Université Concordia University Montréal

31st Biennial Symposium on Communication (BSC 2023)

Welcome!

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4 - 7 July 2023

http://infotheory.ca/bsc2023/

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List of Abstract

Wednesday, July 5

Integrated Sensing and Multi-Access Computation Offloading in Smart Oceans: A Utility Maximization Design

Minghui Dai; Ning Huang; Yuan Wu; Liping Qian; Bin Lin; Zhou Su

With the increasing exploration of smart oceans, a large number of marine wireless devices have been deployed for different marine applications such as ocean environment monitoring and seabed resource exploitation. Although the paradigm of marine edge computing networks is expected to process a variety of marine tasks with low delay and high data rate, the efficiency of computation offloading is a critical issue due to the complex environment in smart oceans. In this paper, we propose an integrated sensing and multi-access computation offloading scheme in smart oceans, with the objective of maximizing marine wireless devices' utilities. Specifically, underwater wireless sensor (UWS) first perceives ocean information via radar sensing and then uploads its workloads to an unmanned underwater vehicle (UUV) and a sea surface sink node (SN) via non-orthogonal multiple access (NOMA) transmission. To improve the offloading efficiency, we formulate the utility of each party and model the task offloading process among UWS, UUV and SN as a Stackelberg game to optimize the UWS's offloading strategy, UUV's and SN's price strategies. Numerical results demonstrate that the proposed algorithms can obtain the optimal solutions and increase the utilities for marine wireless devices.

Paper Link: http://infotheory.ca/bsc2023/papers/p1-dai.pdf

Optimum Digital Twin Response Time for Time-Sensitive Applications

Amirhosein Aghaei; Dongmei Zhao

As the digital replica of a physical system (PS), a digital twin (DT) is responsible for providing real-time information of its PS to applications. However, random network conditions result in uncertainty in future age of information (AoI) at the DT, which makes it complicated for a DT to decide when to response an application request in order to maintain the best information freshness at the application. In this work, we consider the effect of random wireless channel condition between the PS and the DT on the AoI changes at the DT, and formulate a Markov decision process that finds the optimum response time for the DT to send the PS information to an application after receiving a request from the application. The objective is to minimize the average AoI at the application. The MDP has delayed reward, and is solved by redistributing the reward with LSTM network and then finding the optimal policies using Dueling Double Deep Q-learning. Numerical results show that the solutions provide close-to-optimum average AoI performance.

Paper Link: http://infotheory.ca/bsc2023/papers/p23-aghaei.pdf

Buffer-state Aware Task Offloading in Edge Networks With Task Splitting for IoV

Authors: Abbas Yekanlou; Ahmed I Salameh; Jun Cai

The expansion of internet of vehicles (IoV) to host new applications for end users (EUs), such as extended reality (XR) and in-vehicle streaming services, is restrained by the computing capacity available at the EUs locally. To accelerate IoV expansion and abate the computation capacity limitation at the EU side, edge computing (EC) has exploded in recent years. In this work, we devise a workframe to optimize task offloading (TO) and results caching from an EU to an edge network made of two EC nodes with the objective of queuing delay risk assessment to minimize task dropping and maximize earned task credit by the primary EC node. We first formulate an integer non-linear programming (INLP) problem. Then, an algorithm based on the genetics algorithm (GA) is proposed to solve the problem. Our results show that the proposed algorithm achieves the best performance in terms of average task execution time, dropping rate, and earned credit by the primary EC node compared to traditional task offloading methods.

Paper Link: http://infotheory.ca/bsc2023/papers/p145-yekanlou.pdf

A Pricing Model for Energy Transactions in a Blockchain-based Smart Grid with Game Theory

Yiwen Zhang; Ziyu Huang; Ting Li; Dajiang Chen; Zhiguang Qin

Smart grid integrate state-of-the-art communication, metering, and control technologies to address power imbalances and grid instability. Based on the current status and technology of the smart grid, we propose a comprehensive real-time pricing model based on user-side energy storage for demand response by using Stackelberg multi-party game. The experimental result shows that the proposed method can address power imbalances and grid instability to a great extent.

