The Scanning the Literature column provides concise summaries of selected papers that are recently published in the field of networking. Each summary describes the paper's main idea, methodology and technical contributions. The purpose of the column is to bring the state-of-art of networking research to readers of *IEEE Network*. Authors are also welcome to recommend their recently published work to the column, and papers with novel ideas, solid work and significant contributions to the field are especially appreciated. Authors wishing to have their papers presented in the column should contact the editor.

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Mobile Internet has been part of our daily life, providing access to a broad spectrum of Internet services through wireless and mobile network infrastructures. However, the hybrid wireless and wired network fabric increases the complexity of network diagnosis, where it is difficult to locate the glitches incurring the network performance degradation. The column in this issue focuses recent advancement in network diagnosis, which is an important tool to ensure networks' smooth operations. We pay special attention to the work that enables performance degradation detection and prediction utilizing mobile data analysis, which provides a promising methodology for network diagnosis due to the convenience and low cost.

The popularity of mobile devices and mobile applications have changed the way users access and utilize the network. Nowadays, 84 percent of apps require permission for Internet access from a pool of 55,000 Android apps randomly picked from the official Android app market. Consequently, understanding mobile network performance is crucial for providing good quality of experience (QoE) to users. In the following paper, Li *et al.* show their method of network delay measurement.

Toward Accurate Network Delay Measurement on Android Phones

Weichao Li, Daoyuan Wu, Rocky K. C. Chang, and Ricky K. P. Mok, IEEE Transactions on Mobile Computing, Vol. 17, No. 3, pp. 717–732, Aug. 2017.

In this paper, the authors appraise the accuracy of smartphone-based network performance measurement using the Android platform and the network round-trip time (RTT) as the metric. It shows that two of the most popular measurement apps — Ookla Speedtest and MobiPerf — have inflated RTT measurements. The authors build three test apps for three common measurement methods and evaluate them in a testbed, where they overcome the challenge of obtaining a complete trace of packets. Their multi-layer analysis reveals that the delay inflation can be introduced in both the user space and kernel space. The long path of sub-function invocations accounts for the majority of the delay overhead in the Android runtime (both Dalvik VM and ART), and the sleeping functions in the drivers are the major source of the delay overhead between the kernel and the physical layer. The authors propose and implement a measurement app to mitigate the delay overhead in the Android runtime, and the resulting delay inflation in the user space can be kept under 1.5 ms for almost all cases.

MobileInsight: Extracting and Analyzing Cellular Network Information on Smartphones

Yuanjie Li, Chunyi Peng, Zengwen Yuan, Jiayao Li, Haotian Deng, and Tao Wang, Proc. MobiCom, New York City, NY, Oct. 3–7, 2016.

The paper designs and implements MOBILEINSIGHT, a software tool that can collect, analyze, and exploit runtime network information from operational cellular networks. MOBILEINSIGHT runs on commercial off-the-shelf phones without extra hardware or additional support from operators. It exposes protocol messages on both the control plane and data plane from the 3G/4G chipset. It provides in-device protocol analysis and operation logic inference. It further offers a simple application programming interface, through which developers and researchers obtain access to information of underlying network infrastructure for their mobile applications. The authors have built three showcases to illustrate how MOBILEINSIGHT is applied to cellular network research.

Cellular network users using data services expect high end-to-end (E2E) performance, and it is critical for cellular service providers to maintain their competitive edge. In the context of cellular data services, E2E performance means the performance that customers experience for a specific location, content provider, device type, and application type. In the following paper, Ahmed *et al.* show their work, which can localize the root cause of E2E performance degradation.

Detecting and Localizing End-to-End Performance Degradation for Cellular Data Services

Faraz Ahmed, Jeffrey Erman, Zihui Ge, Alex X. Liu, Jia Wang, and He Yan, Proc. INFOCOM, San Francisco, CA, Apr. 10–14, 2016..

