Publications Record

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Research summary

I have a multi-disciplinary publication record in the areas of Network Functions Virtualization (NFV), Software-Defined Networking (SDN), Wireless & Cellular Networks, as well as Machine Learning (ML). My research is published at top systems conferences, i.e., USENIX NSDI 2018, ACM CoNEXT 2019, USENIX NSDI 2022, and journals, i.e., ACM Transactions on Computer Systems (TOCS) 2021. My latest research is featured in the ACM Technews, PHYS.ORG, ECN, KTH, and APNIC.

I have been serving as a reviewer for scientific journals, such as IEEE/ACM Transactions on Networking and Elsevier Computer Networks. Since 2010, I have been participating in 17 (mainly EU) research projects, with my recent focus being on beyond 5G (6G) communications, sensor networks, and cloud & edge computing.

Summary of scientific metrics

Scientific metrics taken on June 08, 2023			
Citation database	**# of citations**		**h-index**
	Total	**Since 2018**	
Google scholar	446	399	9
Scopus	216	197	6

Scientific contributions in NFV and SDN

Conferences

C01 Latest Demo **P5: Event-driven Policy Framework for P4-based Traffic Engineering** [1] - **International Conference on High Performance Switching and Routing (HPSR) 2023**

We present P5; an event-driven policy framework that allows network operators to realize end-to-end policies on top of P4-based data planes in an intuitive and effective manner. We demonstrate how P5 adheres to a service-level agreement (SLA) by applying P4-based traffic engineering with latency constraints.

C02 Top Awarded **Packet Order Matters! Improving Application Performance by Deliberately Delaying Packets** [2] - **USENIX Conference on Networked Systems Design and Implementation (NSDI) 2022**

Data centers increasingly deploy commodity servers with high-speed network interfaces to enable low-latency communication. However, achieving low latency at high data rates crucially depends on how the incoming traffic interacts with the system's caches. When packets that need to be processed in the same way are consecutive, i.e., exhibit high temporal and spatial locality, caches deliver great benefits. In this paper, we systematically study the impact of temporal and spatial traffic locality on the performance of commodity servers equipped with high-speed network interfaces. Our results show that (i) the performance of a variety of widely deployed applications degrades substantially with even the slightest lack of traffic locality, and (ii) a traffic trace from our organization reveals poor traffic locality as networking protocols, drivers, and the underlying switching/routing fabric spread packets out in time (reducing locality). To address these issues, we built Reframer, a software solution that deliberately delays packets and reorders them to increase traffic locality. Despite introducing μs-scale delays of some packets, we show that Reframer increases the throughput of a network service chain by up to 84% and reduces the flow completion time of a web server by 11%, while improving its throughput by 20%.

C03 **Demonstration of Zero-touch Device and L3-VPN Service Management using the TeraFlow Cloud-native SDN Controller [3] - Optical Fiber Communication Conference (OFC) 2022**

We demonstrate zero-touch device bootstrapping, monitoring, and L3-VPN service management using the novel TeraFlow OS SDN controller prototype. TeraFlow aims at producing a cloud-native carrier-grade SDN controller offering scalability, extensibility, high-performance, and high-availability features.

C04 **What You Need to Know About (Smart) Network Interface Cards [4] - International Conference on Passive and Active Network Measurement (PAM) 2021**

Network interface cards (NICs) are fundamental components of modern high-speed networked systems, supporting multi-100 Gbps speeds and increasing programmability. Offloading computation from a server's CPU to a NIC frees a substantial amount of the server's CPU resources, making NICs key to offer competitive cloud services. Therefore, understanding the performance benefits and limitations of offloading a networking application to a NIC is of paramount importance. In this paper, we measure the performance of four different NICs from one of the largest NIC vendors worldwide, supporting 100 Gbps and 200 Gbps. We show that while today's NICs can easily support multi-hundred-gigabit throughputs, performing frequent update operations of a NIC's packet classifier—as network address translators (NATs) and load balancers would do for each incoming connection—results in a dramatic throughput reduction of up to 70 Gbps or complete denial of service. Our conclusion is that all tested NICs cannot support high-speed networking applications that require keeping track of a large number of frequently arriving incoming connections. Furthermore, we show a variety of counter-intuitive performance artefacts including the performance impact of using multiple tables to classify flows of packets.