Paper Link: http://infotheory.ca/bsc2023/papers/p134-zhang.pdf

Entangled Pair Resource Allocation under Uncertain Fidelity Requirements

Rakpong Kaewpuang; Minrui Xu; Stephen J Turner; Dusit Niyato; Han Yu; Dong In Kim

In quantum networks, effective entanglement routing facilitates remote entanglement communication between quantum source and quantum destination nodes. Unlike routing in classical networks, entanglement routing in quantum networks must consider the quality of entanglement qubits (i.e., entanglement fidelity), presenting a challenge in ensuring entanglement fidelity over extended distances. To address this issue, we propose a resource allocation model for entangled pairs and an entanglement routing model with a fidelity guarantee. This approach jointly optimizes entangled resources (i.e., entangled pairs) and entanglement routing to support applications in quantum networks. Our proposed model is formulated using two-stage stochastic programming, taking into account the uncertainty of quantum application requirements. Aiming to minimize the total cost, our model ensures efficient utilization of entangled pairs and energy conservation for quantum repeaters under uncertain fidelity requirements. Experimental results demonstrate that our proposed model can reduce the total cost by at least 20% compared to the baseline model.

Paper Link: http://infotheory.ca/bsc2023/papers/p103-kaewpuang.pdf

Rate-Distortion-Perception Tradeoff Based on the Conditional Perception Measure

Sadaf Salehkalaibar; Buu Phan; Ashish Khisti; Wei Yu

In this paper, we study the rate-distortion-perception tradeoff generalizing the classical rate-distortion the ory by adding a perception constraint to generate visually pleasing reconstructions. The perception metric measures the divergence between the distributions of the input and the reconstruction when both distributions are conditioned on the encoder's output. This metric, originally introduced by Mentzer et al. for the video compression setting, is called as conditional perception measure. We characterize the rate-distortion-perception tradeoff for a general source. In the Gaussian setting, we show that jointly Gaussian reconstructions are indeed optimal. Interestingly, to achieve a perceptually perfect reconstruction, comparing to the minimum mean square error (MMSE) reconstruction, we only need extra 0.5 bits/sample for the compression rate.

Paper Link: http://infotheory.ca/bsc2023/papers/p121-salehkalaibar.pdf

A Novel Framework for Relating Quasi-Cyclic Codes and Quasi-Twisted Codes

Akram Saleh; M. Reza Soleymani

In this paper, we aim to analyze the algebraic structure of repeated-root quasi-cyclic codes of length $p^k n\ell$ and index l over the finite field $\mathbb{F}_q$, where k is a positive integer, q = p and (n, p) = 1. For this purpose, a quasi-cyclic code over $\mathbb{F}_q$ is regarded as a linear code over an auxiliary ring. By introducing a ring isomorphism, we provide a one-to-one correspondence between this class of quasi-cyclic codes and nonrepeated-root (1-u)-quasi-twisted codes of length nl and index l over the chain ring $\mathbb{F}_q + u\mathbb{F}_q + \cdots + u^{p^\kappa - 1}\mathbb{F}_q$, where $u^{p^k} = 0$. Our approach enables us to extend the results regarding non-repeated-root quasi-twisted codes over rings to repeated-root quasi-cyclic codes over finite fields. To illustrate the effectiveness of our method, we provide examples that demonstrate how it simplifies the structure of this class of codes.

Paper Link: http://infotheory.ca/bsc2023/papers/p7-saleh.pdf

Distributed Multi-Pair Computation for Intra C-RAN Bidirectional Communications

Mahmoud Hasabelnaby; Anas Chaaban

Cloud radio-access network (C-RAN) performance is limited by fronthaul capacity constraints. To alleviate this limitation, distributed processing between the distributed radio units (RUs) and the central processing unit (CPU) can be used to relax the communication overhead over the fronthaul links. In this paper, a distributed multi-pair computation approach is proposed for a C-RAN with intra-cloud bidirectional communication, wherein some user-pairs are served locally by an RU whereas others are served centrally at the CPU. The achievable end-toend rate is derived, optimized, and numerically evaluated under limited fronthaul capacity and power constraints. Numerical evaluations reveal the proposed scheme can overcome the fronthaul capacity limitation and significantly improve the achievable.

