Load Balanced Deadlock Free Reconfiguration on Wire cum Wireless Network

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ABSTRACT

In this paper, In this paper, we address to avoid deadlock (Looping) problem during reconfiguration in a wire- cum-wireless network, where wireless LANs extend a wired backbone and supply access to wireless users. The aspire is to achieve proportional fairness amongst the end-to-end sessions in the network. Since the network contains wireless links whose achievable throughput is a (non-convex and non-separable) function and the problem requires joint optimization at both networks. A Load balanced deadlock free reconfiguration protocol (LBDFR) is proposed in this paper to solve the looping (deadlock) problem during reconfiguration situation. It is implemented in the distributed manner, and works at the link level to feed the new routing function in both wired and wireless links in the basic service sets. In 2-layer WNoc architecture, the long distance packets given priority to routed through wireless ports and all short distance packets are passing through wired router by shortest path function through VCs. Based on the load accumulated at wireless router level it decides the best route and port for the incoming packet based on its current load it handles and its distance level to destination. Whenever link failure occurs, the recognized node becomes RC (Reconfiguration controller) and it prepare new routing function based on the available paths and send it to the ambient nodes with token for differentiating old and new routing functions. This idea is inherited in Hybrid Mesh WNOC where a traditional 2D Mesh is divided into several subnets, and each subnet has a wireless node in the center that allows this subnet to directly communicate with other subnets wirelessly. We proved meticulously that the proposed algorithm converges to the global optimal solution to make deadlock freedom on communication networks. Simulation results are provided through NS2 simulator to support our conclusions.

INTRODUCTION

Wire cum wireless Network:

In recent years, wireless LANs are being gainfully used with the latest technology in the present pervasive or nomadic computing environments: It provides adequate bandwidth for office applications with relatively limited mobility, and typically users may roam inside a building or a campus. Although wireless LANs do not replace wired networks, they expand the wired networks where it is unreasonable or overly expensive to use cabling. In a typical wired-cum-wireless network, mobile hosts (MHs), such as laptop computers, peripherals and storage devices can roam in the wireless networks, called basic service sets (BSSs), which are attached at the border of a wired backbone (infrastructure). The wired infrastructure can be an IEEE 802 style Ethernet LAN or some other IP based network. A typical wired-cum-wireless network is shown in Fig. 1.

The wired and wireless networks are interconnected via Access Points (APs), which are really fixed base stations that provide interfaces between the wired and wireless parts of the network and control each BSS. The MHs can roam from one BSS to another. An MH within a BSS can only access the infrastructure through its AP, and it is assumed that, in each BSS, all the MHs are within the broadcast region of that particular AP. This study addresses the problem of deadlock freedom optimization in reconfiguration sessions in wired-cum wireless networks, in which end-to-end sessions run across both wired and wireless links. The deadlock freedom is to provide relative fairness amongst the end-to-end sessions in the network. It has been shown that, since the possible deadlock freedom methods can be stand for by a set of simple, separable, convex constraints in wired networks, globally fair rates are
achievable via distributed approaches based on convex programming. The deadlock optimization complexity for single-hop flows in wireless networks has also received important consideration. The proposed decentralized algorithms that try to attain deadlock free reconfiguration, although these algorithms do not provide any provable guarantees on the fairness attained. The distributed strategies that attain certain link-level fairness criteria in random access wireless networks. However, these prior works do not consider a heterogeneous wired-wireless network, and only focus on single-hop flows. Error control for multi-hop sessions in wireless networks has been considered. However, none of this work considers the scenario where a session may run across both wired and wireless links, and their results are not readily applicable to a wired-cum-wireless network.

Fig. 1: Wire cum Wireless Network.