C05 **TeraFlow: Secured Autonomic Traffic Management for a Tera of SDN flows [5] - Joint European Conference on Networks and Communications 6G Summit (EuCNC/6G Summit) 2021**

TeraFlow proposes a new type of secure, cloud-native Software Defined Networking (SDN) controller that will radically advance the state-of-the-art in beyond 5G networks by introducing novel micro-services architecture, and provide revolutionary features for both flow management (service layer) and optical/microwave network equipment integration (infrastructure layer) by adapting new data models. TeraFlow will also incorporate security using Machine Learning (ML) and forensic evidence for multi-tenancy based on Distributed Ledgers. Finally, this new SDN controller shall be able to integrate with the current Network Function Virtualization (NFV) and Multi-access Edge Computing (MEC) frameworks as well as to other networks. The target pool of TeraFlow stakeholders expands beyond the traditional telecom operators towards edge and hyperscale cloud providers.

C06 **Cloud-Native SDN Network Management for Beyond 5G Networks with TeraFlow [6] - Joint European Conference on Networks and Communications 6G Summit (EuCNC/6G Summit) 2021**

TeraFlow proposes a novel secured transport Software Defined Networking (SDN) controller based on a microservice architecture. The objective is to foster innovation around SDN controller and evolve them to be suitable for beyond 5G networks. This paper presents two TeraFlow scenarios that involve automated network management to demonstrate its feasibility. The first scenario focuses on the necessary transformation of a network operator to support beyond 5G technologies. From edge, up to the transport network, SDN controllers need to include more dinamicity to support operator requirements for new types of connectivity services. The second scenario demonstrates interdomain connectivity services in an automotive scenario. In this scenario, novel techniques for domain interconnection will be studied, as well as the load balancing of the connectivity service requests will be evaluated at cloud-scale.

C07 **Top** **RSS++: load and state-aware receive side scaling [7] - International Conference on Emerging Networking Experiments And Technologies (CoNEXT) 2019**

While the current literature typically focuses on load-balancing among multiple servers, in this paper, we demonstrate the importance of load-balancing within a single machine (potentially with hundreds of CPU cores). In this context, we propose a new load-balancing technique (RSS++) that dynamically modifies the receive side scaling (RSS) indirection table to spread the load across the CPU cores in a more optimal way. RSS++ incurs up to 14x lower 95 th percentile tail latency and orders of magnitude fewer packet drops compared to RSS under high CPU utilization. RSS++ allows higher CPU utilization and dynamic scaling of the number of allocated CPU cores to accommodate the input load while avoiding the typical 25% over-provisioning. RSS++ has been implemented for both (i) DPDK and (ii) the Linux kernel. Additionally, we implement a new state migration technique which facilitates sharding and reduces contention between CPU cores accessing per-flow data. RSS++ keeps the flow state by groups that can be migrated at once, leading to a 20% higher efficiency than a state of the art shared flow table.

C08 **Top** **Most-cited** **Metron: NFV Service Chains at the True Speed of the Underlying Hardware [8] - USENIX Conference on Networked Systems Design and Implementation (NSDI) 2018**

In this paper we present Metron, a Network Functions Virtualization (NFV) platform that achieves high resource utilization by jointly exploiting the underlying network and commodity servers' resources. This synergy allows Metron to: (i) offload part of the packet processing logic to the network, (ii) use smart tagging to setup and exploit the affinity of traffic classes, and (iii) use tag-based hardware dispatching to carry out the remaining packet processing at the speed of the servers' fastest cache(s), with zero inter-core communication. Metron also introduces a novel resource allocation scheme that minimizes the resource allocation overhead for large-scale NFV deployments. With commodity hardware assistance, Metron deeply inspects traffic at 40 Gbps and realizes stateful network functions at the speed of a 100 GbE network card on a single server. Metron has 2.75-6.5x better efficiency than OpenBox, a state of the art NFV system, while ensuring key requirements such as elasticity, fine-grained load balancing, and flexible traffic steering.