Paper Link: http://infotheory.ca/bsc2023/papers/p45-hasabelnaby.pdf

An Adaptive Modulation Coding Cross-Layer Optimization Strategy with Packet Successful Transmission and Delay Constraints

Taotao Tian; Xiaojie Fang; Lizhe Liu; Zunqi Li; Kaiwen Huang

Based on the analysis of the data link layer buffer queue state and the impact of application layer data flows on the physical layer of wireless communication nodes, this paper analyzes the restriction of communication link delay on the transmit power of nodes. Building on this analysis, a cross-layer optimization strategy is proposed with the goal of maximizing energy efficiency (EE), which selects the optimal adaptive modulation and coding (AMC) switching threshold and optimal power selection while considering the constraints of successful packet transmission rate and communication link delay. Finally, simulations are conducted to demonstrate the significant EE advantages of the proposed cross-layer optimization strategy.

Paper Link: http://infotheory.ca/bsc2023/papers/p57-tian.pdf

Non-Reciprocal RIS-Assisted Wireless Communications: Channel Modeling

Zahra Taheri; Mohammad Reza Soleymani; Gursimran Singh Sethi

Non-reciprocal reconfigurable intelligent surface (NR-RIS) has emerged as a promising technology for enhancing the performance of wireless communication systems. Unlike conventional RIS, NR-RIS can support asymmetric signal transmission, which enables different signal paths between the transmitter and receiver. In this paper, we investigate the potential of NRRIS-assisted wireless communication systems and analyze the impact of various system parameters on performance metrics, including the signal-to-noise ratio (SNR) and the bit error rate (BER). Specifically, we first develop a path loss model for a simple RIS-aided system, and we study the effect of different parameters, such as the number of RIS elements, and the distance between the base station, RIS, and user. We then derive a channel model for nonreciprocal RISs, and we study the effects of non-reciprocity on the channel coefficients and phase shift matrix at RIS in both uplink and downlink channels. Simulation results show that nonreciprocity can significantly affect the performance of RISaided systems and that a careful design of the RIS is necessary to achieve optimal performance.

Paper Link: http://infotheory.ca/bsc2023/papers/p140-taheri.pdf

Looping for Encryption Key Generation over the Internet: A New Frontier in Physical Layer Security

Amir K. Khandani

Current key sharing techniques rely on the hardness of solving a solvable, but complex, mathe-matical problem. This entails, in Information The oretical sense, the encryption key is not secret, it can be found by solving the underlying mathematical problem. Sensitive data we encrypt today using traditional techniques can be recorded by malicious parties and be deciphered in the future whenever improved hacking techniques and supporting computing technology permit. Information Theory proves the existence of methods for sharing of encryption keys that are unconditionally secure, but does not show how to bring such theoretical results to practical use. One of the central information theoretical approaches to key sharing is based on exploiting common randomness. This theoretical result states that if two dependent random variables, A and B, are available at Alice and Bob, then, by communicating through a public channel between A and B, it is possible to securely share a key of size $I(A;B)$To bridge the gap between theory and practice, one needs a method to generate two sets of dependent random variables, one at Alice's side and the other one at the Bob'side, as well as a method to extract two identical keys from these dependent random variables. This article presents a novel technique to achieve this goal over the Internet. Dependent random variables are generated by measuring packet travel times between Alice and Bob, and error-free key extraction from dependent random variables is realized by using a randomized Low Density Parity Check Code (LDPC). Through looping of packets between Alice and Bob, the mutual information between random variables is increased. Finally, methods are presented to measure the likelihood values required in

decoding the under- lying LDPC. It is shown that the key rate is approximately equal to $0.5\log_2\left(4L^2/(4L-1)\right) \approx 0.5\log_2(L)$ where L is the number of round trips (loops). Test results (based on measurements between distant nodes over the Internet) are presen ted, demonstrating the feasibility of the proposed technique. The proposed method is implemented entirely in software (through high-level programming, e.g., using C-language, at the application layer). This operation does not require modifying the underlying network.

