategy sends packets and works comfortably. If, there are no packets for transmission of queue, the ordered first process will be stopped until next target in the TNL received all the broadcast DATA until there is a new packet to send. For preventing this, MALMR utilizes flag cs that set to true and then next node in the TNL will be selected and the ordered first process repeats. In between if new sequence numbers joined then flag cs will be set false then remaining targets are visited in the ordered first process without considering the current sequence numbers if any. Upon the completion of RTS to all targets in ordered first process if still no new sequence numbers are identified then ordered first process stops the RTS process till there a new packet is ready for transmission. If new sequence numbers is identified then the flag cs sets wrong and ordered first process repeats.

IV. Congestion Avoidance in Odmrp Using Malmr

A few multicast routing protocols contains AMRoute[9], AMRIS[10], CAMP[11] , multicast AODV[12], and the On-Demand Multicast Routing Protocol (ODMRP)[13, 14, 15]. ODMRP distracts multicast packets on a mesh in place of the traditional multicast tree. By utilizing a mesh, ODMRP bring out excess to combat packet loss in ad hoc networks where channel noise, collisions and mobility are universal. With low traffic load, ODMRP does efficiently. Nevertheless, as traffic load augments, ODMRP continuously suffers from network congestion. Though this disadvantage is not limited to ODMRP it is wide spread among other multicast protocols. The present paper introduces a new MAC protocol, MALMR that allows reliable MAC broadcast in ad hoc networks. In addition to, by excess using MALMR, it is said that congestion control in ODMRP decreases network load when contention is high. This MALMR is not limited only to ODMRP but can apply even on other multicast protocols, like multicast AODV. ODMRP protocol is explained in the sub section I and ODMRP with our congestion avoidance scheme MALMR is explained in the sub section ii where simulation results are provided in section 4. Subsequently, section 5 explains the conclusion of the paper.

a) On-Demand Multicast Routing Protocol

ODMRP creates a group-shared forwarding mesh for every group. Every source carries out periodic flood-response cycles creating multicast forwarding state without depending on present forwarding state. The frequent state discovery helps the protocol to find the present simple paths between every source and the multicast receivers and develops the boisterous protocol due to multiple forwarding paths may present between group members. Due to this ODMRP's packet send number of sources and receivers per multicast group augments and even sometimes increases mobility: the repeat forwarding state devises ODMRP's packet produces ability due to it behaves error correction, and does the protocol robust to mesh. Nevertheless, the frequent identification produces and great number of data transmissions identically augments network load.

Ever multicast source for a group G in ODMRP regularly moves the network with a JOIN QUERY packet that forwards by all nodes in the network. REFRESH INTERVAL, e. g., every 3 seconds send by this packet. Every multicast receiver reacts to this flow by delivering a JOIN REPLY packet that is forwarded in a simple path back to the multicast source that started the QUERY. Anterior of forwarding the packet, every node waits for JOIN AGGREGATION TIMEOUT, and mixes all JOIN REPLYs for the group received during this time into one JOIN REPLY. Every node that forwards the REPLY packet generates (or refreshes) forwarding state for group G.

Every node with forwarding state for G forwards every data packet delivered by a multicast source for G. A data packet use the simplest paths to the multicast receivers within the forwarding mesh, it may even forwarded to other sources of the group who are group members. Forwarding state is ceased after a multiple of regular breaks to assure that in the event that some number of forwarding nodes' multicast state is not refreshed due to packet loss, the forwarding state generated from a earlier flood is also authenticated. This mechanism develops the boisterous protocol, where many overlapping trees will be activated in the network parallel; everything is produced finally by JOIN QUERY flood [16].

i. *Multicast route discovery*

In MALMR, route finds is started and managed by the source. When the source contains packets for transmission for a certain multicast group, the source first decides if there is a route to the group. If a route is not present, MALMR tries to create one through the route finding process. The route finding process is equal to on-demand unicast routing protocols like AODV [17] and DSR [18]. Route discovery process has two steps.

a. Request Round

In the request round, the source moves the network with a member advertisement packet with the data piggybacked which is named as JOIN QUERY. These JOIN QUERY packets regularly broadcast to the total network to refresh membership information and recreate new multicast routes. After receiving a non-duplicate JOIN QUERY, a node inserts or updates in its ROUTING TABLE the upstream node indicates as the next node to the source node. The ROUTING TABLE can also be utilized even in a JOIN REPLY depending on need of the source during the reply round, called as backward learning [19].

b. Reply round

After reaching a non-duplicate JOIN QUERY to multicast member the reply round starts. In the reply round, the multicast member generates and broadcasts JOIN REPLY packet to the network with the address of the node the member receives the JOIN QUERY from stamped in the JOIN REPLY. After receiving the JOIN REPLY, a node decides if its address is stamped in the JOIN REPLY. If so, the node knows it is on the path to the source and set the path FORWARDING_GROUP_FLAG and be a part of the forwarding group. After that, the node resends JOIN REPLY with the upstream node address to the source stamped in the JOIN REPLY. The upstream node address is got from the ROUTE TABLE via backward learning. This process goes on until the JOIN REPLY meets the source. The source receives JOIN REPLY, a mesh of nodes, or forwarding groups, is formed and packets can be sent to the members.

c. Route maintenance

ODMRP manages the group by regular broadcasting JOIN QUERY to the network and receiving JOIN REPLY. The regular broadcast of JOIN QUERY updates the forwarding group nodes and takes membership fluctuations.

b) On-Demand Multicast Routing Protocol With Congestion avoidance

To accomplish congestion avoidance, MALMR is utilized as the underlying MAC layer. MALMR is needed because ODMRP broadcasts data packets to all neighbors in spite of sending them point-to-point to choose individual neighbors, as causally done by multicast protocols. The underlying MAC protocol utilized for broadcast, CSMA avoiding ACK. CSMA, the queue length will denote perfect measure of congestion. Broadcast packets are sending "blindly". If the packet is not reached because of receive-buffer excess flow or channel congestion. it is stopped and no retransmission is done. Accordingly, even in presence of congestion, the queue length is small. In opposite to, the version of the IEEE 802.11 protocol utilized in unicast, point-to-point transmissions is filled with RTS and CTS control packets and ACKs. It is used against receive-buffer overflow and hidden terminals, and thus supplies perfect congestion feedback. This unicast version accordingly is not so attractive for multicast applications because it cannot misuse "broadcast advantage" of the wireless channel, and needs an individual transmission to every multicast member. Hence, MALMR is required to perfect description of the network state via queue lengths as MALMR supply reliable delivery of packets that are broadcasted in the context of multicast.

i. *Congestion Avoidance*

MALMR effectively eliminates the congestion by adapting to ordered first sequence to cast the packet all target nodes in broadcast manner. Here the MALMR process surveyed with an example.

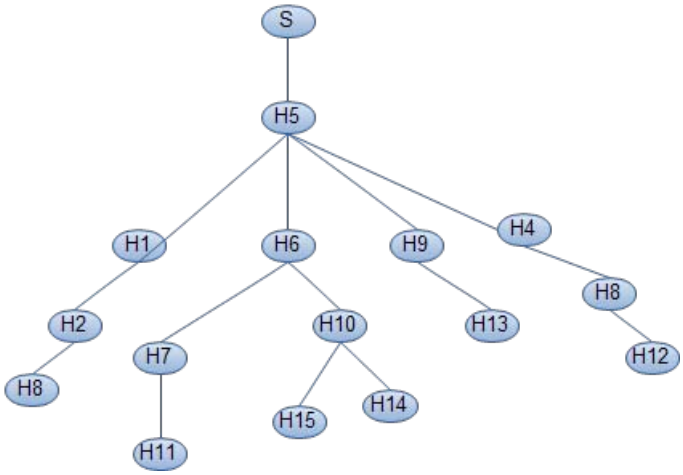


Fig. 1 : Tree Representation of example multicast model

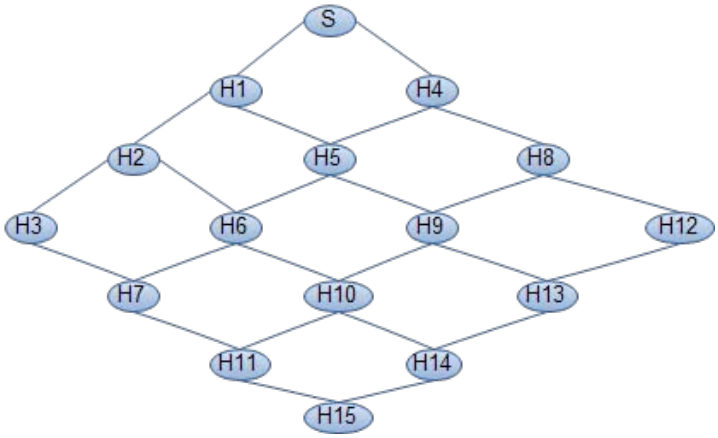


Fig. 2 : Mesh Representation of example multicast model

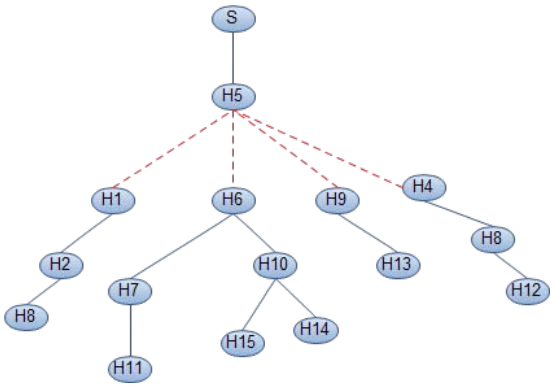


Fig. 3 : An example of group formed in tree based multicasting

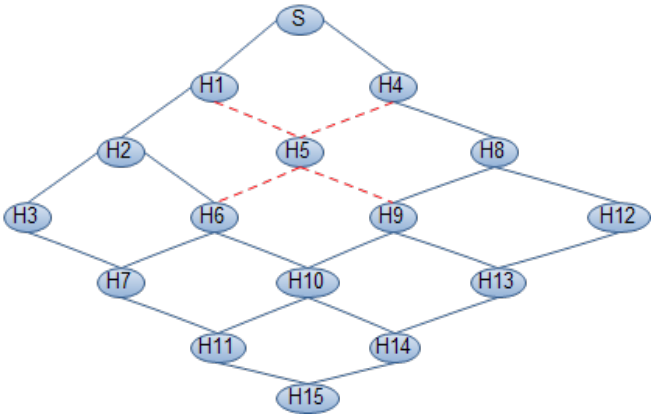


Fig. 4 : An example group formed in mesh based multicasting

The concept of MALMR is explained with an example. First of all we take a tree based multicasting as in figure 1 or mesh based multicasting as in figure 2. The fig 3 and fig 4 denotes a group linked with dotted line formed during path finding. For descriptive convenience same group denotation in tree and mesh (fig 3 and fig 4) is used. We now imagine that node H5 desires to multicast packets to H1, H4, H6, H9 in Figure 3 and fig 4. At the stage of transmitting first packet Node H5 first decides a target node H1 from TNL and sends RTS with sequence numbers ranging from f0 to f0 since no DATA frames have yet been sent. Node H1, upon receiving the RTS frame, responds with sequence number f0 in the CTS frame. Nodes H6, H9, and H4, after receiving the RTS frame, gives for the CTS/DATA/ACK interchange between node H5 and H1. After receiving the CTS frame, node H5 multicasts DATA with sequence number 0 in broadcasting manner. Node 1, after receiving DATA, updates its FR and responds with an ACK. For explanation requirement, a node H6 did not receive the DATA (possibly due to interference from neighboring nodes) while node H9 and H4 received the DATA perfectly. Hence, node H9 and H4 also update their RF. After receiving the ACK, node H5 copies the DATA that was delivered into the FS and goes on to choose nodes from TNL in ordered first form. If we imagine that node H6 chosen in order as immediate neighbor for transmission after executing the collision avoidance round, node H5 delivers RTS with sequence number range f0 to f1. After receiving the RTS, node H6 looks its FR and noticed that frame f0 haven't received. Node H6 then delivers CTS desired sequence number f0. Node H5, after receiving the CTS, gets the DATA with sequence number f0 from the FS and transmits the DATA. After receiving the DATA, node H6 updates its FR and responds with an ACK. Upon receiving the ACK, node H5 delivers RTS repeatedly with sequence number range f0 to f1 since the most recent DATA will not been sent. Node H6, after receiving the RTS, delivering CTS with sequence number 1 after checking its FR. Node H5, upon receiving the CTS, sends the DATA with sequence number f1. Node H6, after receiving the DATA, response with an ACK Again, for explanation process , let's say nodes H1, H9 and H4 receive the DATA and update their respective FR. Node H5, after receiving the ACK, buffers the DATA in FS and selects node H9 as its immediate neighbor. After the collision avoidance round, node H5 transmits RTS with sequence number range f0 to f2. After receiving the RTS, node H9 inquiry its received sequence number list and delivers CTS requesting sequence number f2 (since f0 and f1 were successfully received previously). Node H5, after receiving CTS, transmits DATA with sequence number f2. Node H9, after receiving DATA, transmits ACK and updates its FR. Node H5, after receiving ACK, buffers the DATA in FS, choose node H4 as it's immediate neighbor to transmit to, and the process starts again . In this process if node H5 found that no data with new sequence numbers available, then it set flag cs true and goes on delivering RTS with sequence range already delivered and cached in FS to nodes in TNL in ordered first form. After sending RTS to all the nodes in TNL, checks for data. If still no data with new sequence numbers then this process stops till it discovers data with new sequence numbers. If data is discovered with new sequence number then flag cs sets to wrong and promotes multicast process.

ii. *MALMR Algorithm*

Description of the notations

I. nm ←Node participating in multicasting
II. nu ←Node participating in one of the unicasting path of nm
III. TNL ←Target Node List
IV. bp_{nm} ←Buffer of Packets to multicast at nm
V. FS_{nm} ← Buffer of Frames already sent by nm
VI. FR_{tn} ←Buffer of frames received by target node tn that listed in TNL
VII. cs ← Boolean flag

Input:

$$TNL\ ,\ bp_{nm}\ , cs \leftarrow true$$

Algorithm:

1. Begin
2. Fetch $\{tn_i \mid tn_i \in TNL\}$ that fetched in ordered first manner for $i = 1....|TNL|$
3. Fetch sequence numbers range $fo,....fl$ of the frames such that $fj \in FS$ for each $j = 0,...l$
4. If bp_{nm} is not empty
5. Begin
6. Set $cs \leftarrow false$
7. Pick next sequence number sn of the packet to be multicast.
8. Send sequence numbers range $\{fo,...fl, sn\}$ to tn_i and wait for response from tn_i
9. Receive the sequence number rsn of the frame from tn_i
10. If $rsn \cong sn$
11. Begin
12. Multicast new packet from bp_{nm} and wait for acknowledgement from tn_i
13. End of block Started at line 3
14. Else if $rsn \in \{f0,...fl\}$
15. Begin
16. Multicast cached frames of range $\{rsn,....fl\}$ in a sequence. And then multicast new data packet from bp_{nm} with sequence number sn
17. End of block Started at line 4
18. End of block Started at line 2
19. Else if bp_{nm} is empty and $cs \neq true$
20. Begin
21. Set $cs \leftarrow true$
22. Fetch $\{tn_k \mid tn_k \in TNL\}$ that fetched in ordered first manner for $k = i....|TNL|$
23. Begin
24. Fetch sequence numbers range $fo,....fl$ of the frames such that $fj \in FS$ for each $j = 0,...l$
25. Send sequence numbers range $\{fo,...fl\}$ to tn_k and wait for response from tn_k
26. Receive the sequence number rsn of the frame from tn_k
27. If $rsn \in \{fo....fl\}$
28. Begin
29. Multicast cached frames of range $\{rsn,....fl\}$ in a sequence.
30. End of block Started at line 7
31. End of block Started at line 6
32. Set $i \leftarrow k$
33. End of block Started at line 5
34. Else if bp_{nm} is empty
35. Halt a time interval ti and go to step 1
36. End of block Started at line 1

In step 12, 16 and 29 all nodes of list TNL also receives those frames and according their respective FR status they update FR, that is if the nodes not found that frame in their respective FR then updates otherwise discards.

