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Capsule Reviews

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The Capsule Reviews are intended to provide a short succinct review of each paper in the issue in order to bring it to a wider readership. The Capsule Reviews were compiled by Fairouz Kamareddine. Professor Kamareddine is an Associate Editor of *The Computer Journal* and is based in the Department of Mathematical and Computer Sciences at Heriot-Watt University, Edinburgh, UK.

Formal Analysis of Hybrid Prefix/Carry-Select Arithmetic Systems. FENG LIU, XIAOYU SONG, QINGPING TAN AND GANG CHEN

Classic high-speed adders include carry-lookahead, carry-skip and carry-select adders, however new adders like the hybrid carry-lookahead and carry-select have been introduced in the literature to eliminate the delay of local carry generation. To improve speed further, the hybrid parallel prefix/carry-select has been proposed. This paper gives a generic architecture of hybrid prefix/carry-select adders and show its correctness. This proof methodology is also applied to other hybrid prefix/carry-select adders. First, related work is discussed and then the preliminaries and necessary formal machinery is introduced. Then, the general architecture of the hybrid prefix/carry-select adder is introduced and a formal proof framework is developed to prove the correctness of the proposed general architecture. Thereafter, some typical hybrid prefix/carry-select adders are given as case studies to establish the effectiveness of the proposed proof framework. This is done for the regular hybrid prefix/carry-select adder then for the special hybrid adder with pseudo-carries.

A Multipath Analysis of Biswapped Networks. YONGHONG XIANG AND IAIN A. STEWART

Biswapped networks have been proposed to recapture symmetric aspects of optical transpose interconnection systems. In a biswapped network Bsw(G) where G has n vertices, there are $2n$ copies of G, say $G_1, G_2, \ldots, G_n, G'_1, G'_2, \ldots, G'_n$ where optical edges join vertex v_i in G_j with vertex v_j in G_i' for i, j in $\{1, 2, \ldots, n\}$. This paper is concerned with the construction of $k+1$ vertex-disjoint paths joining any two distinct vertices in Bsw(G), where k is the connectivity of G, giving an upper bound on the $(k+1)$-diameter of Bsw(G), and mapping a deterministic multipath source routing algorithm in G that finds (in time polynomial in the k-diameter of G) k mutually vertex-disjoint paths in G joining any two distinct vertices, into a related simple deterministic multipath source routing algorithm in Bsw(G). After introducing the basic graph-theoretic definitions, the notions of Hamiltonicity and Cayley graphs are given and it is shown that if G is Hamiltonian (respectively, Cayley) then Bsw(G) is also Hamiltonian (respectively, Cayley). Next, G and Bsw(G) are related in terms of connectivity. The first theorem states that if G has connectivity $k \geq 1$ then there are $k+1$ mutually vertex-disjoint paths joining any two distinct vertices of Bsw(G) and this leads to an upper bound on the wide-parameter of Bsw(G). Thereafter, paths joining two distinct vertices of Bsw(G) are constructed, even if connectivity in G itself is low. It is shown how to turn a graph G of low connectivity into a graph Bsw(G) of high connectivity while retaining control over the degree of Bsw(G).

An Integrated Approach to Automatic Management of Virtualized Resources in Cloud Environments. QIANG LI, QIN-FEN HAO, LI-MIN XIAO AND ZHOU-JUN LI

The authors state that current cloud environments statistically predetermine and allocate resource entitlements of applications rather than providing the cloud designer with tools that automatically manage resources. The paper adds that there is a need for an automatic cloud resource management to solve hardware resources and reduce operations costs but that this is challenging because dynamic relationships are complex and virtual machine (VM) placement needs to guarantee service level objects (SLOs) when allocating resources. The paper proposes an automatic management approach that dynamically adjusts multiple virtualized resource allocation to achieve application SLOs in the cloud. The approach consists of three layered resource controllers [the VM controller (VMC), the node controller (NC) and the global controller (GC)]. After an introduction to related work, the architecture for the automatic management of virtualized resources across nodes in the cloud is given with its three control loops (VMC, respectively, NC, respectively, GC control loops) and then it is shown how the proposed architecture can be incorporated with market-based cloud computing. Thereafter, the system modelling and designs of each of the VMC, NC and GC are given in such a way that application SLOs are satisfied. A number of experiments are carried out to evaluate the feasibility and accuracy of VMC, NC and GC.