Paper Link: http://infotheory.ca/bsc2023/papers/p128-khandani.pdf

Thursday, July 6

Optimizing Uniform Linear Arrays for Massive MIMO Applications

Elhamsadat Anarakifirooz; Sergey Loyka

Massive MIMO (mMIMO) systems with uniform linear arrays (ULA) are considered in the non-asymptotic regime, when the number of antennas is bounded. To reduce the complexity of implementation, the number of antennas and their spacing is optimized subject to signal-to-interference plus noise (SINR) constraints. While the resulting constrained optimization problems have difficult analytical structure (due to their nonconvex nature), a novel analytical approach is proposed and a number of globally-optimal solutions/designs are obtained. The proposed designs are robust, they do not require a precise knowledge of directions of arrival for interfering users and preserve other important properties of mMIMO.

Paper Link: http://infotheory.ca/bsc2023/papers/p17-anarakifirooz.pdf

A time-frequency analysis of real clean and noisy electrocardiogram signals

Nacéra Méziane; Dalila Meziane; Merouane Bouzid

The electrocardiogram (ECG) is one of the physiological signals which is part of multi-component nonstationary signals. In the past, the ECG signal was considered and studied in time or frequency domain independently. For that, the wavelet transform has been increasingly considered as a stronger time-frequency analysis and coding tool for those signals that might be contaminated by well known interferences such us the 50/60 Hz power line interference, the movement of electrodes and the breathing signal. In the present work, we developed a Discrete Wavelet Transform (DWT)-based algorithm to denoise the ECG signals from the different aforementioned interferences. Then, we graphically investigate the different components of the ECG waves presented by their spectrograms, time-frequency images and scalograms. The developed tools are applied on both clean and contaminated ECG signals acquired from an ECG acquisition system, we have parallely designed. The experimental results show firstly the performance of our denoising algorithm to totally remove almost kind of interferences. Secondly, the graphical analysis of the ECG signals has given a new interpretation different from that known in time or frequency analysis separately.

Paper Link: http://infotheory.ca/bsc2023/papers/p29-meziane.pdf

Compressive Sensing-Based Channel Estimation for MIMO OTFS Systems

Ali Mohebbi; Wei-Ping Zhu; M. Omair Ahmad

Orthogonal time frequency space (OTFS) modulation is a novel two-dimensional modulation technique that performs in the delay-Doppler (DD) domain. In this work, we present a new compressive sensing (CS)-based algorithm for estimating the channel in the DD domain for multiple-input multiple-output (MIMO) OTFS systems. Exploiting the property that the MIMO channel in the DD domain exhibits structured sparsity, we first obtain a row-block sparse formulation for channel estimation (CE) problem. Then, we propose a row-block orthogonal matching pursuit (RBOMP) algorithm to estimate the channel. Computer simulations demonstrate that the proposed algorithm enhances the estimation accuracy compared with the conventional minimum mean squared error (MMSE)-based and the existing CS-based CE techniques.

Paper Link: http://infotheory.ca/bsc2023/papers/p34-mohebbi.pdf

Improved Multi-stage Vector Quantizer Scheme for Transparent Coding of G.722.2 ISF Parameters

Merouane Bouzid; Nacéra Méziane; Salah Eddine Cheraitia

In this paper, we propose an improved version of the multi-stage vector quantizer (MSVQ) scheme designed for transparent coding of AMR-WB (ITU-T Rec. G.722.2) ISF parameters under noiseless channel conditions. Simulation results will show that the new ISF coding scheme, called ISFIMSVQ coder, performs better than the conventional ISF MSVQ and can save one bit per frame.