In step 12 and 16, if acknowledgement received from target node tn_i then the node nm updates it's FS_{nm} by adding new sequence number to FS_{nm}

V. Simulations and Results Discussion

NS 2 is used in doing experiments. We create a simulation network with hops under mobility and count of 50 to 200. The simulation parameters explained in table 1. Authentication ensures that the buffer is properly allocated to valid packets. The simulation model aims in comparing ODMRP with MALMR and ODMRP. The performance examines of these two brings out against to the metrics displayed in the given table:

Number of nodes Range	50 to 200
Dimensions of space	1500 m × 300 m
Nominal radio range	250 m
Source–destination pairs	20
Source data pattern (each)	4 packets/second
Application data payload size	512 bytes/packet
Total application data load range	128 to 512 kbps
Raw physical link bandwidth	2 Mbps
Initial ROUTE REQUEST timeout	2 seconds
Maximum ROUTE REQUEST timeout	40 seconds
Cache size	32 routes
Cache replacement policy	FIFO
Hash length	80 bits
certificate life time	2 sec

Table1 : Simulation parameters that we considered for experiments

The metrics to verify the performance of the present protocol as follows:

- Data packet delivery ratio: Data packet delivery ratio is calculated as the ratio between the number of data packets that are delivering by the source and the number of data packets that are received by the sink.

- Packet Delivery Fraction: It is the ratio of data packets send to the destinations to those created by the sources. The PDF says about the performance of a protocol that how successfully the packets have been send. Higher the value produces the better results.
- Average End to End Delay: Average end-to-end delay is an average end-to-end delay of data packets. Buffering during route discovery latency, queuing at interface queue, retransmission delays at the MAC and transfer times, may cause this delay. Once the time difference between packets sent and received was recorded, dividing the total time difference over the total number of CBR packets received provided the average end-to-end delay for the received packets. Lower the end to end delay better is the performance of the protocol.
- Packet Loss: It is defined as the difference between the number of packets sent by the source and received by the sink. In our results we have calculated packet loss at network layer as well as MAC layer. The routing protocol forwards the packet to destination if a valid route is known; otherwise it is buffered until a route is available. There are two cases when a packet is dropped: the buffer is full when the packet needs to be buffered and the time exceeds the limit when packet has been buffered. Lower is the packet loss better is the performance of the protocol.
- Routing Overhead: Routing overhead is calculated at the MAC layer which is defined as the ratio of total number of routing packets to data packets.

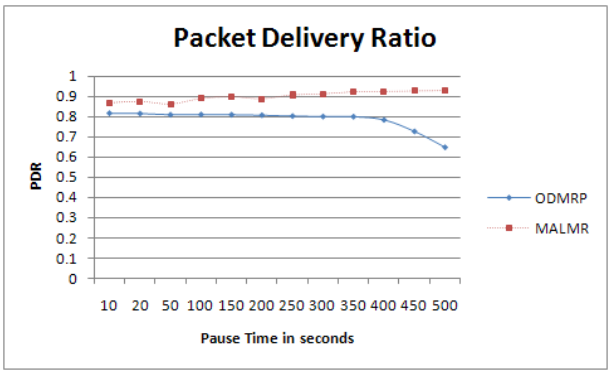
Figure 5(a) displays the Packet Delivery Ratio (PDR) for ODMRP [15] and ODMRP with MALMR. Depending on the results it is clear that MALMR reduces the loss of PDR that observed in ODMRP [15]. The approximate PDR loss recovered by MALMR over [15] is 14. 471%, this is an average of all pauses. The minimum individual recovery observed is 5. 91% and maximum is 30. 345%.

The packet delivery fraction (PDF) is denoted as:

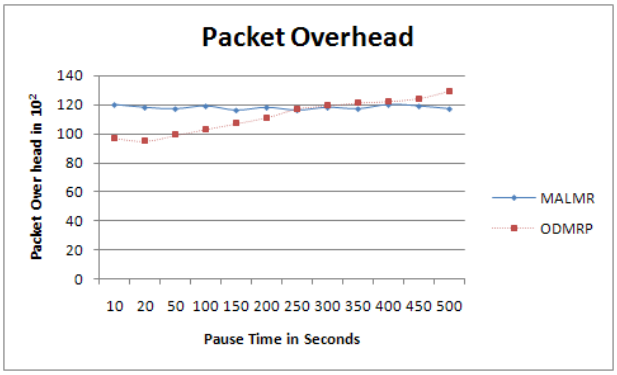
$$P' = \sum_{f=1}^{e} \frac{R_f}{N_f}$$

$$P = \frac{1}{c} * P'$$

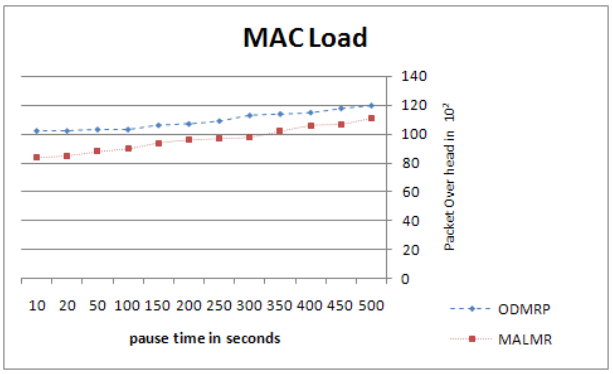
- P is the fraction of successfully delivered packets,
- c is the total number of flow or connections,
- f is the unique flow id serving as index,
- R_f is the count of packets received from flow f
- N_f is the count of packets transmitted to flow f .



(a) Packet delivery ratio



(b) Packet overhead comparison report



(c) Mac load comparison

Fig. 5 : Comparison of performance metric values between ODMRP with MALMR and ODMRP

Figure 5(b) affirms that ODMRP with MALMR have stable packet overhead over ODMRP [15] where the magnitude growth in packet overhead in different pause intervals. Because of congestion avoidance routing mechanism of MALMR this benefit is possible. The average Packet overhead observed for 12 intervals in ODMRP with MALMR is 117. 9 more than packet overhead observed for 12 intervals in ODMRP. But the average growth of the packet over head in ODMRP is 26. 36%, but in the case of ODMRP with MALMR, the average growth in packet over head is 3. 34%. This advantage of ODMRP with MALMR over ODMRP happens due to the collision and congestion avoidance strategy introduced in MALMR.

The advantage of ODMRP with MALMR over ODMRP in MAC load overhead control is shown in the Figure 5(c), . The average growth in MAC load over head in ODMRP with MALMR is 14. 32% is almost equal to MAC load overhead in ODMRP, which are 14. 17%, this resulted due to multicasting of the packets in MALMR to all target nodes unlike in ODMRP, a unicasting packet.

VI. Conclusion

This paper expatiate a MAC level multicast routing algorithm called "Medium Access Level Multicast Routing" i. e. MALMR. The present routing strategy aims at avoidance of congestion at group levels formed in multicast route discovery. This protocol derives an algorithm that transmits the data in multicast manner at group level unlike other multicast protocols, concentrating of data transmission in a sequence to every targeted node. Being independent, the MALMR works with group of either tree or mesh. The present mentioned MALMR is tested by associating with ODMRP where the simulation results indicated that the MALMR improves the PDR and reduces the Packet overhead of ODMRP in order of magnitude. It is further planned to develop an extension to MALMR which can even control the congestion besides avoiding congestion.

References Références Referencias

1. G. Krishna, "Routing protocols in mobile ad-hoc networks," pp. 1-30, 2006 http://www.cs.umu.se/education/examina/Rapporter/Krish naGorantala.pdf
2. L. Sung-Ju, S. William, G. Mario, "On-demand multicast routing protocol in multihop wireless mobile networks," Mobile Networks and Applications, 2001.
3. S. J. Lee, W. Su, J. Hsu, M. Gerla, and R. Bagrodia, "A performance comparison study of ad hoc wireless multicast protocols," Proceedings of the IEEE INFOCOM'00, 2000.
4. P. Madhan, J. James, K. Murugan, V. Ramachandran, "A Comparative and Performance Study of On Demand Multicast Routing Protocols for Ad Hoc Networks," 9th International Conference on High Performance Computing (HiPC), 2002.
5. V. Kumar, O. Katia and T. Gene, "Exploring mesh- and tree based multicast routing protocols for MANETs," IEEE Transactions on Mobile Computing, vol. 5, pp. 28–42, 2006
6. Prashant Dewan, Partha Dasgupta and Amiya Bhattacharya; "On Using Reputations in Ad hoc Networks to Counter Malicious Nodes" Tenth International Conference on Parallel and Distributed Systems, 2004; ICPADS 2004. Proceedings; July 2004
7. L. Butty´an and J.-P. Hubaux. Enforcing Service Availability in Mobile Adhoc WANs, In ACM international symposium on Mobile ad hoc networking and computing, pages 87–96, Boston, Massachusetts, 2000. ACM Press.
8. S. Zhong, J. Chen, and R. Yang Sprite: A Simple, Cheat-proof, Credit-based System for Mobile Ad-hoc Networks. In IEEE INFOCOM, San Francisco, USA, 2002. IEEE Press.
9. E. Bommaiah, M. Liu, A. McAuley, and R. Talpade, "AMRoute: Ad-hoc Multicast Routing Protocol," Internet- Draft, draft-talpade-manet-amroute-00.txt, Aug. 1998, Work in progress.
10. C.W. Wu, Y.C. Tay, and C.-K. Toh, "Ad hoc Multicast Routing Protocol utilizing Increasing id-numberS (AMRIS) Funcational Specification," Internet-Draft, draft-ietf-manet-amris-spec-00.txt, Nov. 1998, Work in progress
11. J.J. Garcia-Luna-Aceves and E.L. Madruga, "The Core-Assisted Mesh Protocol," IEEE Journal on Selected Areas in Communications, vol. 17, no. 8, Aug. 1999, pp. 1380-1394.
12. E. M. Royer and C. E. Perkins, "Multicast Operation of the Ad-hoc On-Demand Distance Vector Routing Protocol," Proceedings of ACM/IEEE MOBICOM'99, Seattle, WA, Aug. 1999.
13. S.-J. Lee, M. Gerla, and C.-C Chiang, "On-Demand Multicast Routing Protocol," Proceedings of IEEE WCNC'99, New Orleans, LA, Sep. 1999, pp. 1298-1302.
14. S.-J. Lee, W. Su, J. Hsu, M. Gerla, and R. Bagrodia, "A Performance Comparison Study of Ad Hoc Wireless Multicast Protocols," Proceedings of IEEE INFOCOM2000, Tel Aviv, Israel, Mar. 2000.
15. S.-J. Lee, W. Su, and M. Gerla, Internet Draft, draft-ietf-manet-odmrp-02.txt, Jan. 2000
16. J. Haartsen, M. Naghshineh, J. Inouye, O.J. Joeressen, and W. Allen, "Bluetooth: Vision, Goals, and Architecture," ACM SIGMOBILE Mobile Computing and Communications Review, vol. 2, no. 4, Oct. 1998, pp. 38-45.
17. C. E. Perkins and E. M. Royer, "Ad-Hoc On Demand Distance Vector Routing," Proceedings of the 2nd IEEE Workshop on Mobile Computing Systems and Applications (WMCSA), New Orleans, LA, Feb. 1999.
18. D. B. Johnson and D. A. Maltz, "Dynamic Source Routing in Ad Hoc Wireless Networks," Mobile Computing, edited by Tomasz Imielinski and Hank Korth, Kluwer Academic Pusblishers, 1996.
19. S. Keshav, "An Engineering Approach to Computer Networking: ATM Networks, the Internet, and the Telephone Network", Addison-Wesley, Menlo Park, California, 1997.

Global Journal of Computer Science and Technology
Network, Web & Security
Volume 12 Issue 13 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Analysis of Decentralized & Diverse Access Control (DDAC) Architecture

By Rajender Nath & Gulshan Ahuja
Kurukshetra University, Kurukshetra, India

Abstract - Access control refers to securing access to the resources and allowing access up to some defined level. This paper presents various approaches implementing access control in an open domain and carries an analysis of decentralized and diverse access control (DDAC) architecture. The DDAC architecture eliminates the role of centralized authority for managing and issuing users' credentials. It allows the users to keep the right of disclosure of their attributes under the sole control of them and also ensures that the users are not able to modify the confidential credentials which have been registered and verified by various trusted attribute providers. This paper explains the metrics for carrying the analysis and then presents a theoretical and experimental analysis of the DDAC architecture.

Keywords : *Access Control, DDAC, Attributes, Credentials.*

GJCST-E Classification: *D.4.6*

Strictly as per the compliance and regulations of:

Analysis of Decentralized & Diverse Access Control (DDAC) Architecture

Rajender Nath [α] & Gulshan Ahuja [σ]

Abstract - Access control refers to securing access to the resources and allowing access up to some defined level. This paper presents various approaches implementing access control in an open domain and carries an analysis of decentralized and diverse access control (DDAC) architecture. The DDAC architecture eliminates the role of centralized authority for managing and issuing users' credentials. It allows the users to keep the right of disclosure of their attributes under the sole control of them and also ensures that the users are not able to modify the confidential credentials which have been registered and verified by various trusted attribute providers. This paper explains the metrics for carrying the analysis and then presents a theoretical and experimental analysis of the DDAC architecture.