Wireless Network-on-Chip (WNoC):
In glow of these technology advancements, the latest research is geared towards the mixed WNoC architectures which make use of wired links between adjacent nodes and use one-hop or multi-hop wireless links between a few selected distant nodes. Current WNoC architectures fall into two categories: single hop wireless NoC with long range on-chip wireless data links, and multi-hop wireless NoC with short range on-chip wireless data links and larger number of wireless routers. For one-hop wireless NoC architectures, data contention cans origin severe performance problems at the wireless routers. The concept of subnet was first introduced in Small World WNoC, where nodes in a local subnet are wire linked and each subnet communicates with other subnets through a hub. This idea is innate in Hybrid Mesh WNoC where a traditional 2D Mesh is divided into several subnets, and each subnet has a wireless node in the center that allows this subnet to directly communicate with other subnets wirelessly. On the other hand, the multi-hop wireless NoC architectures , due to their higher number of wireless routers, can reduce the rivalry at each wireless router, but suffer from great power utilization and require large chip area. To overcome the problems of these existing architectures, we propose a novel wireless WNoC architecture built upon two logically connected meshes, one wireless mesh and another wired one. The wireless mesh supports multiple-hop wireless communications, so the routing paths in the wireless mesh are increased to avoid data congestion.

MATERIALS AND METHODS

Literature Survey:
Wang, et al (2014) constructed an overlaid hybrid wire/wireless interconnection architecture for NoC. The routing algorithm in the lower-layer wired mesh rather simple, while in the upper-layer wireless mesh, the routing algorithm requires to handle the huge data volume passing via wireless nodes. Packets routed in the wired mesh undergo the deterministic XY routing algorithm, which has a low algorithm complexity and ensures the shortest path length. In the top wireless mesh, the partially adaptive West-First routing algorithm was used to route packets to evade data congestion. At the upper layer, nodes can communicate through a wireless mesh network. While at the lower level, nodes can communicate by utilizing wired links. The network congestion was avoided by classifying the packets as long distance and short distance. These two packets was routed at various virtual channels in the upper wireless network to avoid any possible deadlocks.

Maleki, et al(2014) suggested an energy efficient hybrid wired-cum-wireless sensor network design to detect the optimal location of cluster heads and Access Points (Aps). The model incorporates the following variables into its formulation: data
generation rate within each cluster of sensors, communication radius limitations for each sensor, cluster, and AP, the amount of battery power in each cluster, the total life of the network, and practical location consideration for cluster heads. This approach was tested on various test difficulties, which assess the effects of expanding the network. “BARON” solver was used to govern the computational results for actual application problems, which was characterized by up to a hundred cluster heads and a network area of $10^5$ square meters.

Li, et al (2013) illustrated an integration of ReSerVation Protocol (RSVP) and RSVP- flow reservation pattern in wireless LANs, which was an end-to-end explanation for QoS assurance in wired-cum-wireless networks. Functionalities of Access points are shown in figure 2.5. Wired and wireless networks was interconnected through Access Point (AP), or base station, which was skilled of both wired and wireless routing. All Mobile Hosts (MHs) within a cell can only access the structure through AP. Due to the node mobility, end-to-end QoS guarantee in the framework of wireless internet also indicates that if a MH moves between different cells, its bandwidth should be allotted in the new cell and removed from the old cell, making the end-to-end QoS assurance even more challenging.

Chen, et al (2012) represented a WoFAN framework to analyze the performance provided by wired-cum-wireless networks. In this framework, File transfer servers (FTSs) and Streaming media servers (SMSs). This was organized in the wired backbone providing file transfer service and streaming media service correspondingly to users in the Local Area Network (LAN) and the Wireless Local Area Network WLAN. Mobile hosts in the WLAN interact with servers in the wired backbone through an Access router (AR) at the network edge. When responding the requested services, servers require transferring analogous data over multiple hops within the backbone. The flow was made by FTSs and SMSs correspondingly as elastic flows and streaming flows approves the same theories as in Flow Aware Networking (FAN).

Nashiry, et al (2012) devised a performance of TCP over mobile IP in wired-cum-wireless networks. An alteration to Reno TCP called New-Reno TCP was used in this approach. Since most of the TCP sessions occur only for a small period of time, the primary slow start period was important for the overall performance. This method was used to evaluate a finest slow start threshold value by computing the byte correspondent bandwidth delay product of the network when a fresh connection was made.

Moret, et al (2010) analyzed the influences of methodically increasing the ACK frequency and accelerates the ACK clocking. Using a medium access control technique such as distributed coordination function (DCF) in 802.11, divacks and data packets has equal media access chances due to DCF contention nature. The Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) mechanism with the arbitrary exponential back-off inhibits with the predictable performance of enormous sending of divacks. This observation was valid as long as the bottleneck of the network resides in the wireless part. Thus, when the bottleneck was in the wired part of a wired-cum-wireless network, the data packets was delayed and divacks gain more access frequently during the period of time in which the APs buffer was null.