Paper Link: http://infotheory.ca/bsc2023/papers/p81-bouzid.pdf

Principal-Minimum Eigenvalue Algorithm for Signal Sensing

Yumin Zhong; Yanhua Li

This paper proposes a signal sensing method based on principal components to minimum of eigenvalue of the received signal. The signal model and theoretical performance analysis of the principal-minimum eigenvalue (PME) algorithm are provided in detail. A major advantage of the PME algorithm is that it does not need any prior information of noise or signal, making it highly promising in scenarios with uncertain noise power. To evaluate the performance of PME algorithm, simulations are made and compared with state-of-the-art algorithms, including energy detection (ED) algorithm, energy to minimum eigenvalue (EME) algorithm, maximum-minimum eigenvalue (MME) algorithm and arithmetic to geometric mean (AGM) algorithm. Simulation results show that the PME algorithm has superior performance under very low signal-noiseratio (SNR) signals, the performance of PME algorithm is close to the MME algorithm, and has advantages over other methods.

Paper Link: http://infotheory.ca/bsc2023/papers/p109-zhong.pdf

Edge-Coordinated On-Road Perception for Connected Autonomous Vehicles Using Point Cloud

Jiawei Hou; Peng Yang; Tian Qin; Wen Wu

In this paper, we tackle the problem of selecting connected autonomous vehicles (CAVs) with the most valuable point cloud data for edge-coordinated on-road perception. Through extensive experiments, we find that adding a CAV for collaborative perception yields diminishing gain in understanding the on-road environments, while the generated point cloud data size grows linearly with the number of employed CAVs. Meanwhile, both vehicular mobility and diversified road topology lead to the dynamics of data size of the captured point clouds. Based on those findings, we then formulate an optimization problem that maximizes the utility of collaborative perception at

edge nodes. Considering the submodularity of collaborative perception utility and heterogeneity of point cloud data size from individual vehicles, a CAV candidate selection algorithm is proposed. The marginal gain of processing the point cloud data of each candidate is firstly evaluated and ranked, based on which a subset of CAVs are selected subject to bandwidth capacity. Finally, experimental results on an open dataset are presented to demonstrate the superiority of the proposed algorithm under dynamic traffic conditions and bandwidth fluctuations.

Paper Link: http://infotheory.ca/bsc2023/papers/p85-hou.pdf

Worker Assignment in Deadline-aware Heterogeneous Distributed Computing Systems

Mehrad Mehrabi; Maryam Ardakani; Masoud Ardakani

Recently, distributed computing systems have become prevalent due to their capability to handle large-scale computations required by emerging machine learning algorithms and signal processing tasks. In real-world scenarios, these systems often encounter multiple tasks that must be completed within specific deadlines. Furthermore, service providers may offer different levels of service based on their users' subscription tiers. In this study, we focus on the assignment of workers in a heterogeneous coded distributed computing system that comprises multiple masters with distinct subscription tiers. Each master is responsible for a time-sensitive matrix-vector multiplication task that must be completed before a given deadline. The system receives rewards for finishing tasks prior to their deadlines and gives higher priority to tasks associated with higher subscription tiers. Our objective is to devise a worker assignment policy that maximizes the overall reward of the system. To achieve this, we propose a worker assignment policy called "reward greedy." Through simulation results, we demonstrate that our proposed algorithm achieves performance very close to that of a brute-force search while exhibiting significantly lower complexity.

Paper Link: http://infotheory.ca/bsc2023/papers/p97-mehrabi.pdf

Edge-Assisted Video Transmission with Adaptive Key Frame Selection: A Hierarchical DRL Approach

Wenjie Zhu; Ruoyang Chen; Changyan Yi; Jun Cai

This paper proposes a novel hierarchical deep reinforcement learning (HDRL) framework for edge-assisted realtime video transmission in Industrial Internet of Things (IIoT). The system model consists of a gateway, multiple edge servers, and a central controller. The gateway performs key frames selection to compress video chunks from terminal cameras, which are then transmitted through multi-hop links to edge servers for video analysis. The central controller determines the key frames selection and routing path for each video chunk to minimize the transmission delay while ensuring video data accuracy. Different from the existing work, we investigate video transmission under system dynamics that the bandwidth of each link is time-varying and both real-time and accuracy requirements of each chunk are unpredictable. We decompose such problem into routing path and key frames selection sub-problems. To this end, we introduce a deep Q network-based optimal routing approach and an adaptive key frames selection approach to solve the two subproblems, respectively. An HDRL training framework is further developed to integrate these two approaches jointly for improving the overall performance. Simulation results show the superiority of the proposed solution over counterparts.