Keywords : Access Control, DDAC, Attributes, Credentials.

I. Introduction

Open and distributed nature of Internet assists users to use online services for the benefits of costs, time and efficiency. To avail theses services users are required to submit their credentials for the purpose of registration and further verification. The credentials supplied by a user may not be sufficient enough to grant the access to the requested service and a further verification may need to be carried by demanding some confidential and secret credentials from the user.

However user may wish to disclose only basic set of credentials in the form of attributes and may decide to refrain from disclosing the confidential and sensitive attributes to service portals for the concerns of safety and privacy. This creates a requirement for trusted agencies, which can maintain private and confidential information of users and allow this information to be used by service providers without compromising privacy and security of user specific information.

A significant research has been carried in the field of federated identity management, which makes possible to utilize the existing Identity management systems for realizing authentication and authorization decisions. In a federated system, Identity Provider (IdP) plays an important role and issues the certified credentials, which can be utilized at the service provider's (SP) end. The scalability of such system is limited due to the need of IdP to act as a central authority and maintain credentials of ever growing large number of requesters.

As more and more portals are offering online services, there is a strong need to provide authentication and authorization independent of any central authority. A decentralized environment must allow various attribute authorities to collaborate dynamically to produce a set of attributes, which are consumed by the service providers for providing services to the requesting users. The rest of this paper is structured as follows. Section II highlights various decentralized access control mechanisms. Section III describes in brief about the DDAC architecture and its components. Section IV presents the analysis of the DDAC architecture and finally Section V presents the conclusion

II. Related Work

With the increase in number of service requesters and service providers, there was an increase in the complexity related with access management activities. The researchers started considering attribute management frameworks, which worked without involvement of any central authority to manage or process the users' attributes.

Cantor et al. [1], Chappell [2], Klingenstein [3], Jill et al. [4] approaches relied on IdPs and SPs for issue and consumption of attributes. The establishment of trust between IdPs and SPs required them to become part of the federated identity management. In federated system every IdP could define its own attribute release policy for each SP within the federation. The IdP had the full authority to decide about which attributes could be released to a particular SP based on the concerned access control policy. The service requester had no right to specify about attributes that could be released to an SP.

Regina N. Hebig et al. [5] proposed a decentralized identity and attribute based access control approach. The authors described a prototype implementation with an architecture based on the standards XACML, SAML, WSPolicy, WS-SecurityPolicy and WS-Trust, which put the focus on sharing identity and attribute information across independent domains for the purpose of access control.

Author α : Rajender Nath, Department of Computer Science & Applications, Kurukshetra University, Kurukshetra, India.
E-mail : rnath_2k3@rediffmail.com
Author σ : Gulshan Ahuja, Research Scholar, Kurukshetra University, Kurukshetra, India. E-mail : ahujag_24@yahoo.com

A recent framework Aditi [6] for user centric identity federation enhanced the standard federated model with new IdP and SP components operated directly by users. These components were termed as user IdP and user SP, respectively to provide an interface between the user and the federation. In Aditi system, the user could obtain all attributes from the IdP and store them locally. Aditi addressed issues like redirection of user requests, use of cookies, removal of need for introduction of an SP to the identity federation, scalability, providing complete user control over his attributes, trust management in order to help the SPs to find out the trustworthiness of an IdP. In this approach all the attributes of the user were still kept with IdP and the user had to download all attributes from IdP to the card selector in order to utilize these attributes for authorization decisions. This provided users with full control over their attributes, which could be changed at the will of the user. Therefore ADITI framework was not well suited for service portals where users' attributes were required to be verified without control of users over their own attributes and independent of any centralized authority.

The problem evolved in relation to management of attributes in multiple federations. With the continuous and fast pace increase in the number of service requesters, the numbers of federations also increased. Each SP had to manage its linkages across multiple federations. This increased the complexity related with access management across multiple federations. Moreover, the IdPs still played the role of central authority for issuing and managing the attributes of users. There was a need for attribute management framework, which worked without involvement of any central authority to manage or process the user attributes.

The DDAC architecture presented by Rajender Nath et al. [7] considered the use and verification of diverse attributes for supporting online services in a decentralized manner. It allowed utilizing diverse attributes without involvement of any centralized agency for management and issue of access related attributes. In the next section, we outline in brief about DDAC architecture and its components.

III. DDAC Architecture Components

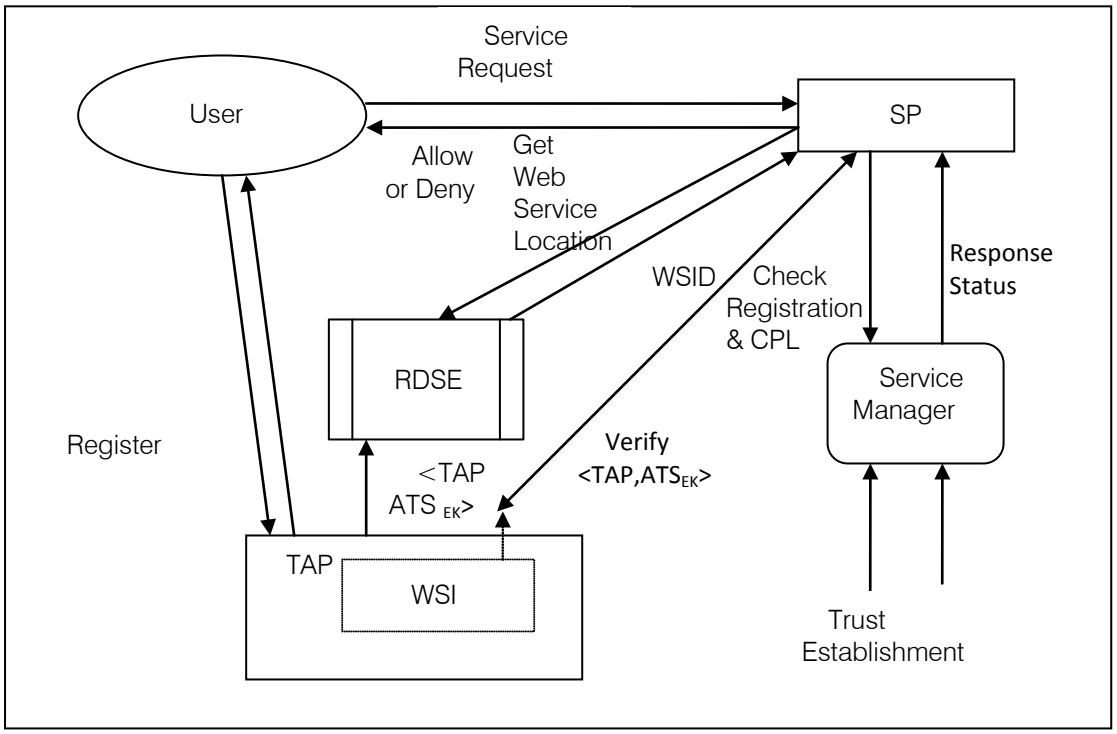


Fig.1.1 : Components of DDAC Architecture

The DDAC architecture allows safe integration of users, service providers (SPs) and attributes authorities (AAs) for disclosure & utilization of the attributes. The DDAC architecture permits SPs to verify about the user's attributes without involvement of any central authority. It eliminates the role of any central agency for issue and management of attributes and provides complete control over user's attributes. Figure 1.1 depicts the detailed view of the overall architecture.

The DDAC architecture mainly comprises of four components such as (a) user attribute management (UAM) module (b) resource description search engine (RDSE) (c) web service interface (d) service manager. The UAM is a requester side module, which implements

three basic operations - attribute creation, attribute-authority mapping, attribute storage. The RDSE provides both information collection and information retrieval functions for all SPs. It also provides the means for all trusted attribute providers (TAPs) to register their information, which is utilized by SPs to verify about users' attributes. Each TAP provides a web service, which is accessed by the SPs, for verification of users' attributes. The TAP provides the means for communication with the web service through a well defined service interface. The service manager is located on the SP's end and is composed of six components such as (a) Policy Store (b) Controller Module (c) Users' Registration List (d) Credibility Profile Level (CPL) Data Store (e) Credibility Verification Module (CVM) (f) CPL Computation Module.

The policy store keeps information about users' attributes along with the set of policies, which specify the rules and conditions under which access can be granted or denied. The Controller Module acts as the overall organizer for invoking and fetching response from the other components. Once a user sends a request for a service to an SP, the controller module intercepts the incoming request, invokes the credibility verification module (CVM) and directs it to process the service request. The CVM evaluates the registration time attributes against the registration list to verify whether user is already registered or not.

The Users' Registration List contains registration details about all those users who have already registered with an SP for accessing a service. The CPL data store contains the information about service access request related parameters. The CVM verifies the attributes against a data registry to check whether the requesting user is already registered or not. If the user is already registered, the CVM module invokes CPL computation module for calculating CPL value for the requesting user. Otherwise, the CVM module asks the user for registration and carries the verification through RDSE query. The CPL computation module computes the value for CPL based on service request related parameters

The next section carries the analysis of DDAC architecture and presents the performance results.

IV. Analysis of Ddac Architecture

To analyze the merits of the DDAC architecture three main parameters have been identified such as (a) Performance (b) Time Effectiveness (c) Cost Effectiveness. The analysis of the DDAC architecture based on the above mentioned parameters is presented below:

a) Performance

The DDAC architecture is implemented using Java Framework. The portal interface has been deigned using Java Server Pages. The experiment is conducted on a 2.4 GHz Intel Dual Core Pentium machine with 1 GB of RAM, Windows XP operating system. The attribute storage and retrieval services are provided by installing IBM Tivoli Directory Server for Windows on a remote site. A web service is implemented for receiving of verification request, query of attributes from Tivoli Server and generating response for the SP.

The working of the architecture is tested for two different cases

Case 1: For requests based on registration time attributes.

Case 2: For requests based on registration time attributes & another set of attributes stored with TAP.

The experimental details for first case are described as follows:-

The experiment is performed for 100 requests, where each access request contains only registration time attributes. For each access request, the types of registration time attributes and threshold values are varied. The CPL value is computed as per eq. 1, 2, 3 & 4 and is normalized in the range of <1, 10>.

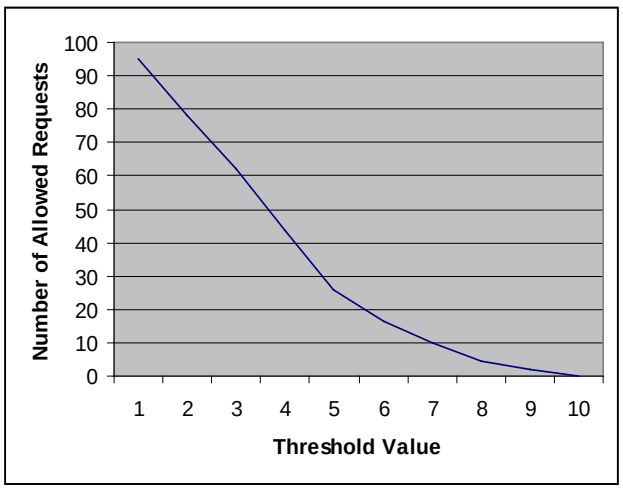


Figure 1.2 : Threshold Value vs. Number of Allowed Requests

The obtained results as per figure 1.2 highlight that with the increase in threshold value the number of allowed access requests also decrease. At mid of the total threshold range, there is found a sharp decline in the allowed number of requests. A further increase in the threshold value results in the rejection of most of the number of access requests as their computed CPL value comes out as below than the permissible limits.

The experimental details for second case are described as follows:

The experiment is performed for 100 requests, where each request contains registration time attributes and another set of attributes, which are maintained with TAP. For each access request the types of registration time attributes and TAP's attributes are varied. The experiment is conducted by varying the threshold values in the same intervals as in above presented case 1.

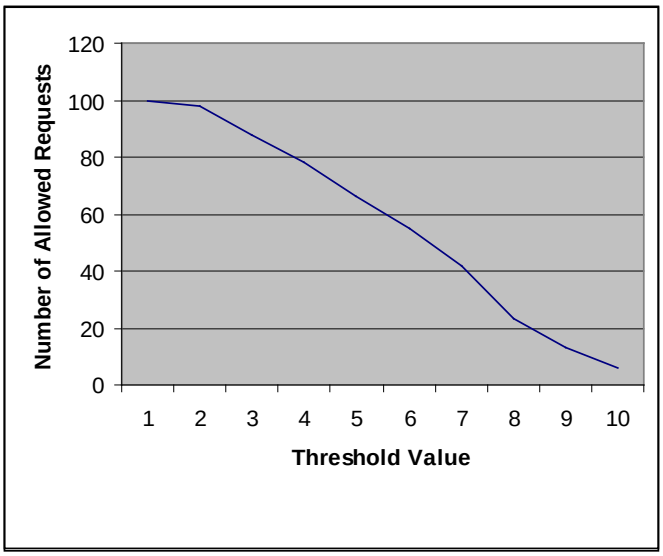


Figure 1.3 : Threshold Value vs. Number of Allowed Requests

As Per Figure 1.3, It Is Found That For The Same Threshold Levels; Most of The Access Requests Are Allowed. A Further Increase in the Threshold Value Results in a Steady Decline in the Number of Allowed Requests. At Maximum Level of Threshold Value, Some Requests Are Still Allowed. Thus it is found that the Ddac Architecture Performs Well as Compared to Existing Access Control Mechanisms.

b) Time Effectiveness

The use of DDAC architecture results in considerable saving in time required to deliver the required products to the requesters. The computation and use of CPL values for access request allows an SP to establish some degree of trust with the requesting client. The degree of trust further increases with the AR and PDR values associated with the same client.

The time effectiveness of the DDAC architecture is calculated as follows:

Assuming that there are N numbers of requests for purchase of products and out of total of N requests, for P requests the products are returned for valid reasons and for Q number of requests due to some defaults.

Total time T1 required to serve N requests, when no verification is carried, is computed based on time required to deliver the product (TD), time required to receive back the rejected product (TR) and time required to receive back the product in case of a default (TU).

$$T_1 = P*(T_D + T_R) + Q*(T_D + T_U)$$

Now, considering the case where the verification is carried based on CPL value, the time T2 required to serve N number of requests is computed as follows:

$$T_2 = P*(T_D + T_R)$$

The use of CPL value, leads to elimination of time caused by Q number of defaulting requests.