Dunaytsev (2010) proposed a TCP performance evaluation over wired-cum-wireless networks. An analytical cross layer approach for a TCP SACK connection, which runs over a wireless channel either with completely reliable or semi-reliable Automatic Repeat Request/ Error Correction (ARQ/EC). It measure the mutual effect of many application based specific parameters on TCP performance over both correlated and uncorrelated wireless channels, which was suitable for optimization studies. Since a large number of transmission was allowed for a frame, which enhances the reliability of a wireless channel by decreasing the number of non-congestion losses and a high persistence or perfectly-persistent ARQ scheme.

Dutta and Misra (2010) presented a service curve for resource reservation in wired-cum-wireless scenario. Service curve may be either lower or upper. The lower service curve deterministically assesses amount of network traffic, which was important for the accurate utilization of the service of the multiplexer. On the other side, the upper service curves offer a deterministic measure of maximum allowable data, which was fed to the multiplexer without corrupting the end-to-end QoS. Both the upper and the lower service curve relies on the traffic arrival rate, service rate or processing rate of the multiplexer and bandwidth of the out coming line in the multiplexer.

Wang, et al (2009) suggested a dual based algorithm to solve the rate optimization problem. It was active in the scattered manner and works at the link layer to regulate scheduling rates for the wireless links in the general service sets. This algorithm iteratively detects the optimal session rates for given wireless link capacities. Then the wireless link scheduling rates was adjusted in a way so that the restricted access wireless link capacities were improved and the aggregate utility was further increased. The algorithm operates at both the transport and the link layer. Every time a Carrier sense multiple access with collision avoidance (CSMA/CA) based Base Station Subsystem (BSS) selects the scheduling rates for its links, the wireless link rates are updated accordingly.
Pentikousis (2000) presented the basic characteristics of wired-cum-wireless networks. Modification in end-host abilities limits to some degree the applications, which was running on each group of devices. Differences in computing power, memory size, input and output devices, in addition to mobility and power consumption issues, detect the potential uses of each end-host category. At the same time, end hosts exploits a distant larger spectrum of networking technologies to connect to the internet, which includes traditional wires and optical fibers. TCP assumes that the fundamental network infrastructure has restricted to service capabilities. TCP uses algorithms related to those of standard TCP for connection management and flow control. However, it follows a various approach with respect to the congestion control. The receiver was responsible for setting the suitable rate for thesender to use. The receiver, upon the arrival of each incoming segment, services an algorithm to decide whether to ask the sender to maximize, minimize, or maintain the current sending rate.

The literature survey focuses on deadlock avoidance mechanism in the wired cum wireless networks in order to enhance the efficiency of the networks and to model the deadlock free communication network.

Network Model:

We consider a general wired-cum-wireless network topology. The wired backbone can be modeled as network \( N = (R, A, L) \), where \( R \) denotes the set of fixed nodes (routers) in the wired network, \( A \) denotes the set of wireless access points connected to the wired backbone, and \( L \) represent the set of directed (wired) links that connect the nodes (routers \( R \) as well as access points \( A \)) in the network. Each access point in \( A \) is uniquely associated with a BSS, and let \( W \) denote the set of all BSSs in the system (clearly, \( |W| = |A| \)). We assume that each MH belongs to only one BSS, and is therefore connected with only one AP. Each BSS \( w \in W \) can be modeled as a network \( N_w = (M_w, A_w, E_w) \), where \( M_w \) is the set of the MHs in BSS \( w \), \( A_w \) is the unique AP connected with BSS \( w \), and \( E_w \) is a set of directed links (edges) on behalf of active communication pairs in the BSS. Denote \( A(s) \) as the AP connected with any MH \( s \in U_w \in E_w M_w \), i.e., \( A(s) = A_w \) if \( s \in M_w \). Since end-to-end sessions within a BSS are not allowed (by assumption), a mobile host communicates directly only with its access point. In other words, each link in \( E_w \) must originate or terminate in \( A_w \). We assume that each wireless node (including the access points) has a single transceiver. Therefore, a node cannot transmit and receive simultaneously, and cannot communicate with multiple nodes simultaneously. This implies that at most one wireless link in a BSS can be scheduled at any time. We assume that the scheduling point process for each wireless link \((s, t)\) represents a point in time at which the source node \( s \) would like to transmit on the link \((s, t) \in E_w \) is Poisson and is independent of all other such processes in the network.