Journals

J01 **Top** **Metron: High-Performance NFV Service Chaining Even in the Presence of Blackboxes [9] - ACM Transactions on Computer Systems 2021**

Deployment of 100 Gigabit Ethernet (GbE) links challenges the packet processing limits of commodity hardware used for Network Functions Virtualization (NFV). Moreover, realizing chained network functions (i.e., service chains) necessitates the use of multiple CPU cores, or even multiple servers, to process packets from such high speed links. Our system Metron jointly exploits the underlying network and commodity servers' resources: (i) to offload part of the packet processing logic to the network, (ii) by using smart tagging to setup and exploit the affinity of traffic classes, and (iii) by using tag-based hardware dispatching to carry out the remaining packet processing at the speed of the servers' cores, with zero inter-core communication. Moreover, Metron transparently integrates, manages, and load balances proprietary "blackboxes" together with Metron service chains. Metron realizes stateful network functions at the speed of 100 GbE network cards on a single server, while elastically and rapidly adapting to changing workload volumes. Our experiments demonstrate that Metron service chains can coexist with heterogeneous blackboxes, while still leveraging Metron's accurate dispatching and load balancing. In summary, Metron has (i) 2.75–8× better efficiency, up to (ii) 4.7× lower latency, and (iii) 7.8× higher throughput than OpenBox, a state-of-the-art NFV system.

J02 **Profiling and accelerating commodity NFV service chains with SCC [10] - Elsevier Journal of Systems and Software 2017**

Recent approaches to network functions virtualization (NFV) have shown that commodity network stacks and drivers struggle to keep up with increasing hardware speed. Despite this, popular cloud networking services still rely on commodity operating systems (OSs) and device drivers. Taking into account the hardware underlying of commodity servers, we built an NFV profiler that tracks the movement of packets across the system's memory hierarchy by collecting key hardware and OS-level performance counters. Leveraging the profiler's data, our Service Chain Coordinator's (SCC) run-time accelerates user-space NFV service chains, based on commodity drivers. To do so, SCC combines multiplexing of system calls with scheduling strategies, taking time, priority, and processing load into account. By granting longer time quanta to chained network functions (NFs), combined with I/O multiplexing, SCC reduces unnecessary scheduling and I/O overheads, resulting in three-fold latency reduction due to cache and main memory utilization improvements. More importantly, SCC reduces the latency variance of NFV service chains by up to 40x compared to standard FastClick chains by making the average case for an NFV chain to perform as well as the best case. These improvements are possible because of our profiler's accuracy.

J03 **SNF: Synthesizing high performance NFV service chains [11] - PeerJ Computer Science 2016**

In this paper we introduce SNF, a framework that synthesizes (S) network function (NF) service chains by eliminating redundant I/O and repeated elements, while consolidating stateful cross layer packet operations across the chain. SNF uses graph composition and set theory to determine traffic classes handled by a service chain composed of multiple elements. It then synthesizes each traffic class using a minimal set of new elements that apply single-read-single-write and early-discard operations. Our SNF prototype takes a baseline state of the art network functions virtualization (NFV) framework to the level of performance required for practical NFV service deployments. Software-based SNF realizes long (up to 10 NFs) and stateful service chains that achieve line-rate 40 Gbps throughput (up to 8.5x greater than the baseline NFV framework). Hardware-assisted SNF, using a commodity OpenFlow switch, shows that our approach scales at 40 Gbps for Internet Service Provider-level NFV deployments.