The time effectiveness value (TE), which describes the total saving in time, is computed as

$$TE = T_1 - T_2$$

The value of TE results in a significant amount of saving in time for the organization.

c) Cost Effectiveness

The DDAC architecture allows an SP to verify about the genuineness and validity of service requester. The services are provided only after ascertaining about the details about the requester.

The method employed in the architecture considers CPL as one important factor for serving users requests. The CPL is computed based on the service request related parameters such as the number of times requested items accepted by the user on delivery, the total number of items supplied, timely payment, number of times delay occurred during payments, the time delay in payment, the time allowed for payment etc. The values of these parameters for a user varies based on the past transaction details interactions with an SP. The DDAC architecture has been designed in a manner that it significantly reduces the request processing overhead based on the CPL value of a user. This results in a considerable saving in terms of costs of delivery.

V. Conclusion

This paper has presented a theoretical and practical analysis of the working of DDAC architecture. The DDAC architecture works well in a decentralized manner and provides means by which various attribute providers can dynamically collaborate to utilize users' attributes. The concept of CPL in DDAC architecture leads to reduction in the time required to verify service requests, based on the users' credibility values and previous experiences. The change in the value of one or more attributes can be easily carried by trusted attribute provider without any hassles of intimation to any other party. The trusted attribute providers only provide the location and signature of web service in resource descriptive search engine. The information about signature of web service in resource descriptive search engine remains unchanged and do not effect any operation even when there is a change in the value of one or more users' attributes.

References Références Referencias

1. S. Cantor, S. Carmody, M. Erdos, K. Hazelton, W. Hoehn, R. Morgan, T. Scavo and D.Wasley, "Shibboleth Architecture, Protocols and Profiles", Working Draft 02, "http://shibboleth.internet2.edu/", 2005.

2. D. Chappell, "Introducing Windows CardSpace", Microsoft MSDN website, http://msdn.microsoft.com/enus/library/aa480189.aspx, 2006.
3. N. Klingenstein, "Attribute Aggregation and Federated Identity", International Symposium on Applications and the Internet Workshops (SAINTW'07), pp. 26, 2007.
4. Jill Gemmill, John-Paul Robinson, Tom Scavo, Purushotham Bangalore, "Cross-domain authorization for federated virtual organizations using the myVocs collaboration environment", Concurrency and Computation: Practice and Experience, pp. 509-532, July 2008.
5. Regina N. Hebig et al., "A Web Service Architecture for Decentralized Identity and Attribute based Access Control", IEEE International Conference on Web Services, pp. 551 – 558, 2009.
6. Michal Prochazka, Daniel Kouril, Ludek Matyska, "User Centric Authentication for Web Applications", IEEE, pp. 67-74, 2010.
7. Rajender Nath, Gulshan Ahuja, "Decentralized & Diverse Access Control Architecture (DDAC) for Online Purchases", International Journal of Computer Applications (IJCA), Volume 30, No.1, p.p. 26-30, September 2011.

This page is intentionally left blank

Global Journal of Computer Science and Technology
Network, Web & Security
Volume 12 Issue 13 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Comparative Analysis of Routing Protocols for Mobile Adhoc Networks

By Dr.Gurjeet Singh & Er. Manish Goyal
Desh Bhagat Institute of Engg & Management Moga

Abstract - Mobile ad-hoc networks (MANETs) are self-configuring networks of nodes connected via wireless. This kind of networks is currently one of the most important research subjects, due to the huge variety of applications (emergency, military, etc...). In MANETs, each node acts both as host and as router, thus, it must be capable of forwarding packets to other nodes. Topologies of these networks change frequenly. To solve this problem, special routing protocols for MANETs are needed because traditional routing protocols for wired networks cannot work efficiently in MANETs.

GJCST-E Classification: C.2.m

Strictly as per the compliance and regulations of:

Comparative Analysis of Routing Protocols for Mobile Adhoc Networks

Dr. Gurjeet Singh [α] & Er. Manish Goyal [σ]

Abstract - Mobile ad-hoc networks (MANETs) are self-configuring networks of nodes connected via wireless. This kind of networks is currently one of the most important research subjects, due to the huge variety of applications (emergency, military, etc...). In MANETs, each node acts both as host and as router, thus, it must be capable of forwarding packets to other nodes. Topologies of these networks change frequenly. To solve this problem, special routing protocols for MANETs are needed because traditional routing protocols for wired networks cannot work efficiently in MANETs.

I. Introduction

Mobile Ad-Hoc networks or MANET networks are mobile wireless networks, capable of autonomous operation. Such networks operate without a base station infrastructure. The nodes cooperate to provide connectivity. Also, a MANET operates without centralized administration and the nodes cooperate to provide services. Figure 1.1 illustrates an example of Mobile Ad-Hoc network.

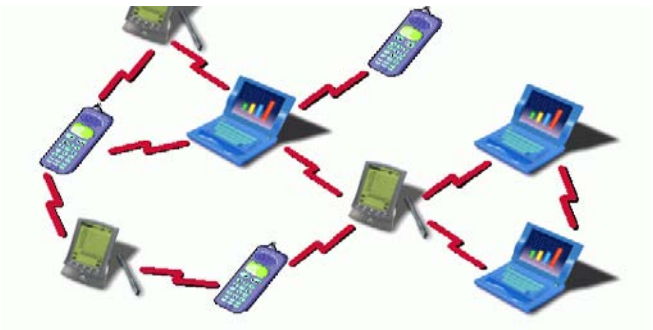


Figure 1.1 : Mobile Adhoc Networks

II. Routing Protocols for Mobile Adhoc Networks

MANETs are necessary to have different routing protocols from the wired networks. There are three types of routing protocols for MANETS:

- **Table-driven (Proactive):** OLSR, TBRPF, DSDV (Dynamic Destination Sequenced Distance Vector), CGSR (Cluster head Gateway Switch Routing protocol), WRP (Wireless Routing Protocol), OSPF (Open Shortest Path First) MANET, etc.
- **Demand-driven (Reactive):** AODV, DSR, TORA (Temporally Ordered Routing Algorithm), etc.
- **Hybrids:** ZRP (Zone Routing Protocol), HSLS (Hazy Sighted Link State), etc.

In the proactive protocols, each node has a routing table, updated periodically, even when the nodes don't need to forward any message.

In the reactive protocols, the routes are calculated only when required. When a source wants to send information to some destination, it calls on route discover mechanisms to find the best route to this destination.

The hybrids protocols try to use a combination of both to improve them.

a) Reactive Routing Protocols

These protocols find the route on demand by flooding the network with Route Request packets. The main characteristics of these protocols are:

- Path-finding process only on demand.
- Information exchange only when required.
- For route establishment, the network is flooded with requests and replies.

i. *The Dynamic Source Routing (DSR)*

DSR is a reactive routing protocol. It uses source routing. The source node must determine the path of the packet. The path is attached in the packet header and it allows to update the information stored in the nodes from the path. There are no periodical updates. Hence, when a node needs a path to another one, it determines the route with its stored information and with a discovery route protocol. This protocol has 2 parts:

- Route Discovery
- Route Maintenance

a. Route Discovery

When a node sends a packet to a destination, firstly it looks at its Route Cache the routes previously learned. If no route is found in its cache, then the node begins the route discovery process with a Route Request Packet (RREQ) broadcast. This packet includes the destination address, the source address and an identification number (request id). Each node receiving the RREQ, looks for the destination in its cache. If it does not know the route to the destination, it adds its

Author α : AP,Deptt of CSE/IT Desh Bhagat Institute of Engg & Management Moga.
Author σ : AP,Deptt of CSE/IT Desh Bhagat Institute of Engg & Management Moga.

address to the 'route record' in the RREQ and propagates it by transmitting it as a local broadcast packet (with the same request id). To limit the number of RREQ's, if one node receiving the RREQ has recently seen another RREQ from the same source, with the same request id, or if it finds its own address in the route record, then it discards the RREQ. In Figure 1.2 the development of the route record while the RREQ is spreading through the network is shown.

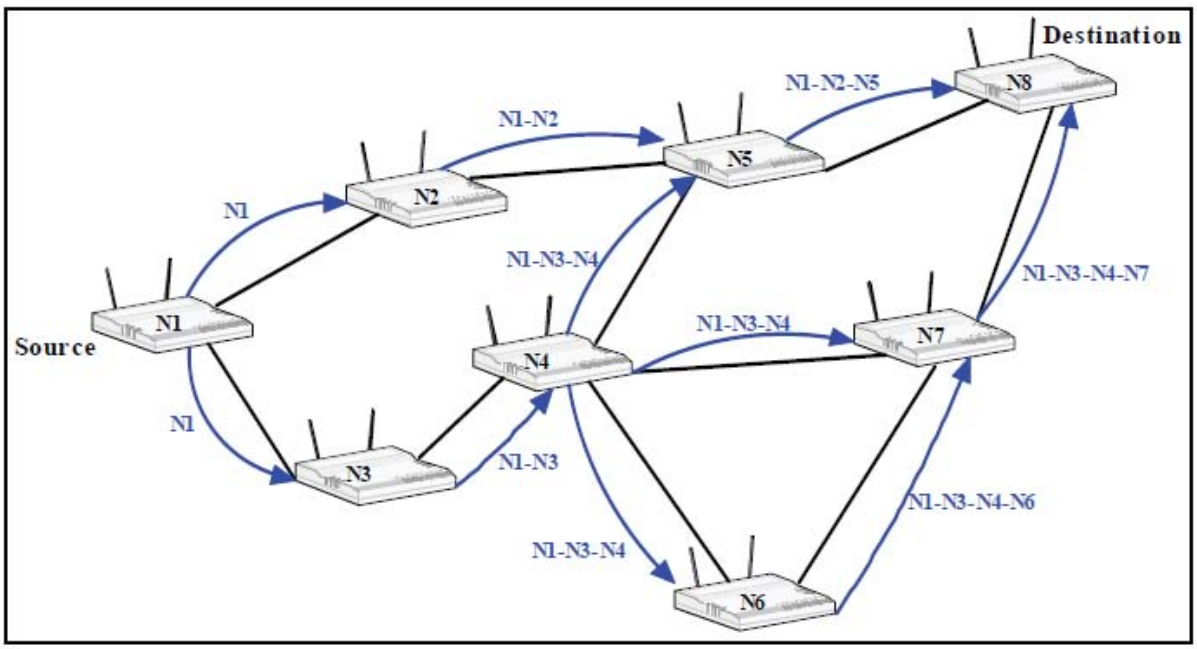


Figure 1.2 : Construction of the route record in the route discovery

b. Route Maintenance

The maintenance of the routes is useful to check the operation of a route and to report any routing error to the source. This check is made between consecutive nodes. When there is a problem in the transmission found by the link level, the RERR (Route Error) packets are sent by the node. This RERR has the addresses of both nodes in which the link failed. For example, in the situation illustrated in Figure 1.3 N1 has originated a packet for N8 using a source route through intermediate nodes N2 and N5. In this case, N1 is responsible for the reception of the packet at N2, N2 is responsible for the reception at N5, and N5 is responsible for the reception at the final destination N8.

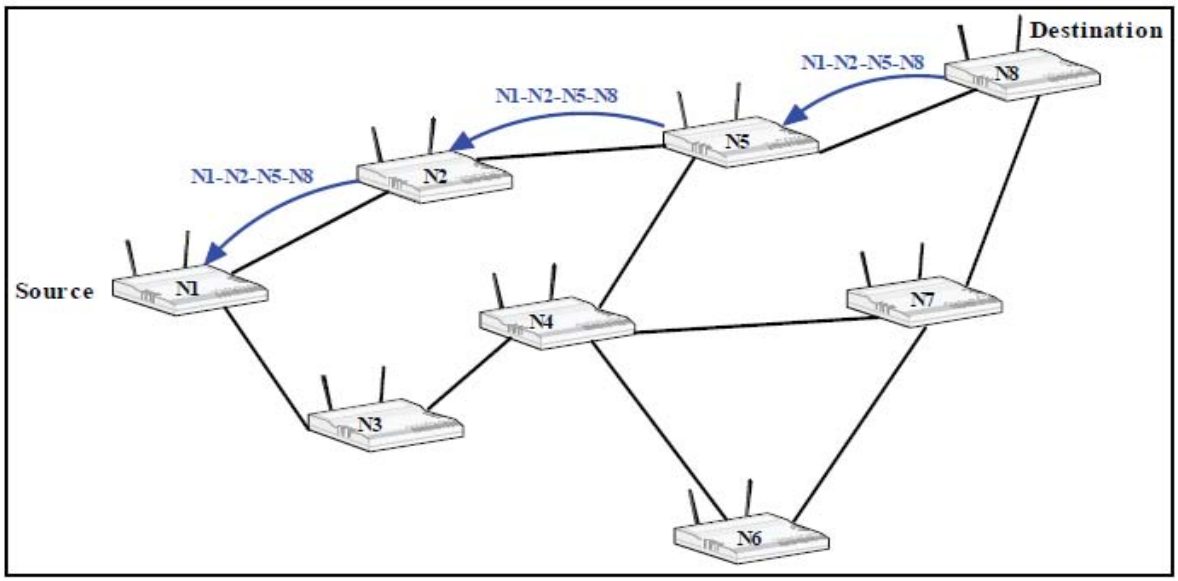


Figure 1.3 : Forwarding of the RREP with the route record

As N5 is unable to deliver the packet to N8, N5 returns a Route Error to N1 stating that the link from N5 to N8 is currently 'broken'. N1 then removes this broken link from its cache. In other words, when a node receives a RERR, it deletes the link failed in its routes list, and all the routes that have this link are cut at this point. Besides the RERRs, ACKs (acknowledgements) can be used to verify the links availabity.

ii. *The Adhoc On Demand Distance Vector (AODV)*

The AODV protocol is a reactive routing protocol. It is a Single Scope protocol and it is based on DSDV. The improvement consists of minimizing the number of broadcasts required to create routes. Since it is an on demand routing protocol, the nodes who are not in the selected path need not maintain the route neither participate in the exchange of tables.

When a node wants to transmit to a destination and it does not have the valid route, it must begin the Path Discovery process. Firstly, it sends a broadcast of the Route Request (RREQ) packet to its neighbours, and they relay the packet to their neighbours and so on until they reach the destination or any intermediate node which has a 'fresh' route to the destination (Figure 1.4). Just like in DSDV sequence numbers are used to identify the most recent routes and to solve the loops.