Proposed Design and Algorithm:

In this proposed LBDRP protocol, we classify the data packets into two types: long distance packets and short distance packets. When these two kinds of packets exist in the network at the same time, it is very likely to cause a deadlock with formed cyclic routing paths involving both wired and wireless links. To resolve this potential deadlock problem, we introduce split of channels concept to reduce traffic load by the proper routing design by routing algorithm. For example the wireless router has 10 input ports 3 port as wireless and remain all are wired ports. The long distance packets given priority to routed through wireless ports and all short distance packets are passing through wired router by shortest path function through VCs. Based on the load accumulated \( r \) at wireless router level it decides the best route and port for the incoming packet based on its current load it handles and its distance level to destination. As the wireless port of router handles long distance packets only, one buffer (VC0) is sufficient. The Switch Allocator handles the requests of the virtual channels, and the switch is used alternately by these VCs. Because the long distance packets and the short distance packets are routed through different virtual channels, and no VC can dictate the switching fabric indefinitely, the possibility of having a deadlock can be eliminated. Whenever the network link failure occur, the first recognized node becomes RC (Reconfiguration Controller) and it prepare the new routing algorithm based on the available node except the damaged node. For one-hop wireless NoC architectures, data contention can cause severe performance problems at the wireless routers. The concept of subnet was first introduced in Small World WNoC, where nodes in a local subnet are wire linked and each subnet communicates with other subnets through a hub. This idea is inherited in Hybrid Mesh WNoC where a traditional 2D Mesh is divided into several subnets, and each subnet has a wireless node in the center that allows this subnet to directly communicate with other subnets wirelessly. On the other hand, the multi-hop wireless NoC architectures, due to their higher number of wireless routers, can reduce the competition at each wireless router, but suffer from great power consumption and require large chip area. To overcome the problems of these existing architectures, we propose a novel wireless WNoC architecture built upon two logically connected meshes, one wireless mesh and another wired one. The wireless mesh supports multi-hop wireless communications, so the routing paths in the wireless mesh are increased to avoid data congestion. We demonstrate the proposed architecture has low delay.
and high scalability. To overcome many problems inherent in wired NoC, we propose 2-Level WNoC architecture. Our WNoC architecture is based on a conventional wired 2-D mesh topology. Each IP here consists of a functional core, Network Interface (NI) and a router. Each router directly connects with its neighbor routers through multi-bit bidirectional links. The proposed 2-Level WNoC architecture is shown in Fig.2.

In the lower wired mesh, the network is divided into a number of subnets. In each subnet, one wireless router (WR) is located in the center for inter-subnet wireless communication, and other wired routers are around the WR for intra-subnet wired communication. Then, all the WRs are connected to each other by wireless links and constitutes the upper wireless mesh. Due to availability of multiple channels, Frequency Division Multiple Access (FDMA) method is adopted for channelization that can achieve simultaneous multiple communications between WRs.

![Fig. 2: 2-Level WNoc Architecture.](image)

**LBDRP Algorithm for wired nodes:**

**Failure Detection:**

If link or node failure detection, first recognized node becomes RC

RC sends the Hello message to neighbors of failure node

Collect the connectivity status by NW_STAUS message

Prepare the new routing based on NW_STATUS

RC passes the new routing information to ambient nodes along with token

**Input:** Source node S and destination node D, the router load;

**Output:** Packet routing decision;

Compute the Routes of nodes S and D based on load of the router;

If Buffer size of router == (below queue size) then //--it is a short distance packet

Route the packet to D through the wired mesh using available VCs by shortest path;

Else //--it is a long distance packet

If S and D are in the same subnet then

Route the packet to D through wired mesh route by shortest path

Else //--nodes S and D are in different subnets

Route the packet to the central node (Wire) of current subnet through the wired mesh then find the shortest path to D.