PC-Nash: QoS Provisioning Framework with Path-Classification Scheme Under Nash Equilibrium. KALIKA SUKSOMBOON, PANITA PONGPAIBOOL, YUSHENG JI AND CHAODIT ASWAKUL

The authors state that internet service providers (ISPs) need an efficient methodology to meet their customers' requirements while optimizing their network resources and that challenges arise because inter-domain networks are administered by multiple ISPs, the interaction policies of which can be subtle. Efficient provisioning of guaranteed quality of service (QoS) connections across inter-domain networks remain an open problem. Earlier approaches at dealing with QoS proposed proper cooperation and exchange of information among ISPs using path reservation information to both traffic engineering information across domains and to share QoS. However, these approaches face a problem because of the trade-offs between path reservation efficiency and the dissemination of information. This paper proposes to solve this problem by formulating the inter-domain routing problem as a non-cooperative problem. The non-cooperative ISPs call for a non-cooperative game theory. Therefore, this paper is focused on providing end-to-end QoS across multiple domains in the framework of a non-cooperative game with respect to Nash equilibrium. After an introduction to the network model used in this paper, three conventional path-provisioning policies are described. Then, the proposed QoS provisioning framework with path-classification scheme under Nash (PC-Nash) is given. PC-Nash partitions the set of all possible paths into path groups according to their QoS levels. PC-Nash is defined in three stages: QoS provisioning with a path-classification scheme, evaluation of a QoS-level selection and game-theoretical analysis of optimal QoS-level selection. An algorithm is given to find the PC-Nash performance. An accuracy evaluation is given for the three conventional path-provisioning policies and for PC-Nash using first a discrete-event simulation model followed by a performance evaluation of the four policies.

Bit Energy Consumption Minimization for Multi-path Routing in Ad Hoc Networks. MUSTAFA K. GURCAN, HADHRAMI AB GHANI, JIHAI ZHOU AND ANUSORN CHUNGTRAGARN

This paper states that currently no existing approach addresses the issue of significant residual energy inherent in multi-code high speed downlink packet access (HSDPA) systems. For this reason, the authors design an energy-aware disjoint routing discovery scheme as a multi-path routing technique for wireless ad hoc networks. A basic idea is that as the total transmission energy is limited, the energy consumption is a suitable path metric for discovering the routing paths. A resource allocation scheme is implemented to maximize the transmission rates in wireless ad hoc networks where multi-code HSDPA is in place by utilizing the residual energy. The scheme is called the two-group resource allocation scheme. Since the energy received at each node varies according to the distance of the wireless link between the transmitting node and the adjacent receiving node, the realizable data should vary and hence the use of the two-group resource allocation scheme is to maximize the varying rates over each wireless link. This allows to minimize the amount of energy consumed per bit for each routing path and to take the path metric to be the minimized energy consumption per bit achieved from maximizing the link data rates via the two-group resource allocation algorithm. Two methods are developed to discover multiple least-cost routing paths: the trellis-hop diagram routing discovery scheme and an improved version of it, the modified Viterbi algorithm. Different transmission schemes are tested.