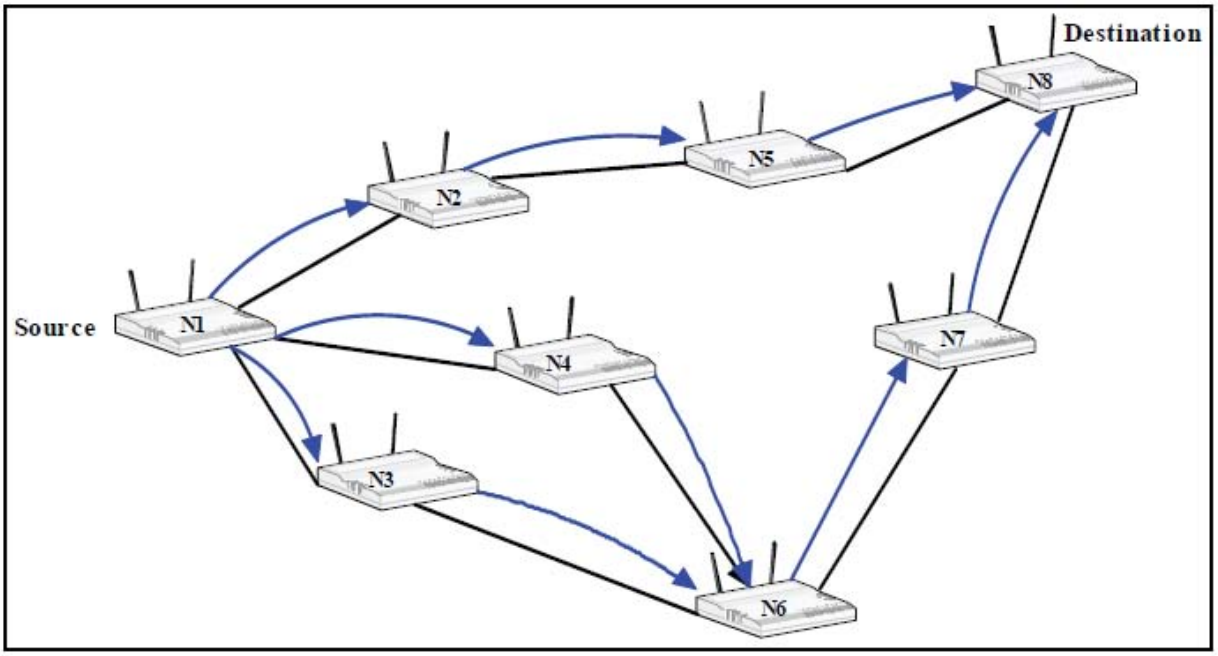


Figure 1.4 : Propagation of RREQ

Each node maintains two counters: the sequence number of the node (to solve the loops) and the broadcast ID which is incremented when a broadcast is started in the node. To identify only one RREQ (see Figure 1.6) it is used the broadcast ID and the IP (Internet Protocol) address of the source node. The RREQ has the following fields: Source address, Source sequence number, Broadcast_id, Destination address, Destination sequence number, and the number of hops to the destination.

The intermediate nodes only answer to the RREQ if they have a path to the destination with a sequence number greater or equal to the sequence number of the RREQ. Hence, only if they have paths equal (in age) or more recent. While the RREQ is sent, the intermediate nodes increase the field 'number of hops to the destination' and, also store in its routing table the address of the neighbour from whom they first received the message, in order to establish a 'Reverse Path' (Figure 1.6). The copies of the same RREQ received later which are coming from the other neighbours are deleted.

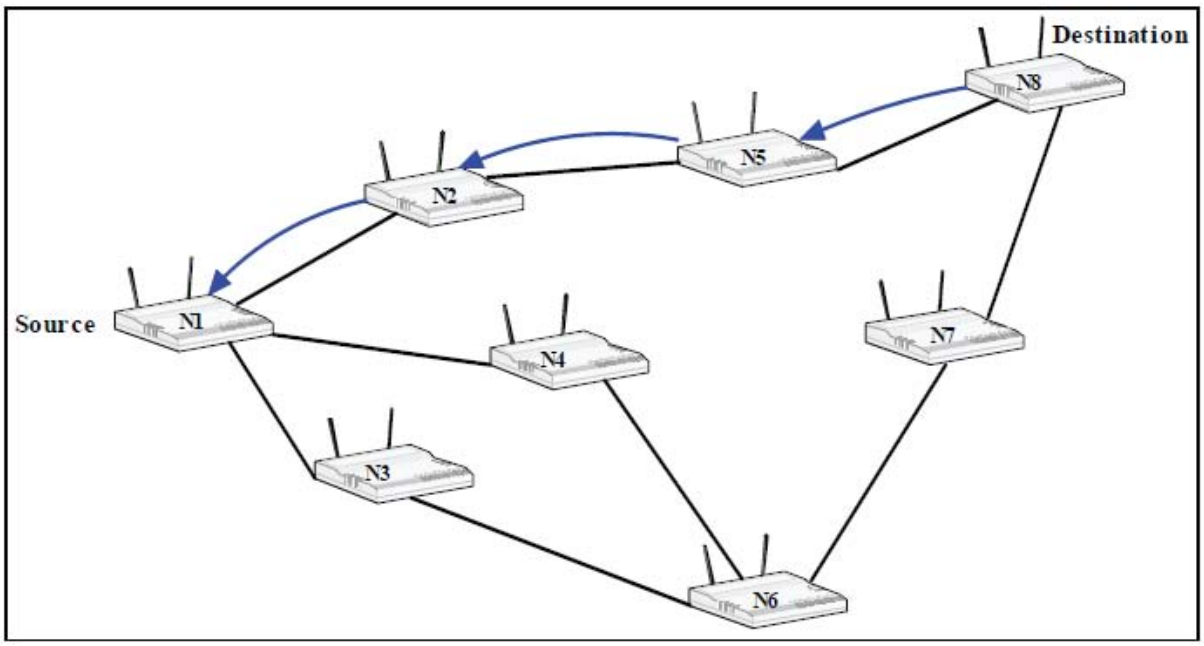


Figure 1.6 : Path of the RREP to the source

When the 'destination node/intermediate node with the fresh route' has been found, it answers with a Route Reply (RREP) to the neighbour from which it received the first RREQ. The RREP has the following fields: Source address, Destination address, Number of Hops to the destination, Sequence number of the destination, Expiration time for the Reverse Path (Figure 1.8). Then, the RREP uses the return path established to the source node. In its path, every node forwarding the RREP sets the reverse path as the freshest path to the destination node. Therefore, AODV can only use bidirectional links.

If a source node moves, it is capable of restarting the discovery protocol to find a new path to the destination. If an intermediate node moves, its previous neighbour (in source-destination way) must forward a RREP not requested with a fresh sequence number (greater than the known sequence number) and with a number of hops to destination infinite to the source node. In this way, the source node restarts the path discovery process if it is still needed.

Hello messages (periodic broadcasts) are used to inform mobile node about all the neighbourhood nodes. These are a special type of RREP not solicited, of which sequence number is equal to the sequence number of the last RREP sent and which has a TTL=1 (Time To Life) to not flood the network. They can be used to maintain the network connectivity, although other methods used more often exist for this function, like for example, to listen to the neighbour nodes transmissions.

Src_addr	Src_Seq_Nr	Bcast_ID	Dest_addr	Dest_Seq_Nr	Hop_cnt

Figure 1.7 : RREQ Packet

Src_addr	Dest_addr	Hop_cnt	Dest_Seq_Nr	Exp_Time_RP

Figure 1.8 : RREP Packet

b) Proactive Routing Protocols

These algorithms maintain a fresh list of destinations and their routes by distributing routing tables in the network periodically. The main characteristics are:

- These protocols are extensions of wired network routing protocols.
- Every node keeps one or more tables.
- Every node maintains the network topology information.
- Tables need to be updated frequently.

i. *Optimized Link State Routing (OLSR)*

OLSR is a proactive link state routing protocol. It is a point to point routing protocol based in the link state algorithm.

Each node maintains a route to the rest of the nodes of the ad hoc network. The nodes of the ad hoc network periodically exchange messages about the link state, but it uses the 'multipoint replaying' OLSR strategy to minimize the messages quantity and the number of nodes that send in broadcast mode the routing messages. The strategy MPR (Multipoint Relay) [MANET lies in that each node uses 'Hello' messages to discover what nodes are in a one hop distance and makes a list. Each node selects a group of neighbours of that list that are able to reach all the nodes in a distance of two hops with regard to the node that is making the selection. For example, in Figure 1.9 the node A selects the nodes B, C, K and N as the MPR nodes, because they are capable of reaching all the nodes at two hops distance with regard to the node A.

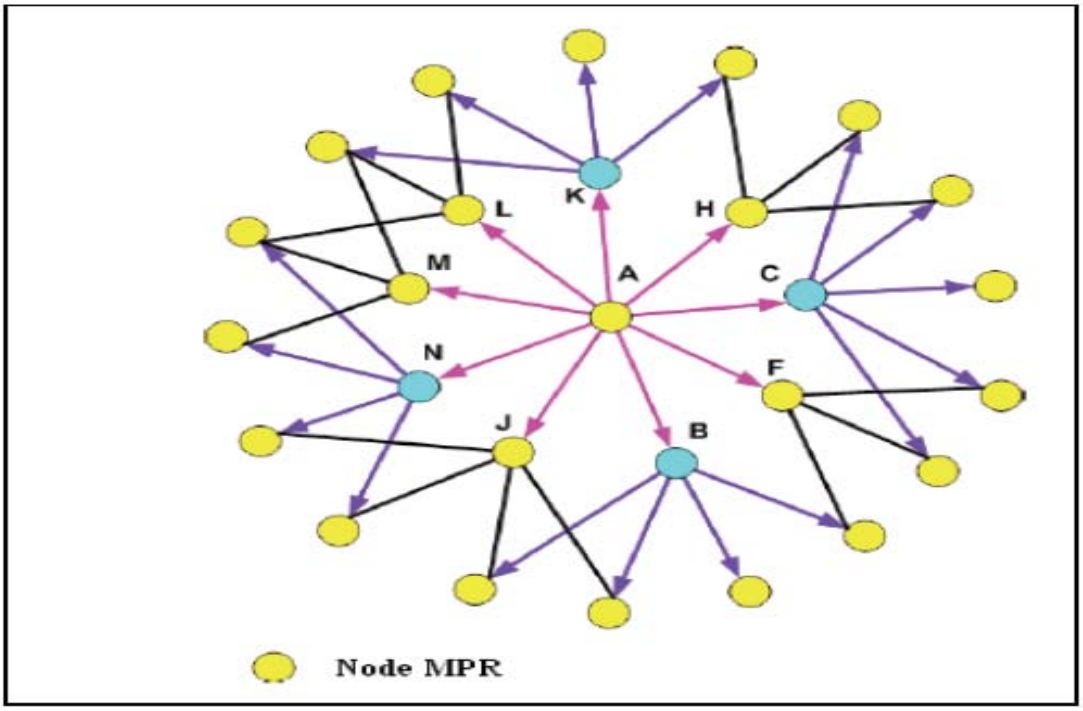


Figure 1.9 : Multipoint Relays

These neighbours selected are the only nodes in charge to relay the routing packets and are called MPRs (Multipoint Relays). The rest of the neighbourhood process the routing packets that they receive, but they can not relay them. Each node decides an optimum path (in number of hops) to each destination using the stored information (in its topology routing table and in of their neighbours ones). Besides each node stores that information in a routing table for usage when a node wants to sent data. This protocol selects bidirectional links to send packets, and does not use unidirectional links. The OLSR protocol is more efficient in networks with high density and highly sporadic traffic. The quality metrics are easy to expand to the current protocol. OLSR requires that it continuously has some bandwidth in order to receive the topology updates messages.

ii. *The Destination Sequenced Distance Vector (DSDV)*

The DSDV is a distance vector, proactive routing protocol. It is based in the Bellman-Ford algorithm, but improved to solve the routing loop problem. It uses the distance vector algorithm to find the shortest path to the destination.

Each node within the ad hoc network maintains a routing table with the following information to each destination.

- Destination IP address.
- Destination sequence number.
- Next hop (IP address).

- Cost (in number of hops).
- Install time: used to delete old routes.

Each node sends periodically broadcasts with the routing table updated to its neighbours:

- Each node adds its sequence number when it sends its routing table.
- When the other nodes receive this information, they update its routing tables.

The routing tables also can be sent if there are topology changes (link creation or breakage). In this case, the update information travelling in the routing messages is:

- Destination IP address.
- Number of hops.
- Sequence number.

The nodes use the sequence numbers to distinguish between old and new routes to a destination. A node increases its sequence number when there is a topology change (a new link is created or deleted). The route to a destination with the biggest sequence number (the more current) is the valid one. If there are two routes with the same sequence number, the valid is the one which number of hops is smaller. Two types of route update are used

- **Full dump:** This packet carries the whole routing table. It is unusual to send this packet.
- **Incremental:** This packet carries only the routing table information of a node that has changed since the last full dump sent. These packets are sent more frequently. Hence, the control overhead and the bandwidth consumption are smaller.

c) Hybrid Routing Protocols

These protocols are a combination of reactive and proactive routing protocols, trying to solve the limitations of each one.

Hybrid routing protocols have the potential to provide higher scalability than pure reactive or proactive protocols. This is because they attempt to minimise the number of rebroadcasting nodes by defining a structure (or some sort of a backbone), which allows the nodes to work together in order to organise how routing is to be performed. By working together the best or the most suitable nodes can be used to perform route discovery.

i. *The Zone Routing Protocol (ZRP)*

The Zone Routing Protocol (ZRP) is a hybrid routing protocol. It combines the advantages from reactive and proactive routing protocols. This protocol divides its network in different zones. These zones are the nodes local neighbourhood. Each node has its own zone. Each node can be into multiple overlapping zones, and each zone can be of a different size. The size of a zone is given by a radius of length, where the number of hops is the perimeter of the zone. Within each zone it is used a proactive routing protocol. Therefore, each node into the zone knows how to reach its neighbours. However, if the packets are sent to a node outside of the zone, it is used a reactive routing protocol.

ZRP runs three routing protocols:

- Intrazone Routing Protocol (IARP)
- Interzone Routing Protocol (IERP)
- Bordercast Resolution Protocol (BRP)

IARP is a link state routing protocol. It operates within a zone and learns the routes proactively. Hence, each node has a routing table to reach the nodes within its zone.

IERP uses the border nodes to find a route to a destination node outside of the zone. IERP uses the BRP.