**LBDRP Algorithm for Wireless Nodes:**

**Input:** Source node S and destination node D, the available buffer sizes of wireless nodes in neighbor subnets;

**Output:** Packet routing decision;

Compute the subnet locations of nodes S and D;

If buffer sizes of router == (below queue size) then //--it is a short distance packet
Route the packet to D through wired mesh shortest path
Else //--it is a long distance packet
If S and D are in the same subnet then
Route the packet to D through wired mesh by shortest path;
Else //--nodes S and D are in different subnets
Route the packet to the central node of current subnet through the wired mesh then central node (Wireless) to D

The operation performed by both wired and wireless nodes are illustrated in the above algorithm. At last, the routing decision of the packet is made based on the load of the router. If the buffer size of the router is zero, then the packet is the short distance packet. Therefore, the packet is transmitted through the wired network; otherwise the packet transmission is obtained through wireless network.

RESULTS AND DISCUSSIONS
The exemplary simulation model and its parameter analysis:
We alluded simulation is the definition for mimics the real world in system. So now we scrutinize and examine the pensive performance of the deadlock free efficient reconfiguration protocol with an adhesive simulation study based on the paragon concept of NS2 network simulator. We just compare our TBDFR examination result with DSDV and WFXY protocols. We flashed the comparison analysis of proposed and existing protocols in the ineffable simulation which is elicited in figure 4, 5, 6 and 7 respectively.

Performance measured (Metrics):
Here we persuaded the following wireless network performance parameters energy, delay, Throughput and deliver rate are measured in various time intervals. Now we probe, confer and infer the following analysis.
Hybrid (Wire cum Wireless) Model
We know hybrid (wire and wireless) network consists of the nexus with wire and wireless routers. The main flavor of hybrid network is giving shortest path to cover all the nodes. The long distance packets are passing through wireless and short distance packets are passing through wired network. The simulation made through NS2 and energy, throughput, delay and delivery rate parameters are measured. The model snapshot generated through NS2 simulator for wire cum wireless network is shown here (Fig.3)

Throughput:
We know that throughput (data transmitted per unit time) is one of the important parameter deciding the network performance. Throughput against the packet size values are measured for existing AODV, ARS and proposed TBDFR protocols. The results are furnished for throughput in fig.4. Based on the result the proposed system produced the very high performance than existing systems. From that result of the simulator, we have drawn the graphs as follows.

Fig. 3: Simulation model of Wire cum Wireless Network.
Fig. 4: Throughput Analysis.

Delay:

The another important parameter of the network is delay (time spent for transmission). The Delay measured against the packet size for the popular existing protocol like DSDV, existing WFXY and the proposed LBDFR protocols. The following graphs are made, based on simulation. Based on output graph in fig 5. we found that our proposed system produce minimum delay than other existing systems.

Fig. 5: Latency (Delay) Analysis

Energy:

The Energy is another important parameter in wire cum wireless network analysis. In our experiment, we have measured the energy level in various time intervals against its life time. Based on this analysis our proposed protocol LBDFR system produced higher energy level than the existing DSDV and WFXY protocols. The following graphs are received from our experiment. Fig 6 shows that our proposed system produced the higher energy level than others.
Deliver ratio or hit rate:

It’s a most important parameter in our wireless network to decide its overall efficiency of the system. Based on the graphs made by simulation test, the comparison made for the various systems like AODV, ARS and LBDFR. We found based on graph 7 that the hit rate of proposed LBDFR systems produced higher than others.

Fig. 7: Deliver ratio analysis.

Conclusion:

In this paper, we have proposed a new WNoC structure and protocol, its routing algorithm, and correspondingly, the design of the wireless router. In essence, the proposed architecture is an overlay of two networks. At the upper layer, nodes can communicate through a wireless mesh network. While at the lower level, nodes can communicate by wired links. To avoid network congestion, packets are classified as long distance packets and short distance packets, and these two packets will be routed at different virtual channels in the upper wireless network to avoid any possible deadlocks. Experiment results have shown that the proposed LBDFR protocol outperforms the other two existing protocols.

REFERENCES