Theses

T01 **NFV Service Chains at the Speed of the Underlying Commodity Hardware [12] - Doctoral Thesis, KTH Royal Institute of Technology, School of Electrical Engineering and Computer Science 2018**

Link speeds in networks will in the near-future reach and exceed 100 Gbps. While available specialized hardware can accommodate these speeds, modern networks have adopted a new networking paradigm, also known as Network Functions Virtualization (NFV), that replaces expensive specialized hardware with open-source software running on commodity hardware. However, achieving high performance using commodity hardware is a hard problem mainly because of the processor-memory gap. This gap suggests that only the fastest memories of today's commodity servers can achieve the desirable access latencies for high speed networks. Existing NFV systems realize chained network functions (also known as service chains) mostly using slower memories; this implies a need for multiple additional CPU cores or even multiple servers to achieve high speed packet processing. In contrast, this thesis combines four contributions to realize NFV service chains with dramatically higher performance and better efficiency than the state of the art. The first contribution is a framework that profiles NFV service chains to uncover reasons for performance degradation, while the second contribution leverages the profiler's data to accelerate these service chains by combining multiplexing of system calls with scheduling strategies. The third contribution synthesizes input/output and processing service chain operations to increase the spatial locality of network traffic with respect to a system's caches. The fourth contribution combines the profiler's insights from the first contribution and the

synthesis approach of the third contribution to realize NFV service chains at the speed of the underlying commodity hardware. To do so, stateless traffic classification operations are offloaded into available hardware (i.e., programmable switches and/or network cards) and a tag is associated with each traffic class. At the server side, input traffic classes are classified by the hardware based upon the values of these tags, which indicate the CPU core that should undertake their stateful processing, while ensuring zero inter-core communication. With commodity hardware, this thesis realizes Internet Service Provider-level service chains and deep packet inspection at a line-rate 40 Gbps and stateful service chains at the speed of a 100 GbE network card on a 16 core single server. This results in up to (i) 4.7x lower latency, (ii) 8.5x higher throughput, and (iii) 6.5x better efficiency than the state of the art. The techniques described in this thesis are crucial for realizing future high speed NFV deployments.

T02 **Realizing High Performance NFV Service Chains [13] - Licentiate Thesis, KTH Royal Institute of Technology, School of Information and Communication Technology 2016**

Network functions (NFs) hold a key role in networks, offering in-network services, such as enhanced performance, policy enforcement, and security. Traditionally, NFs have been implemented in specialized, thus expensive hardware. To lower the costs of deploying NFs, network operators have adopted network functions virtualization (NFV), by migrating NFs from hardware to software running in commodity servers. Several approaches to NFV have shown that commodity network stacks and drivers (e.g., Linux-based) struggle to keep up with increasing hardware speed. Despite this, popular networking services still rely on these commodity components. Moreover, chaining NFs (also known as service chaining) is challenging due to redundancy in the elements of the chain. This licentiate thesis addresses the performance problems of NFV service chains. The first contribution is a framework that (i) profiles NFV service chains to uncover performance degradation reasons and (ii) leverages the profiler's data to accelerate these chains, by combining multiplexing of system calls with scheduling strategies. These accelerations improve the cache utilization and thereby the end-to-end latency of chained NFs is reduced by a factor of three. Moreover, the same chains experience a multi-fold latency variance reduction; this result improves the quality of highly-interactive services. The second contribution of this thesis substantially revises the way NFV service chains are realized. NFV service chains are synthesized while eliminating redundant input/output and repeated elements, providing consolidated stateful cross layer packet operations across the chain. This software-based synthesis achieves line-rate 40 Gbps throughput for stateful and long service chains. This performance is 8.5x higher than the performance achieved by the software-based state of the art FastClick framework. Experiments with three example Internet Service Provider-level service chains show that this synthesis approach operates at 40 Gbps, when the classification of these chains is offloaded to an OpenFlow switch.