Paper Link: http://infotheory.ca/bsc2023/papers/p75-zhu.pdf

Joint Computation Offloading and Energy Trading in Electric Vehicular Networks

Weiyang Feng; Xiao Xiao; Siyu Lin; Ashab Uddin; Niloofar Naghdi Pour; Ning Zhang

With the rising number of electric vehicles (EVs), the high computational task and energy management of vehicles bring great challenges to the intelligent transportation system. In this work, we investigate the joint offloading and

energy trading strategy in vehicular edge computing (VEC) network. We propose an offloading-trading framework, in which EVs can offload tasks to road side unit (RSU) equipped with edge servers or Energy Fog Center (EFC), i.e, edge nodes and fog nodes, and sell excess power to EFC through Vehicle-to-grid (V2G) technology to improve energy efficiency. We aim to maximize the system utility while satisfying the offloading-trading requirements. Since the original problem is non-convex, we decompose it into two subproblems, i.e., trading energy subproblem and trading-offloading subproblem, and proposed the Farthest and Nearest Comparison Searching (FNC-S) algorithm. Specifically, we derive the closed-form expressions of trading electric energy in the trading energy subproblem. Besides, trading-offloading strategy is obtained at two boundaries of distance based on optimal moving distance searching in the trading-offloading subproblem. Simulation results show that the proposed FNCS algorithm can significantly improve the utility compared with other baseline schemes.

Paper Link: http://infotheory.ca/bsc2023/papers/p91-feng.pdf

Friday, July 7

Towards Modeling Computation Capacity of a Vehicular Cloud while Overcoming Resource Volatility

Chinh Tran; Mustafa Mehmet-Ali

Future vehicles will become computationally more powerful to be safer, more autonomous, and more convenient for passengers. However, the computing resources onboard the vehicles will often be underutilized and can be pooled to form a computing cluster called vehicular cloud (VC). The VC operators inherently would like to know the capabilities of the VC to predict its performance adequately. Since the vehicles are mobile, their residency time in the VC will be random. As a result, resources in the VC will be volatile. In this work, we analyze computing capacity of a VC while overcoming its volatility characteristics. We assume that computing jobs consist of random number of tasks that can be executed independently. A job is completed when execution of all its tasks are completed. We employ a service strategy that assigns each task to a single vehicle. Further, a task is assigned to a vehicle only if the vehicle can complete its execution during the vehicle's residency time. Using a stochastic modeling approach, we provide a tractable solution to the distribution of the number of completed jobs during the lifetime of a VC, which often cannot be obtained through other approaches. Then we employ the Monte Carlo simulation method to verify the numerical results from the analytical model.

Paper Link: http://infotheory.ca/bsc2023/papers/p11-tran.pdf

High-Reliability, Low-Latency, and Load-Balancing Multipath Routing for LEO Satellite Networks

Yufei Wang; Lin Cai; Jun Liu

Being a critical part of the sixth generation mobile networks (6G) infrastructure, satellite networks have rapidly developed in recent years. With the increasing number of satellites and high mobility, the challenges of Ultra-Reliable and Low-Latency (URLL) services are increasingly prominent. The regular topology and orbital movement of low earth orbit (LEO) satellites present a new opportunity for the design of network routing for URLL services. In this paper, we propose a High-Reliability, Low-Latency, and Load-Balancing Multipath Routing (HLLMR) to

support URLL services for LEO satellite networks. To ensure the reliability of satellite network transmission, a packet is transmitted through multiple paths. The path and link selection strategy avoids hotspots through load balancing to ensure end-to-end reliability and delay and minimize the link cost. Using the Starlink constellation, we illustrate the advantages of HLLMR routing in terms of delay and reliability.