BRP is responsible for the forwarding of a route request.

When the Route Discovery process begins, the source node asks to its routing table and if necessary, it starts a route search between different zones to reach a destination. If a route is broken by a node's mobility into the same zone where the node was, the routing tables used for the proactive routing protocol must be updated. If the node's mobility is from one zone to another one, then it is necessary to execute a query between zones.

To use a reactive routing protocol to find a route from a source node to a destination node placed in another zone reduces the control overhead (in comparison with the proactive ones) and the delays in the Route Discovery (in comparison with the pure reactive ones), since these routes are discovered much faster. The reason is because to find a route to a node placed outside the routing zone, the route request is send only to the border router within the zone where the destination is. This border router can answer to the request since it has a routing table to do the proactive routing and knows how to reach the destination.

The disadvantage of ZRP is that it becomes a proactive routing protocol if the radius is big. Otherwise, if the radius is small, it becomes a reactive routing protocol.

In Figure 1.10 a Route Discovery process is shown; the node S sends information to the node X, and by IARP decides X is not in the same zone that S. The search travels through the border nodes to find the zone where X is. Finally, the border node G discovers that X is in its zone and sends a route response to S.

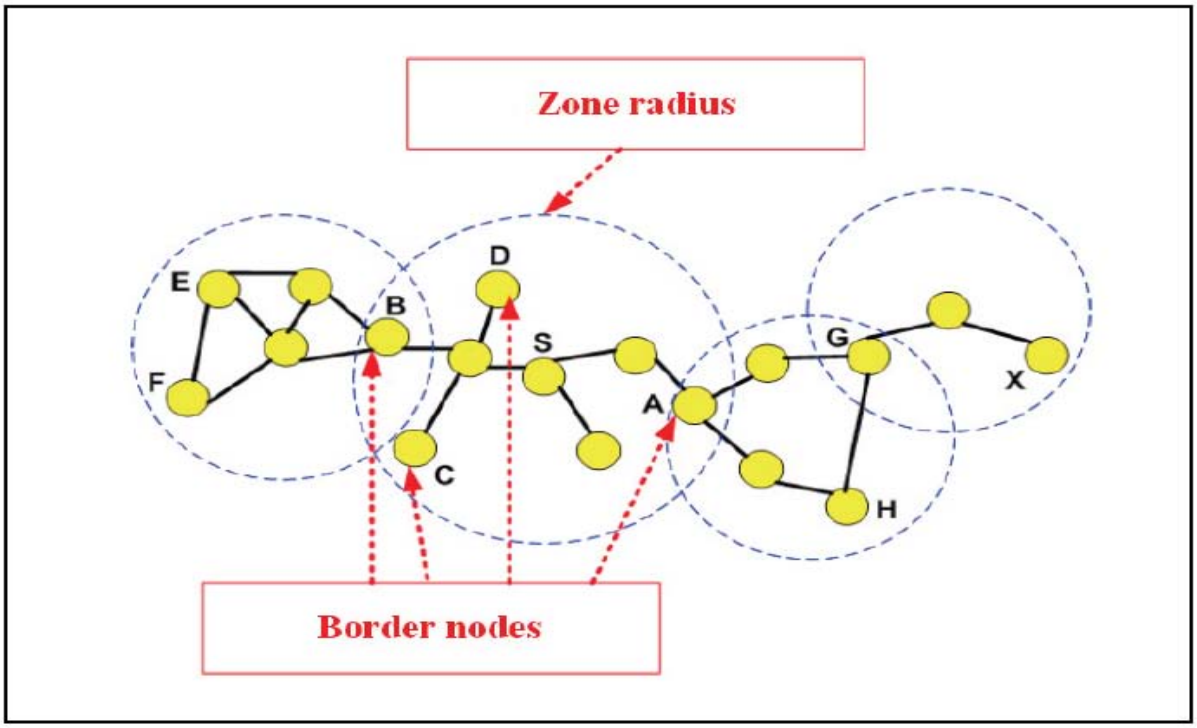


Figure 1.10 : Example of a Route Discovery in an ad hoc network using the routing protocol ZRP

Even though the hybrid nature of the ZRP seems to indicate that it is a hierarchical protocol, it is important to point out that the ZRP is in fact a flat protocol. ZRP is more efficient for large networks.

d) Reactive Vs Proactive

Proactive routing protocols loose more time updating their routing tables. Therefore when the topology changes frequently, most of the current routes in the tables can be wrong. Hence, these protocols are recommended for ad-hoc networks semi dynamics.

Reactive routing protocols have delay in route determination, because of the flooding mechanism. They are recommended for networks with nodes moving constantly.

Intuitively, we can think in the advantages and disadvantages of both looking the table 1.1:

Parameters	Proactive/Table-driven	Reactive/On Demand driven
Route availability	Always available	Available when required
Latency	Minimum	Long delays when there is not an available route
Route updating periodically	Yes	No
Movement	Advertises to other nodes to update the routing tables.	Only advertises if affect to the source node. Uses alternative routes.
Control traffic	Greater than On Demand driven	Increase if mobility of the active routers increase.
Energy consumption	Greater	Depends of the nodes mobility

Table 1.1 : Comparison between proactive and reactive routing protocols

e) Quality of Service

Quality of service can be used as a measurement of how good the routes in the network are. The routes should guarantee a set of pre specified service attributes, such as delivery, bandwidth and delay variance (jitter). It also involves the specification of latency, loss, availability etc...

For a protocol to provide good QoS it must determine new routes rapidly and with minimal bandwidth consumption. There are several metrics that directly affect the QoS of every protocol, for example: Packet delivery ratio, control packet overhead (packets and total bytes), average hop count, end-to-end latency and power consumption to mention a few. Using a protocol that provides good quality of service will greatly affect the MANETs performance.

f) Comparing the Protocols

As a proactive routing protocol, OLSR inserts high control traffic overhead on the network. To maintain and to update the routing table for the entire network it needs a lot of communication between the nodes, as well as periodic updates flooding the network. The use of MPR's reduces this control traffic overhead, but for small networks the improvement is minimal. The traffic overhead also consumes bandwidth.

The behaviour of reactive protocols AODV and DSR is different. The main part of control traffic is emitted during route discovery. Therefore, a lot of the resource and bandwidth consumption is related to actual data traffic.

Protocol Property	OLSR	AODV	DSR	ZRP
Routing Structure	Flat	Flat	Flat	Flat
Loop Free	Yes	Yes	Yes	Yes
Multiple Routes	No	No	Yes	No
Distributed	Yes	Yes	Yes	Yes
Reactive	No	Yes	Yes	Hybrid
Unidirectional Link Support	No	No	Yes	No
Qos Support	Yes	No	No	No
Multicast	Possible	Yes	No	No
Security	No	No	No	No
Power Efficiency	No	No	No	No
Periodic Broadcasts	Yes	Yes	No	Yes

Table 1.2 : Comparison between the Protocols

III. Results

In Figure 1.11, the Control Overhead curve for the Node Density experiments is shown. The control overhead measurements are normalized. The horizontal axis represents the distance between neighbouring nodes in the grid. The sparse networks have higher paths lengths. Thus, in these networks there are more rebroadcasts of route requests, and more route reply packets. For that reason DSR increases its control overhead when the density is smaller. However, AODV begins with a high overload when the node density is high, but uses fewer control packets as the density is smaller.

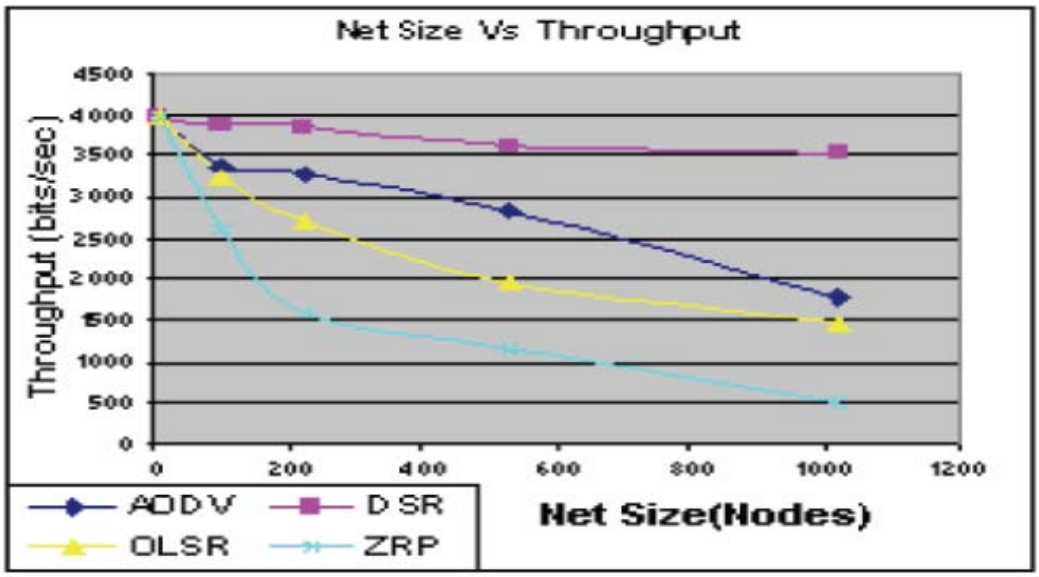


Figure 1.11 : Throughput for Network Size

ZRP performs similar to AODV. When the density is high, it performs better and this is because the original route acquisition process depends on neighbouring nodes overhearing and rebroadcasting route requests, and if router requests are lost, the entire process stalls. The hidden terminal problem can contribute to route request losses, and is more prevalent in sparse networks. These protocols have difficulty dealing with a network with few neighbours.

a) Number of Hops

The strangest result is to see that the latency for OLSR has the highest values from 1 to 10 hops, and generally the highest slope. For OLSR to lose its innate advantage in latency, network route convergence would have to be slower than route acquisition, and given the high control overhead data that was collected for this experiment set, it is easy to see that this is the case. However, under normal circumstances the OLSR is supposed to be the best of the analyzed protocols since the point of view of the latency.

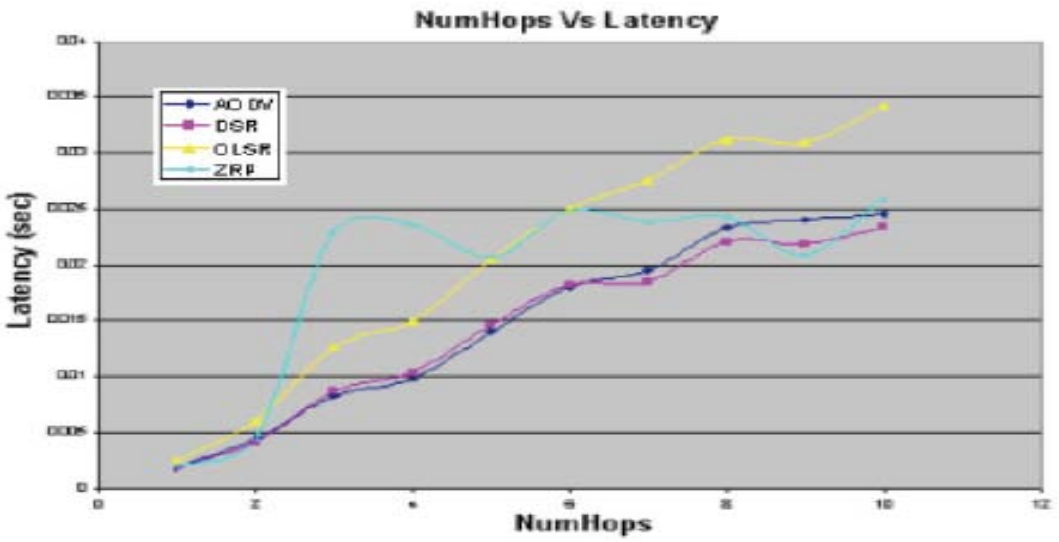


Figure 1.12 : Number of Hops Vs Latency

For ZRP at the 1 and 2 hop has better latency than OLSR. This is because the proactive zone of interest is much smaller. At 3 hops and beyond, this result is indicative of the interzone routing, and it shows a fairly flat graph from 3 to 10 hops, with some oscillation caused by random number seeds not being completely filtered out.

IV. Conclusion

For a network with a large number of nodes, which move with changing velocities and have different traffic patterns, a hybrid routing protocol is the best choice. The nodes moving slowly and with high traffic should run the proactive routing features, and the rest of nodes implement the reactive ones. Besides, the choice should be a hierarchical approach to achieve a big scalability. The AODV and DSR protocols will perform better in the networks with static traffic and with a number of source and destination pairs relatively small for each host. In this case, AODV and DSR use fewer resources than OLSR, because the control overhead is small. Also, they require less bandwidth to maintain the routes. Besides, the routing table is kept small reducing the computational complexity. Both reactive protocols can be used in resource critical environments.

References Références Referencias

1. M. Abolhasan, T. A. Wysocki, and E. Dutkiewicz,(2004) "A Review of Routing Protocols for Mobile Ad hoc Networks", In Elsevier Journal of Ad hoc Networks, 1-22.
2. C. E. Perkins(2003) "Ad Hoc Networking", Addison-Wesley, Boston, 2001. [AODV_03] C. Perkins, E.Belding-Royer, S. Das, "Ad hoc On-Demand Distance Vector (AODV) Routing", IETF RFC 3561,
3. "Ad hoc On-Demand Distance Vector (AODV) Routing". November 2002 <draft-ietf-manet-aodv-12.txt>
4. Benzaid M., Minet P., Al A. K. (2003) "Analysis and simulation of fast-OLSR". The 57th IEEE Semiannual Vehicular Technology Conference. 3. 1788 – 1792 pp
5. Benzaid M., Minet P., Al A. K.(2002) "Integrating fast Mobility in the OLSR routing protocol". Proceedings of the 4th IEEE Conference on Mobile and Wireless Communications Networks, Stockholm, Sweden.
6. "Comparative Study of Routing Protocols for Mobile Ad-hoc NET works". Thomas Heide Clausen, Philippe Jacquet and Laurent Viennot.
7. Charles E. Perkins, Pravin Bhagwat(2010) "Highly Dynamic Destination Sequenced Distance Vector (DSDV) for Mobile Computers", In Proceedings of the SIGCOMM'94 Conference on Communications Architectures, Protocols and Applications,
8. D. Johnson, D. Maltz, Y. Hu(2011) "The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks(DSR)", IETF Internet-Draft.