Scientific contributions in Wireless and Cellular networks

Conferences

C09 **Int5Gent: An integrated end-to-end system platform for verticals and data plane solutions beyond 5G [14] - Joint European Conference on Networks and Communications 6G Summit (EuCNC/6G Summit) 2021**

Int5Gent targets the integration of innovative data plane technology building blocks under a flexible 5G network resource, slice and application orchestration framework, providing a complete 5G system platform for the validation of advance 5G services and Internet of Things (IoT) solutions. The platform can act as the enabler for the transition beyond the current 5G networking capabilities allowing novel and state-of-the-art data transport and edge processing solutions to be evaluated under a cutting-edge network orchestration framework, with intelligent service allocation and management capabilities. A sample of the envisioned technologies include: flexible multi-Radio Access Technology (multi-RAT)

baseband signal processing, millimeter Wave (mmWave)technology solutions at 60GHz and 150GHz bands, hardware-based edge processor with Time Sensitive Networking (TSN), Graphical Processing Unit (GPU) processing capabilities, and elastic Software Defined Networking (SDN)-based photonic data transport. The integration of the technology blocks is performed as part of an overall architecture that promotes edge processing and is orchestrated by a Network Function Virtualization Orchestrator (NFVO) compatible framework with edge node extensions at the network layer and an overlay vertical services application orchestrator at the user plane layer.

C10 A dynamic governance framework for efficient orchestration of hetnet empowerment mechanisms [15] - **International Conference on Smart Communications in Network Technologies (SaCoNeT) 2013**

Nowadays autonomic network management systems are a significant part of Future Internet vision. These systems may be considered as Network Empowerment Mechanisms (NEMs) in an Heterogeneous, Multi-tier Network Environment. Their main purpose is to monitor network manageable entities, perform decision functions, and start possible healing actions. The NEMs deployment and interworking is proven to be a challenging task, as they increase network complexity in Future Internet paradigm. The decisions and the enforced actions of different NEMs may be conflicting for the underlying network environment thus increasing the complexity of the Network Management. The Unified Management Framework (UMF), solves the aforementioned problems by enabling the efficient orchestration of NEM entities. Following the UMF paradigm, in this work we provide the implementation of the Governance functionality based on an ontology implementation. Furthermore, building on the outcomes of the ontology, we implement the conflict detection and resolution functionality, aiming at handling conflicts in policies introduced by the network operator. The afore-described approach enables the dynamic introduction of newly deployed NEMs into the Governance lifecycle, through the use of OWL language, under specific time constraints.

C11 Network and service governance for the management of future networks [16] - **Future Network and Mobile Summit (FNMS) 2013**

The emergence of new technologies and services forces the network operator to manage uniformly and efficiently the complex network environment of Future Networks. The interworking of multiple underlying heterogeneous network domains with proprietary network management systems is currently a tedious task, and this fact will be exacerbated in the near future. To this end, we address the challenge of dynamic, efficient administration of Future Networks introducing the Network Governance paradigm; the latter automates the dynamic joint network and service management while fulfilling different QoS requirements for the users. The proposed governance framework supports the dynamic definition of operators' business goals, their translation to network policies and management actions and their enforcement onto the network. Moreover, an experimental case study on management of FFTH and WLAN testbeds has been implemented through two main mechanisms: policy-driven wireless access load balancing and self-diagnosis and monitoring, thereby proving the feasibility and applicability of the introduced concepts. The results show the performance gains including e.g. the QoS optimisation for packet loss and delay for a user class.

C12 Video-to-Video for e-Health: Use Case, Concepts and Pilot Plan [17] - **International Conference on Artificial Intelligence Applications and Innovations (AIAI) 2012**

Future Internet and smart cities are creating a very promising paradigm for providing advanced services to citizens. The paradigm of e-Health forms a valuable yet demanding use case for design, develop, deploy and provide related services. The aim of LiveCity project is to empower the citizens of a city to interact with each other in a more productive efficient and socially useful way by using high quality video-to-video (v2v); v2v can be used to improve medical services. This paper presents the related concepts, the scenario and the pilot set for the tele-monitoring service realization, deployment and provision.