The authors propose a holistic approach to detecting and localizing E2E performance degradation at cellular service providers across the four dimensions of user locations, content providers, device types, and application types. First, the authors use training data to build models that can capture the normal performance of every E2E instance, which means flows corresponding to a specific location, content provider, device type, and application type. Second, the authors use their models to detect performance degradation for each E2E instance on an hourly basis. Third, after each E2E instance has been labeled as non-degrading or degrading, the authors use association rule mining techniques to localize the source of performance degradation. Their system detected performance degradation instances over a period of one week. In 80 percent of the detected degraded instances, content providers, device types, and application types were the only factors of performance degradation.

Mobile video streaming has become increasingly popular in recent years. It now dominates cellular traffic, accounting for 60 percent of all mobile data traffic and is predicted to grow to 78 percent by 2021. However, delivering good QoE over cellular networks is technically challenging. A recent Internet-scale study indicates that 26 percent of smartphone users face video streaming QoE problems daily. To solve this problem, Xu *et al.* present their research in the following paper.

Dissecting VOD Services for Cellular: Performance, Root Causes and Best Practices

Shichang Xu, Z. Morley Mao, Subhabrata Sen, Yunhan Jia, and Jiming Chen, PROC. IMC, London, U.K., Nov. 1–3, 2017.

This paper conducts a detailed measurement study of a wide cross-section of popular streaming video-on-demand (VOD) services to develop a holistic understanding of these services'

design and performance. The authors identify performance issues and develop effective practical best practice solutions to mitigate these challenges. By extending the understanding of how different, potentially interacting components of service design impact performance, their findings can help developers build streaming services with better performance.

There has been a dramatic rise in the volume of HTTP-based adaptive video streaming traffic in recent years. Delivering good application-level video QoE entails new metrics such as low buffering and smooth bit rate delivery. To meet these new application-level QoE goals, video players need intelligent bit rate selection and adaptation algorithms. The following paper bridges this gap of systematically quantifying real-world throughput predictability and developing good prediction algorithms.

CS2P: Improving Video Bitrate Selection and Adaptation with Data-Driven Throughput Prediction

Yi Sun, Xiaoqi Yin, Junchen Jiang, Vyas Sekar, Fuyuan Lin, Nanshu Wang, and Tao Liu, Proc. SIGCOMM, Florianopolis, Brazil, Aug. 22–26, 2016.

This paper makes three contributions. First, the authors analyze the throughput characteristics in a dataset with 20M+ sessions. The authors find:

• Sessions sharing similar key features (e.g., ISP, region) present similar initial throughput values and dynamic patterns.

• There is a natural "stateful" behavior in throughput variability within a given session.

Second, building on these insights, the authors develop CS2P, a throughput prediction system which uses a data-driven approach to learn

•Clusters of similar sessions

•An initial throughput predictor

•A hidden-Markov-model-based midstream predictor modeling the stateful evolution of throughput

Third, the authors develop a prototype system and show using trace-driven simulation and real-world experiments that:

• CS2P outperforms existing prediction approaches by 40 and 50 percent in terms of the median prediction error for initial and midstream throughput.

• CS2P achieves 3.2 percent improvement on overall QoE and 10.9 percent higher average bit rate over the state-of-the-art Model Predictive Control (MPC) approach, which uses harmonic mean for throughput prediction.

Unveiling network and service performance issues in complex and highly decentralized systems such as the Internet is a major challenge. Indeed, the Internet is based on decentralization and diversity. However, its distributed nature leads to operational brittleness and difficulty in identifying the root causes of performance degradation. In such a context, network measurements serve as a fundamental pillar to shed light on and unveil design and implementation defects. To tackle this fragmentation and visibility problem, Casas *et al.* propose their solution in the following paper.

Unveiling Network and Service Performance Degradation in the Wild with mPlane

Pedro Casas, Pierdomenico Fiadino, Sarah Wassermann, and Stefano Traverso, IEEE Communications Magazine, Vol. 54, No. 3, pp. 71–79, Mar. 2016.

This paper conceives the mPlane, a distributed measurement platform that runs, collects, and analyzes traffic measurements to study the operation and functioning of the Internet. In this paper, the authors show the potential of the mPlane approach to unveil network and service degradation issues in live operational networks, involving both fixed-line and cellular networks. In particular, the authors combine active and passive measurements to troubleshoot problems in end-customer Internet access connections, or to automatically detect and diagnose anomalies in Internet-scale services (e.g., YouTube) that impact a large number of end users.

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