ID Repetition in Structured P2P Networks. JIE YU, ZHOUJUN LI, PENG XIAO, CHENGFANG FANG, JIA XU AND EE-CHIEN CHANG

A structured P2P network employs a distributed hash table (DHT) to map a peer to the hash space and map an object [which usually has an identity (ID) which may or may not be unique] to one or multiple peers. Since uniqueness is not enforced it leads to the question whether sharing and repetition of ID exist in DHT-based systems. This paper states that a significant amount of repetition exists in DHT networks (e.g. Kad and Mainline) when ID uniqueness is essential in DHT-based systems. Furthermore, without taking repetition into account, modelling on DHTs might be distorted and parameters may not perform as expected. This paper studies the effect of ID repetition concentrating more on Kad rather than on Mainline. After an overview of the backgrounds, of Kad and Mainline, related work is introduced and this is followed by a measurement of ID distribution in Kad and Mainline to show ID repetition on these DHT networks. Thereafter, repetition is analysed in an attempt to find the reasons why around half of Kad peers in routing tables do not respond to BOOTSTRAP request messages and why the fraction of repetitions among peers in routing tables is much larger than that among active peers. The effects of genuine ID repetition on routing, publishing and searching are investigated. It is shown that ID repetition will reduce the performance of Kad by increasing the possibility of a failure in searching for a published key. Finally, the mitigation to this repetition is discussed.

Fault Tolerance in Data Gathering Wireless Sensor Networks. GUANGYAN HUANG, YANCHUN ZHANG, JING HE AND JINLI CAO

Data gathered by wireless sensor networks (WSN) should be of high quality without loss of important information. Data loss in WSN can be reduced by tolerating link and node failures. However, fault tolerance (FT) techniques require lots of energy and time to detect and recover failure. This paper proposes a Dual Cluster Heads Cooperation (CoDuch) scheme to reduce data loss and minimize extra cost spending on FT. CoDuch is said to reduce data loss from p to p^2

$(0 \leq p \leq 1)$ where p is the link error rate, does not require much extra cost to gather data, and can detect and tolerate both link and node faults. After an introduction to the needed preliminaries and the related work, the CoDuch scheme for cluster-based data gathering is introduced and two algorithms are developed for implementing FT in CoDuch. The first algorithm tolerates link faults whereas the second tolerates both link and node faults. Thereafter, a dependability theory is developed to improve both internal and external dependability in CoDuch and to achieve the lowest data loss rate. Energy dissipation for FT is analysed and it is shown that CoDuch consumes less energy than the so-called Dual-Homed Routing (DHR) system. The effectiveness and efficiency of CoDuch are demonstrated through experiments which analyse the energy and time spent on improving dependability. It is shown that the two proposed algorithms exceed both LEACH and DHR in tolerating link/node faults in terms of the number of lost packets per round and data loss rate.

A Depth-optimal Low-complexity Distributed Wireless Multicast Algorithm. A. SINAN AKYUREK AND ELIF UYSAL-BIYIKOGLU

Rather than sending data along unicast routes to each destination, a multicast route is constructed which makes efficient use of the wireless links, avoids bottlenecks and maximizes energy efficiency by keeping the number of forwarding nodes (NFN) low while preserving low delay for each destination. This paper develops an algorithm that keeps the depth of a destination node to a minimum while keeping the NFN as low as possible. In order to do so, one needs to revisit the so-called wireless multicast tree (WMT) problem which is NP-complete. This problem involves finding a routing tree with the minimum number of transmissions needed to reach all destinations. This paper presents a WMT construction algorithm which constructs a tree on which each multicast destination has the minimum possible depth. The Source-initiated Wireless Multicast (SWIM) algorithm is depth optimal in both single- and multiple-source cases. After a review of the related work, the SWIM algorithm is presented which works in two phases (level setting and tree formation). The correctness and computational complexity of SWIM are studied. Thereafter, it is shown that SWIM is optimal in terms of minimizing the hop count of any node from the source and hence, SWIM is depth optimal. The performance of SWIM is studied with respect to three aspects: delay and delivery ratio simulations, tree depth simulations and NFN simulations. Finally, a method to use existing table-based unicast algorithms for SWIM tree construction is given followed by an extension for dynamic networks.