C13 **On accomplishing context awareness for autonomic network management** [18] - **Future Network and Mobile Summit (FNMS) 2012**

Future generation networks are characterized by a high level of complexity and dynamicity due to a relevant level of heterogeneity in terms of nodes and devices as well as provided services. In this context, network operators face the challenge of managing this complexity, while lowering the operational expenses. Context awareness becomes a necessity for the efficient management of resources, dynamic deployment of value added services towards guaranteeing the end to end quality of services. This paper presents a novel framework for the context management of future networks, that is able to collect, transform and reason on context information. Embedded in this framework, mechanisms for the building of knowledge are also introduced, with special focus on autonomic context discovery, monitoring, diagnosis and prediction.

Journals

J04 **Popular** **Drones in B5G/6G Networks as Flying Base Stations** [19] - **Drones 2022**

Advances in the fields of networking, broadband communications and demand for high-fidelity low-latency last-mile communications have rendered as-efficient-as-possible relaying methods more necessary than ever. This paper investigates the possibility of the utilization of cellular-enabled drones as aerial base stations in next-generation cellular networks. Flying ad hoc networks (FANETs) acting as clusters of deployable relays for the on-demand extension of broadband connectivity constitute a promising scenario in the domain of next-generation high-availability communications. Matters of mobility, handover efficiency, energy availability, optimal positioning and node localization as well as respective multi-objective optimizations are discussed in detail, with their core ideas defining the structure of the work at hand. This paper examines improvements to the existing cellular network core to support novel use-cases and lower the operation costs of diverse ad hoc deployments.

Book Chapters

B01 **Spectrum Aggregation in Cognitive Radio Access Networks from Power Control Perspective** [20] - **Evolution of Cognitive Networks and Self-Adaptive Communication Systems 2013**

Spectrum scarcity has motivated researchers and standardization bodies to work towards flexible spectrum usage. One of the solutions, Spectrum Aggregation, as proposed by 3GPP, is a way to increase wireless capacity through providing additional bandwidth to users. This chapter presents the Spectrum Aggregation scenario as it is proposed to be incorporated in LTE-Advanced. Furthermore, the interesting extensions of FP7 SACRA European research project regarding Spectrum Aggregation are described. The business and the functional aspects stemming from the incorporation of this solution in the LTE-Advanced networks are presented in detail. From the functionalities that are the cornerstone of the Spectrum Aggregation, namely spectrum sensing, admission control, and power control, the latter one is studied, which is not thoroughly investigated yet, and the authors present its key features. Moreover, a typical power control algorithm is described and enhanced with learning capabilities and policies in order to meet the requirements of the Spectrum Aggregation scenario; the simulation results highlight the need for power control schemes in Spectrum Aggregation cases.

Scientific contributions in Machine Learning and Artificial Intelligence

Conferences

C14 A Scheme for Adaptive Self-Diagnosis of QoS Degradation in Future Networks [21] - IFIP/IEEE International Symposium on Integrated Network Management (IM) 2013

The capability of a network to identify problematic situations, named self-diagnosis, enables it to react promptly and autonomously once an event or error has been identified. The use of service information in this process enables it to identify more composite problems and to act more targeted in order to solve complex errors. This paper proposes a novel fuzzy logic-based self-diagnosis mechanism for identifying Quality of Service (QoS) degradation events. Furthermore, we introduce a framework for the adaptation of the self-diagnosis scheme, which enables the network elements to evolve the way they interpret the context information. The adaptation scheme is based on the statistical analysis of the measurements and reacts accordingly without requiring any external human intervention. The adaptive self-diagnosis scheme has been evaluated through simulations in order to showcase the benefits from its application in IP networks for the VoIP service. The simulation results show that the adaptive self-diagnosis scheme performs very well compared to existing solutions, increases significantly the event detection rate and, as a result, the capability of controlling the QoS on top of the involved network elements.