Global Journal of Computer Science and Technology
Network, Web & Security
Volume 12 Issue 13 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Improving Network Security: Next Generation Firewalls and Advanced Packet Inspection Devices

By Steven Thomason
East Carolina University

Abstract - Standard firewalls alone can no longer protect the enterprise from Internet dangers; new technologies such as next generation firewalls and advanced packet inspection devices can improve security around your gateways.

GJCST-E Classification: *C.2.0*

Strictly as per the compliance and regulations of:

Improving Network Security: Next Generation Firewalls and Advanced Packet Inspection Devices

Steven Thomason

Standard firewalls alone can no longer protect the enterprise from Internet dangers; new technologies such as next generation firewalls and advanced packet inspection devices can improve security around your gateways.

Why do we need to improve firewalls at the perimeter? In the beginning there was the Internet and it was only used by a limited number of people due to the cost and limited content. The general public was just not interested in what the Internet had to offer. If you wanted to connect to the Internet, you connected your computer to a modem and dialed into an Internet provider at speeds up to an average of 33600 bps, which is incredibly slow compared to today's access rates. Security was not much of an issue. Someone sitting on the other side of the world did not have much incentive to try and break into your system. Then came ISDN, frame relay, and T1 connections to the Internet and security issues started to appear. Content on the Internet grew at rapidly expanding rates. The most likely security issue was a user getting infected software that caused damage to their computer or company network. A typical method of blocking incoming or outgoing connections was to configure an access list on a router or on a basic firewall to block the IP address or IP port being used by that virus or Trojan.

As viruses and hackers became more motivated and more technical, a better method for protecting the company network was needed. Firewalls now were developed to actually inspect what was contained within each packet. The first firewalls only looked at the header information showing source, designation, and port for each packet. There was not much of a visibility into the actual packet. Now a days standard firewall shave the ability to look at specific strings within each packet. This ability now allows for signature or pattern based inspection at the network or session layer of the OSI model, but not at the application layer. Some of the more current models have advanced packet inspection abilities.

Blocking ports and IP addresses is no longer good enough. Operating systems contain security vulnerabilities and often as soon as they are discovered are exploited. The most common ports open on almost every firewall are the browsing ports 80 and 443, ftp, and frequently email smtp port 25. It is impossible to know about every possible new security hole or new virus that is written and released into the wild. According to 2008 report on the US-CERT[i] government website, over 200 new Trojans and viruses and an untold number of variants are released each month.

The Internet carries several types of traffic; the two most common are TCP and UDP. TCP traffic is connection oriented so the firewall knows when the connection has terminated. The sending and receiving of packets is acknowledged so the firewall can add timestamps and other methods to verify where the traffic is coming from. UPD traffic however is connectionless. It is up to the sending or receiving application to build up and take down the connection. If the application does not terminate the connection, then the firewall or security device has to have a timer to drop the connection when traffic has completed. This gap gives unauthorized traffic time to build a connection to your end point and have access through your gateway.

Now about one third of the people in the world have access to the Internet. Almost every company in business today needs to have access to the Internet. One third of every cell phone in the world has access to the Internet and that number is expected to grow to over 65% by 2015. Companies have confidential and proprietary data that criminals want. They want account information, names, passwords, anything that they can get that could possibility make them money. If they cannot get that information because it is well secured or there is nothing that they deem of value, then they want control of your computers to use them in attacks against other systems.

Up until now firewalls that performed stateful packet inspection were adequate to handle the traffic flowing into and out of the corporate network. That changed with the introduction of Web 2.0. Web 2.0 is more of a concept than an actual software product. Previously, applications were used or provided to access websites and their content. For example, if you wanted to "blog" on a certain website you installed their software on your computer and saved your data to the website for others to view.

Now with Web 2.0 multiple applications are run from the website itself and not on the client computer. According to Tim O'Reilly, Web 2.0[ii] now allows the web to be presented as a platform where services and not

packaged applications are now the main focus. People now purchase and use a service instead of a single application. A typical site might create many different "applets" that allow different functions, such as video, data sharing, social media, and collaboration to take place within a single website. All of this can take place over http on port 80 and https on port 443. About two thirds of the traffic on the Internet is web traffic. While this allows for ease of access for the end user, it allows attackers the ability to "sneak" illicit programs and attacks through a standard stateful firewall. This ability to pass through the border defenses of the network can make it harder for intrusion detection systems to catch the intrusion. NSS Labs has stated that technical sophistication of the criminal element has grown at a rate faster than security companies' abilities to stay up-to-date. [iii]

Here is where the next generation firewalls come into play. They not only perform deep packet inspection but also can evaluate the data coming into the network at the application layer of the OSI model, Layer 7. Up until the introduction of next generation firewalls (NGFW), a fully protected network had an application or appliance firewall, an intrusion protection system, an intrusion prevention system, and probably a syslog server to gather logs from all of the different devices for analysis[iv]. At a basic level, what a NGFW does is to combine all three systems into a single device so that the data is checked on a single pass making it more efficient.

In 2010, only between 5 percent and 10 percent of the number of security devices deployed were next generation firewalls. According to Gartner by 2014 35 percent of installed firewalls will be next generation firewalls with 65 percent of new purchased being next generation firewalls.

What next generation firewalls bring to the table is the ability to look within the data streams passing through the firewall and determine whether or not the actual application or command is allowed or suspicious [v]. SQL queries are very common within websites. A NGFW should have the ability to scan your HTTP traffic, look for SQL commands and check to see that the format of the command is acceptable or possibility malicious. NGFW also should give you the ability to be more granular with your firewall rules. Many businesses today reluctantly need to grant access to social media sites such as Facebook. With a standard firewall you would either allow complete access to Facebook or completely block Facebook. A NGFW gives you the ability to allow or block based on user access credentials or group membership such as being able to allow only the marketing group to use Facebook. Restricting types of access to a website is also possible. Companies could allow all users access to Facebook pages but disallow Facebook games such as Farmville and Treasure Isle.

To be classified as a next generation firewall, the system needs to be able meet at a minimum 5 basic requirements[vi].

1. It needs to have the deep packet inspection ability that currently exists on today's firewall. Confirm that the NGFW scans all files for threats including encrypted files. Some systems may allow large files through to increase performance.
2. The system needs to have application intelligence. In other words, it has to have the ability to know what applications are traversing on http and https ports and what the applications are doing. Vendors must be able to provide updates, as new applications are available.
3. Since a NGFW has to be able to look deeper into what is happening, performance is an issue. The system has to be able to perform all of its functions at wire speed. An underpowered system will become a network bottleneck and/or miss anomalies that it is looking for. Due to the requirements of these systems, many vendors are creating specialized hardware devices to run their software. Processing much take place in real time.
4. A NGFW needs to have good reporting abilities that are easy to understand. If you don't have the ability to review what is actually happening with the system then you really don't know whether or not the system is performing as expected. You need to be able to see more that just the source and destination IP addresses and ports. If you cannot see what is happening, you cannot optimize it.
5. It needs to be manageable; most system failures are due to human errors and misconfiguration. Check the system to see if each instance is managed separately or if a number of NGFWs can be managed centrally. How intuitive is the interface?

Other criteria that define a NGFW are the ability to become very granular with rules and access. Controls need to be available for specific user access and specific application layer controls. Another attribute of an advance firewall system is the ability to learn new applications and dynamically have the ability to apply new application signatures to its rules. To use Facebook as an example again, when a new application becomes available on the website a new signature update would allow that application to be specifically allowed or disallowed based on the company policies. Another key feature of a NGFW is the ability to look within HTTPS SSL connections. Current firewall systems do not have the ability to look within encrypted sessions.

Currently Gartner's Magic Quadrant only has two players in its top right corner, Check Point Software Technologies and Palo Alto Networks[vii]. Some of the other major players are Barracuda Networks, Fortinet, Juniper Networks, Sonic WALL, Cisco Systems, and Stone soft.

Check Point Systems - http://www. checkpoint. com/products/appliances/index.html

"Today's enterprise security gateway needs to be more than just a firewall – it must use multiple technologies to secure and protect networks against evolving threats."

Palo Alto Networks - http://www.paloaltonetworks.com/

"Using a Palo Alto Networks next-generation firewall, your security team can strike an appropriate balance between blocking all personal-use applications and allowing them. Secure application enablement begins with first knowing exactly what applications are being used and by whom."

Barracuda Networks - https://www. Barracuda networks.com/

"Barracuda Networks offers the broadest range of advanced security solutions in the industry. Leveraging the benefits of hardware, cloud and virtual technology — backed by threat intelligence from Barracuda Central - our solutions consistently deliver zero-hour protection."

Cisco Systems – www.cisco.com

"The Cisco ASA 5500 Series Content Security and Control Security Services Module (CSC-SSM) delivers industry-leading threat protection and content control at the Internet edge providing comprehensive antivirus, anti-spyware, file blocking, anti-spam, anti-phishing, URL blocking and filtering, and content filtering-all available in a comprehensive easy-to-manage solution delivered by industry leaders."

Fortinet - http://www.fortinet.com/

"Fortinet'sFortiGate consolidated security platforms provide you with the ability to protect your network with the fastest firewall technology on the market. You also have the freedom to deploy the widest range of security technologies available, to fit your dynamic network environment."

Juniper Networks - http://www.juniper.net/us/en/

"Juniper Networks Adaptive Threat Management Solutions adapt to changing network security threats and risks throughout the distributed enterprise. The result is a responsive and trusted security environment for high-performance networks."

Sonic WALL - http://www.sonicwall.com/

"Dell® Sonic WALL® Next-Generation Firewalls, deliver superior intrusion prevention, malware protection, application intelligence and control, real-time traffic visualization and inspection for SSLencrypted sessions at the gateway by tightly integrating a patented Reassembly-Free Deep Packet Inspection® engine with multi-core hardware."

Stonesoft - http://www.stonesoft.com/en/

"The Stonesoft Security Engine changes how network security is delivered. Unlike traditional security products, the Security Engine is one solution that delivers the adaptability, agility and scalability of a service."

Other companies have systems that they are calling NGFWs but don't meet the current definition of a next generation firewall[viii]. Some have all of the required components but are not integrated into a single pass device. For instance their current firewall may allow you to add an IDS/IPS module, avirus-scanning module, and an Internet proxy module. There is little difference in having multiple systems doing different functions from having one device with multiple modules other than maybe physical size and cost. A true NGFW is a single device that combines all of the required functions along with reporting into a single pass-through single scanning system.

Many enterprises have no idea what is traversing their firewalls and have just now started to implement IDS and IPS systems. Those that are aware of their shortcomings are reluctant to increase the complexity of the firewalls and the policies controlling them. For those not quite ready to do a rip and replace there are two options for introducing NGFWs. One method is to place the NGFW in front of the Internet and keep the existing firewall as a safeguard until comfortable with the new system. The other method is to place the NGFW behind the firewall and see what is actually getting through and into your network. However, according to Greg Young, a Gartner research VP, 95% of next generation purchases are for firewall replacements. Since many companies are replacing separate logging, IDS, IPS, and management systems with a single device, they are easily justifying the expense of an upgrade.

So what a NFGW gives you is the ability to look deeper into what is entering and leaving your network. It gives you the ability to have greater control over what access is granted to users within your network and to users coming to your websites. By being able to look at Layer 7 applications you also have a much greater chance of catching anomalies or attacks coming at your network and internal systems. Attacks are getting much more sophisticated and presenting a much more challenging job for network security. Next generation firewalls are the next step in the line of defense for corporate networks.

---

[i] United States Computer Emergency Readiness Team http://www.us-cert.gov/

[ii] WhatIs Web 2.0 September 2005 http://oreilly.com/web2/archive/what-is-web-20.htmlJune 9, 2012

[iii]Next-generation firewalls: In depth, Neil Roiter, October 17, 2011, http://www.csoonline.com/article/print/691651, July 1, 2012,

[iv]What is a next-generation firewall? Joel Snyder, August 22, 2011 http://www.networkworld.com/reviews/2011/082211-palo-alto-next-gen-test-249395.html July 22, 2012

[v]http://www.networkcomputing.com/security/232601723?pgno=3

[vi] How to Choose a Next-Generation Firewall, Patrick Sweeney, February 29, 2012. http://www.crn.com/blogs-op-ed/channel-voices/232301521/how-to-choose-a-next-generation-firewall. htm; jsessionid=2HIUeJMfJrxkHSSq-o9FnQ**.ecappj03July 1, 2012

[vii]RSA: Trio Of Next-Gen Firewalls Try To Keep Up With Evolving Threats, Robert Mullins, February 2012, http://www.network computing.com/security/232601723?pgno=2 May 24, 2012

[viii]Choosing a next-generation firewall: Vendor comparison. March 2011 http://searchnetworking. techtarget.com/feature/Choosing-a-next-generati- on-firewall-Vendor-comparison June 9, 2012.

Next-Generation Firewalls will include Intrusion Prevention http://www.gartner.com/research/spotlight/asset_91268_895.jsp

The Cisco ASA 5500 as a Superior Firewall Solution http://www.cisco.com/en/US/prod/collateral/vpndevc/ps6032/ps6094/ps6120/prod_white_paper0900aecd8058ec85.html

Next Generation Firewall http://www.nsslabs.com/research/network-security/firewall-ngfw/

The Network Security Sonic OS Platform Next-Generation Firewalls http://www.sonicwall.com/us/products/Next-Generation_Firewall.html

Global Journals Inc. (US) Guidelines Handbook 2012

www.GlobalJournals.org

FELLOW OF ASSOCIATION OF RESEARCH SOCIETY IN COMPUTING (FARSC)

- 'FARSC' title will be awarded to the person after approval of Editor-in-Chief and Editorial Board. The title 'FARSC" can be added to name in the following manner. eg. **Dr. John E. Hall, Ph.D., FARSC or William Walldroff Ph. D., M.S., FARSC**
- Being FARSC is a respectful honor. It authenticates your research activities. After becoming FARSC, you can use 'FARSC' title as you use your degree in suffix of your name. This will definitely will enhance and add up your name. You can use it on your Career Counseling Materials/CV/Resume/Visiting Card/Name Plate etc.
- 60% Discount will be provided to FARSC members for publishing research papers in Global Journals Inc., if our Editorial Board and Peer Reviewers accept the paper. For the life time, if you are author/co-author of any paper bill sent to you will automatically be discounted one by 60%
- FARSC will be given a renowned, secure, free professional email address with 100 GB of space eg.johnhall@globaljournals.org. You will be facilitated with Webmail, Spam Assassin, Email Forwarders, Auto-Responders, Email Delivery Route tracing, etc.
- FARSC member is eligible to become paid peer reviewer at Global Journals Inc. to earn up to 15% of realized author charges taken from author of respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account or to your PayPal account.
- Eg. If we had taken 420 USD from author, we can send 63 USD to your account.
- FARSC member can apply for free approval, grading and certification of some of their Educational and Institutional Degrees from Global Journals Inc. (US) and Open Association of Research, Society U.S.A.
- After you are FARSC. You can send us scanned copy of all of your documents. We will verify, grade and certify them within a month. It will be based on your academic records, quality of research papers published by you, and 50 more criteria. This is beneficial for your job interviews as recruiting organization need not just rely on you for authenticity and your unknown qualities, you would have authentic ranks of all of your documents. Our scale is unique worldwide.
- FARSC member can proceed to get benefits of free research podcasting in Global Research Radio with their research documents, slides and online movies.
- After your publication anywhere in the world, you can upload you research paper with your recorded voice or you can use our professional RJs to record your paper their voice. We can also stream your conference videos and display your slides online.
- FARSC will be eligible for free application of Standardization of their Researches by Open Scientific Standards. Standardization is next step and level after publishing in a journal. A team of research and professional will work with you to take your research to its next level, which is worldwide open standardization.