Paper Link: http://infotheory.ca/bsc2023/papers/p40-wang.pdf

Millimeter Wave Full-Duplex Networks: MAC Design and Throughput Optimization

Shengbo Liu; Wen Wu; Liqun Fu; Kaige Qu; Qiang Ye; Weihua Zhuang; Sherman Shen

Full-duplex (FD) technique can remarkably boost the network capacity in the millimeter wave (mmWave) bands by enabling simultaneous transmission and reception. However, due to directional transmission and large bandwidth, the throughput and fairness performance of a mmWave FD network are affected by deafness and directional hidden-node (HN) problems and severe residual self-interference (RSI). To address these challenges, this paper proposes a directional FD medium access control protocol, named DFDMAC to support typical directional FD transmission modes by exploiting FD to transmit control frames to reduce signaling overhead. Furthermore, a novel busy-tone mechanism is designed to avoid deafness and directional HN problems and improve fairness of channel access. To reduce the impact of RSI on link throughput, we formulate a throughput maximization problem for different FD transmission modes and propose a power control algorithm to obtain the optimal transmit power. Simulation results show that the proposed DFDMAC can improve the network throughput and fairness by over 60% and 32%, respectively, compared with the existing MAC protocol in IEEE 802.11ay. Moreover, the proposed power control algorithm can effectively enhance the network throughput.

Paper Link: http://infotheory.ca/bsc2023/papers/p114-liu.pdf

An Analysis of DHCP Vulnerabilities, Attacks, and Countermeasures

Abdulaziz Abdulghaffar; Sumit Kumar Paul; Ashraf Matrawy

A large number of devices use the Dynamic Host Control Protocol (DHCP) protocol to obtain network configurations like IP address, gateway, Domain Name System (DNS) address, etc. However, the security aspect was not considered thoroughly during its design phase. As a result, it has several very lucrative vulnerabilities to many attackers. In this analysis, we discuss the major vulnerabilities of the DHCP protocol that can result in different attacks. These vulnerabilities include a lack of authentication, confidentiality, and integrity. We also explain different attacks that can be performed by exploiting these vulnerabilities, like rogue DHCP server attacks, DHCP starvation attacks, or replay attacks. Furthermore, we summarize the countermeasures proposed by the researchers to nullify and mitigate these attacks. Moreover, the advantages and drawbacks of the countermeasures are also discussed in this paper.

Paper Link: http://infotheory.ca/bsc2023/papers/p51-abdulghaffar.pdf

A Buffer Occupancy Estimation Model for Opportunistic Networks

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When designing routing schemes for opportunistic networks (OppNets), node's buffer congestion is one of the major concerns. Most buffer management schemes for OppNets are reactive ones, which require that more messages be transmitted. In this paper, a Buffer Occupancy Estimation Model (denoted BOEM) for OppNets is proposed, which uses the Chernoff's bound to estimate the expected buffer occupancy of any node without involving the communication of messages. Through simulations using both the realistic and synthetic mobility models, the effectiveness of the proposed model is proven, showing that it can significantly reduce the overall quantity of messages sent while leading to reduce node's buffer congestion.

Paper Link: http://infotheory.ca/bsc2023/papers/p63-singh.pdf

Adaptive Application Deployment for Multi-Access Edge Computing Based on Mobility Prediction

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In this paper, the proactive application deployment based on mobility prediction for multi-access edge computing (MEC) is studied. Since mobility prediction is commonly imperfect, there is an inherent conflict between the prediction accuracy and the prediction duration (i.e., the length of time ahead). As a result, proactively deploying applications for MEC based on a shorter (longer) term mobility prediction may lead to a higher (lower) accuracy, and thus reduces (increases) the service delay while suffers (avoids) from a larger deployment cost. To strike such balance, we propose a novel adaptive application deployment scheme, taking the mobility predictions of different mobile users in multiple future time periods as the input, for optimizing their corresponding application deployments (i.e., which applications should be deployed on which edge nodes and how long they should be deployed in advance). Specifically, a residual LSTM framework is utilized for mobility prediction, and based on this, a low-complexity greedy algorithm is developed. Simulation shows the feasibility of the proposed scheme and demonstrate its superiority over counterparts.

Paper Link: http://infotheory.ca/bsc2023/papers/p69-wang.pdf