C15 Feedback-based Learning for Self-Managed Network Elements [22] - IFIP/IEEE International Symposium on Integrated Network Management (IM) 2011

Autonomic network management systems will operate in a volatile network environment; thus they should be able to continuously adapt their decision making mechanism through learning from the behavior of the communication system. In this paper, a novel learning scheme is proposed based on the network-wide collected performance experience, targeting the enhancement of network elements' decision making engine. The algorithm employs a fuzzy logic inference engine in order to enable self-managed network elements faults or optimization opportunities identification, which is enhanced by applying data mining techniques on the accumulated observations.

C16 Learning Enhanced Environment Perception for Cooperative Power Control [23] - Mobile Ubiquitous Computing, Systems, Services and Technologies (UBICOMM) 2011

The vast proliferation of wireless networking devices, coupled with the trend for short-range communications in dense residential environments, imposes new challenges for the efficient addressing of problems resulting from co-existence of heterogeneous devices (e.g., interference) under capacity and energy constraints. This paper proposes and evaluates a cooperative distributed algorithm for power control and interference mitigation based on ad-hoc communication of heterogeneous yet peer networking devices, driven by enhanced situation awareness and learning capabilities; the learning capabilities evolve the way a network element perceives its environment. The gains of this approach are highlighted through its application in WiFi APs. The results reveal that the introduction of learning capabilities in cooperative power control leads to interference mitigation while introducing minimum overhead in the network nodes.

Journals

J05 Enhancing Environment Perception for Cooperative Power Control: an Experimental Perspective [24] - International Journal on Advances in Intelligent Systems 2012

Short range communications in dense residential environments enable anytime high data rate connectivity, however also pose new challenges regarding the efficient operation of network devices, related to their co-existence. These challenges mainly concern capacity requirements on the one hand and the interference effect that each device creates to its neighboring ones on the other. This paper presents a cooperative distributed algorithm for power control and interference mitigation based on ad-hoc communication of networking devices. The algorithm also incorporates learning capabilities for

strengthening the situation perception of each network element. Both versions of the algorithm, the core cooperative power control, and the learning enhanced one, have been deployed in WiFi Access Points and tested in an office environment in order to showcase their applicability. The experimental results prove that the incorporation of the presented algorithms leads to significant gains both in the energy consumption and the interference mitigation at the same time.

J06 Enhancing a Fuzzy Logic Inference Engine through Machine Learning for a Self-Managed Network [25] - Springer Mobile Networks and Applications 2011

Existing network management systems have static and predefined rules or parameters, while human intervention is usually required for their update. However, an autonomic network management system that operates in a volatile network environment should be able to adapt continuously its decision making mechanism through learning from the system's behavior. In this paper, a novel learning scheme based on the network wide collected experience is proposed targeting the enhancement of network elements' decision making engine. The algorithm employs a fuzzy logic inference engine in order to enable self-managed network elements to identify faults or optimization opportunities. The fuzzy logic engine is periodically updated through the use of two well known data mining techniques, namely k-Means and k-Nearest Neighbor. The proposed algorithm is evaluated in the context of a load identification problem. The acquired results prove that the proposed learning mechanism improves the deduction capability, thus promoting our algorithm as an attractive approach for enhancing the autonomic capabilities of network elements.

Book Chapters

B02 Testing End-to-End Self-Managemet in a Wireless Future Internet Environment [26] - The Future Internet, Future Internet Assembly 2011: Achievements and Technological Promises 2011

Federated testbeds aim at interconnecting experimental facilities to provide a larger-scale, more diverse and higher performance platform for accomplishing tests and experiments for future Internet new paradigms. In this work the Panlab experimental facilities and specifically the Octopus network testbed has been used in order to experiment on the improvement of QoS features by using the Self-NET software for self-management over a WiMAX network environment. The monitoring and configuration capabilities that different administrative domains provide has been exploited in order to test network and service layers cooperation for more efficient end-to-end self-management. The performance results from the experiments that have been performed prove that the proposed self-management solution and the mechanisms for the selection of the appropriate network or service level adaptation improve end-to-end behaviour and QoS features.

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