- FARSC is eligible to earn from their researches: While publishing his paper with Global Journals Inc. (US), FARSC can decide whether he/she would like to publish his/her research in closed manner. When readers will buy that individual research paper for reading, 80% of its earning by Global Journals Inc. (US) will be transferred to FARSC member's bank account after certain threshold balance. There is no time limit for collection. FARSC member can decide its price and we can help in decision.

MEMBER OF ASSOCIATION OF RESEARCH SOCIETY IN COMPUTING (MARSC)

- 'MARSC' title will be awarded to the person after approval of Editor-in-Chief and Editorial Board. The title 'MARSC" can be added to name in the following manner. eg. Dr. John E. Hall, Ph.D., MARSC or William Walldroff Ph. D., M.S., MARSC
- Being MARSC is a respectful honor. It authenticates your research activities. After becoming MARSC, you can use 'MARSC' title as you use your degree in suffix of your name. This will definitely will enhance and add up your name. You can use it on your Career Counseling Materials/CV/Resume/Visiting Card/Name Plate etc.
- 40% Discount will be provided to MARSC members for publishing research papers in Global Journals Inc., if our Editorial Board and Peer Reviewers accept the paper. For the life time, if you are author/co-author of any paper bill sent to you will automatically be discounted one by 60%
- MARSC will be given a renowned, secure, free professional email address with 30 GB of space eg.johnhall@globaljournals.org. You will be facilitated with Webmail, Spam Assassin, Email Forwarders, Auto-Responders, Email Delivery Route tracing, etc.
- MARSC member is eligible to become paid peer reviewer at Global Journals Inc. to earn up to 10% of realized author charges taken from author of respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account or to your PayPal account.
- MARSC member can apply for free approval, grading and certification of some of their Educational and Institutional Degrees from Global Journals Inc. (US) and Open Association of Research, Society U.S.A.
- MARSC is eligible to earn from their researches: While publishing his paper with Global Journals Inc. (US), MARSC can decide whether he/she would like to publish his/her research in closed manner. When readers will buy that individual research paper for reading, 40% of its earning by Global Journals Inc. (US) will be transferred to MARSC member's bank account after certain threshold balance. There is no time limit for collection. MARSC member can decide its price and we can help in decision.

AUXILIARY MEMBERSHIPS

ANNUAL MEMBER

- Annual Member will be authorized to receive e-Journal GJCST for one year (subscription for one year).
- The member will be allotted free 1 GB Web-space along with subDomain to contribute and participate in our activities.
- A professional email address will be allotted free 500 MB email space.

PAPER PUBLICATION

- The members can publish paper once. The paper will be sent to two-peer reviewer. The paper will be published after the acceptance of peer reviewers and Editorial Board.

Process of submission of Research Paper

The Area or field of specialization may or may not be of any category as mentioned in 'Scope of Journal' menu of the GlobalJournals.org website. There are 37 Research Journal categorized with Six parental Journals GJCST, GJMR, GJRE, GJMBR, GJSFR, GJHSS. For Authors should prefer the mentioned categories. There are three widely used systems UDC, DDC and LCC. The details are available as 'Knowledge Abstract' at Home page. The major advantage of this coding is that, the research work will be exposed to and shared with all over the world as we are being abstracted and indexed worldwide.

The paper should be in proper format. The format can be downloaded from first page of 'Author Guideline' Menu. The Author is expected to follow the general rules as mentioned in this menu. The paper should be written in MS-Word Format (*.DOC,*.DOCX).

The Author can submit the paper either online or offline. The authors should prefer online submission.Online Submission: There are three ways to submit your paper:

(A) (I) First, register yourself using top right corner of Home page then Login. If you are already registered, then login using your username and password.

(II) Choose corresponding Journal.

(III) Click 'Submit Manuscript'. Fill required information and Upload the paper.

(B) If you are using Internet Explorer, then Direct Submission through Homepage is also available.

(C) If these two are not convenient, and then email the paper directly to dean@globaljournals.org.

Offline Submission: Author can send the typed form of paper by Post. However, online submission should be preferred.

Preferred Author Guidelines

MANUSCRIPT STYLE INSTRUCTION (Must be strictly followed)

Page Size: 8.27" X 11'"

- Left Margin: 0.65
- Right Margin: 0.65
- Top Margin: 0.75
- Bottom Margin: 0.75
- Font type of all text should be Swis 721 Lt BT.
- Paper Title should be of Font Size 24 with one Column section.
- Author Name in Font Size of 11 with one column as of Title.
- Abstract Font size of 9 Bold, "Abstract" word in Italic Bold.
- Main Text: Font size 10 with justified two columns section
- Two Column with Equal Column with of 3.38 and Gaping of .2
- First Character must be three lines Drop capped.
- Paragraph before Spacing of 1 pt and After of 0 pt.
- Line Spacing of 1 pt
- Large Images must be in One Column
- Numbering of First Main Headings (Heading 1) must be in Roman Letters, Capital Letter, and Font Size of 10.
- Numbering of Second Main Headings (Heading 2) must be in Alphabets, Italic, and Font Size of 10.

You can use your own standard format also.
Author Guidelines:

1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

1. GENERAL

Before submitting your research paper, one is advised to go through the details as mentioned in following heads. It will be beneficial, while peer reviewer justify your paper for publication.

Scope

The Global Journals Inc. (US) welcome the submission of original paper, review paper, survey article relevant to the all the streams of Philosophy and knowledge. The Global Journals Inc. (US) is parental platform for Global Journal of Computer Science and Technology, Researches in Engineering, Medical Research, Science Frontier Research, Human Social Science, Management, and Business organization. The choice of specific field can be done otherwise as following in Abstracting and Indexing Page on this Website. As the all Global

Journals Inc. (US) are being abstracted and indexed (in process) by most of the reputed organizations. Topics of only narrow interest will not be accepted unless they have wider potential or consequences.

2. ETHICAL GUIDELINES

Authors should follow the ethical guidelines as mentioned below for publication of research paper and research activities.

Papers are accepted on strict understanding that the material in whole or in part has not been, nor is being, considered for publication elsewhere. If the paper once accepted by Global Journals Inc. (US) and Editorial Board, will become the copyright of the Global Journals Inc. (US).

Authorship: The authors and coauthors should have active contribution to conception design, analysis and interpretation of findings. They should critically review the contents and drafting of the paper. All should approve the final version of the paper before submission

The Global Journals Inc. (US) follows the definition of authorship set up by the Global Academy of Research and Development. According to the Global Academy of R&D authorship, criteria must be based on:

1) Substantial contributions to conception and acquisition of data, analysis and interpretation of the findings.

2) Drafting the paper and revising it critically regarding important academic content.

3) Final approval of the version of the paper to be published.

All authors should have been credited according to their appropriate contribution in research activity and preparing paper. Contributors who do not match the criteria as authors may be mentioned under Acknowledgement.

Acknowledgements: Contributors to the research other than authors credited should be mentioned under acknowledgement. The specifications of the source of funding for the research if appropriate can be included. Suppliers of resources may be mentioned along with address.

Appeal of Decision: The Editorial Board's decision on publication of the paper is final and cannot be appealed elsewhere.

Permissions: It is the author's responsibility to have prior permission if all or parts of earlier published illustrations are used in this paper.

Please mention proper reference and appropriate acknowledgements wherever expected.

If all or parts of previously published illustrations are used, permission must be taken from the copyright holder concerned. It is the author's responsibility to take these in writing.

Approval for reproduction/modification of any information (including figures and tables) published elsewhere must be obtained by the authors/copyright holders before submission of the manuscript. Contributors (Authors) are responsible for any copyright fee involved.

3. SUBMISSION OF MANUSCRIPTS

Manuscripts should be uploaded via this online submission page. The online submission is most efficient method for submission of papers, as it enables rapid distribution of manuscripts and consequently speeds up the review procedure. It also enables authors to know the status of their own manuscripts by emailing us. Complete instructions for submitting a paper is available below.

Manuscript submission is a systematic procedure and little preparation is required beyond having all parts of your manuscript in a given format and a computer with an Internet connection and a Web browser. Full help and instructions are provided on-screen. As an author, you will be prompted for login and manuscript details as Field of Paper and then to upload your manuscript file(s) according to the instructions.

To avoid postal delays, all transaction is preferred by e-mail. A finished manuscript submission is confirmed by e-mail immediately and your paper enters the editorial process with no postal delays. When a conclusion is made about the publication of your paper by our Editorial Board, revisions can be submitted online with the same procedure, with an occasion to view and respond to all comments.

Complete support for both authors and co-author is provided.

4. MANUSCRIPT'S CATEGORY

Based on potential and nature, the manuscript can be categorized under the following heads:

Original research paper: Such papers are reports of high-level significant original research work.

Review papers: These are concise, significant but helpful and decisive topics for young researchers.

Research articles: These are handled with small investigation and applications

Research letters: The letters are small and concise comments on previously published matters.

5.STRUCTURE AND FORMAT OF MANUSCRIPT

The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

Papers: These are reports of significant research (typically less than 7000 words equivalent, including tables, figures, references), and comprise:

(a)Title should be relevant and commensurate with the theme of the paper.

(b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.

(c) Up to ten keywords, that precisely identifies the paper's subject, purpose, and focus.

(d) An Introduction, giving necessary background excluding subheadings; objectives must be clearly declared.

(e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.

(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and to make suggestions to improve briefness.

It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

Format

Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

Abbreviations supposed to be used carefully. The abbreviated name or expression is supposed to be cited in full at first usage, followed by the conventional abbreviation in parentheses.

Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

Structure

All manuscripts submitted to Global Journals Inc. (US), ought to include:

Title: The title page must carry an instructive title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) wherever the work was carried out. The full postal address in addition with the e-mail address of related author must be given. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining and indexing.

Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

The Editorial Board and Global Journals Inc. (US) recommend that, citation of online-published papers and other material should be done via a DOI (digital object identifier). If an author cites anything, which does not have a DOI, they run the risk of the cited material not being noticeable.

The Editorial Board and Global Journals Inc. (US) recommend the use of a tool such as Reference Manager for reference management and formatting.

Tables, Figures and Figure Legends

Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.

Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

Preparation of Electronic Figures for Publication

Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution (at final image size) ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs) : >350 dpi; figures containing both halftone and line images: >650 dpi.

Color Charges: It is the rule of the Global Journals Inc. (US) for authors to pay the full cost for the reproduction of their color artwork. Hence, please note that, if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a color work agreement form before your paper can be published.

Figure Legends: Self-explanatory legends of all figures should be incorporated separately under the heading 'Legends to Figures'. In the full-text online edition of the journal, figure legends may possibly be truncated in abbreviated links to the full screen version. Therefore, the first 100 characters of any legend should notify the reader, about the key aspects of the figure.

6. AFTER ACCEPTANCE

Upon approval of a paper for publication, the manuscript will be forwarded to the dean, who is responsible for the publication of the Global Journals Inc. (US).

6.1 Proof Corrections

The corresponding author will receive an e-mail alert containing a link to a website or will be attached. A working e-mail address must therefore be provided for the related author.

Acrobat Reader will be required in order to read this file. This software can be downloaded

(Free of charge) from the following website:

www.adobe.com/products/acrobat/readstep2.html. This will facilitate the file to be opened, read on screen, and printed out in order for any corrections to be added. Further instructions will be sent with the proof.

Proofs must be returned to the dean at dean@globaljournals.org within three days of receipt.

As changes to proofs are costly, we inquire that you only correct typesetting errors. All illustrations are retained by the publisher. Please note that the authors are responsible for all statements made in their work, including changes made by the copy editor.

6.2 Early View of Global Journals Inc. (US) (Publication Prior to Print)

The Global Journals Inc. (US) are enclosed by our publishing's Early View service. Early View articles are complete full-text articles sent in advance of their publication. Early View articles are absolute and final. They have been completely reviewed, revised and edited for publication, and the authors' final corrections have been incorporated. Because they are in final form, no changes can be made after sending them. The nature of Early View articles means that they do not yet have volume, issue or page numbers, so Early View articles cannot be cited in the conventional way.

6.3 Author Services

Online production tracking is available for your article through Author Services. Author Services enables authors to track their article - once it has been accepted - through the production process to publication online and in print. Authors can check the status of their articles online and choose to receive automated e-mails at key stages of production. The authors will receive an e-mail with a unique link that enables them to register and have their article automatically added to the system. Please ensure that a complete e-mail address is provided when submitting the manuscript.

6.4 Author Material Archive Policy

Please note that if not specifically requested, publisher will dispose off hardcopy & electronic information submitted, after the two months of publication. If you require the return of any information submitted, please inform the Editorial Board or dean as soon as possible.

6.5 Offprint and Extra Copies

A PDF offprint of the online-published article will be provided free of charge to the related author, and may be distributed according to the Publisher's terms and conditions. Additional paper offprint may be ordered by emailing us at: editor@globaljournals.org .

the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. **Pick a good study spot:** To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. **Think technically:** Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be

sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page

- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to

shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.
- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic

principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.

- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

Administration Rules Listed Before Submitting Your Research Paper to Global Journals Inc. (US)

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

Segment Draft and Final Research Paper: You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.

- Do not give permission to anyone else to "PROOFREAD" your manuscript.

- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

Criterion for Grading a Research Paper (Compilation) by Global Journals Inc. (US)

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals Inc. (US).

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

Index

T

U

V

W

save our planet

Global Journal of Computer Science and Technology

Visit us on the Web at www.GlobalJournals.org | www.ComputerResearch.org
or email us at helpdesk@globaljournals.org

ISSN 9754350