Scalable and Efficient Content Distribution

CENIIT final project report 11.07 (2011-2016)

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This project was funded 2011-2016. During this time, we have had six successful and productive years, during which we have published twelve (8+4) papers in premier journals (including IEEE/ACM Transactions on Networking, IEEE Transactions on Parallel and Distributed Systems, ACM Transactions on Web, ACM CCR, and Performance Evaluation), two (2) articles in a reputable magazines (IEEE Network and IEEE Internet Computing), thirty-eight (38) papers in selective conferences (including premier venues such as ACM Multimedia, IEEE INFOCOM, ACM SIGKDD, and IFIP Performance), and three (3) papers in workshops of premium conferences (ACM FhMN@SIGCOMM, ACM WISCS@CCS, and UEOP@NDSS). We have also won the best paper award at the ACM SIGCOMM Workshop on Future Human-Centric Multimedia Networking (FhMN) 2013, been runner-up for the best paper award at ACM/SPEC ICPE 2016, and won an outstanding poster award at ACM CODASPY 2015.

Important scientific results: The results produced during this project cover a wide range of topics. First, we have designed, implemented, and evaluated novel protocols and systems to serve personalized "branched video" content and other novel and generalized variations of video streaming services for tomorrow's users. This work has been published in premier venues such as ACM Multimedia (twice), received a best paper award at an ACM SIGCOMM workshop, and based on this work the PI recently was awarded a grant from the Swedish Research Council (VR). Within the scope of this work, we have also applied for additional funding from EU and are actively continue to pursue this line of research. Second, we have modeled and analyzed various aspects of the content delivery process, content popularity dynamics, answered questions related to what makes some content more popular than others, and designed novel protocols that help deliver this content. This include works that look at the most popular content (e.g., works published at ACM KDD, IFIP Performance, and ACM TWEB), works that look at serving the long tail of less popular content (e.g., IEEE TPDS, IFIP Performance), or works that focus on the full content catalogue under static (e.g., IPTPS, IEEE P2P) and dynamic workloads (e.g., IEEE INFOCOM). Third, we have designed systems and protocols for improved system utilization or that in other ways push the performance of routers, web servers, or multi-core machines in general (e.g., ICPE papers). Fourth, we have addressed various security related aspects, including BGP-routing related problems (e.g., PAM, IFIP Networking), third-party authentication (e.g., PAM, IFIP SEC, IEEE Internet Computing), and HTTPS-related characterizations (e.g., PAM, IEEE LCN).

Degrees and promotions: In February 2013, the PI was given the docent title. At LiU, the PI has graduated two PhD students: Anna Vapen and Rahul Hiran, both co-supervised with Nahid Shahmehri. Furthermore, his current PhD student (Vengatanathan Krishnamoorthi) has defended his licentiate in Dec. 2016 and is expected to graduate in Dec. 2017. During the project, the PI has also assisted in the supervision of, and helped graduate, two remote PhD students: Aniket Mahanti (University of Calgary, Canada) and Youmna Borghol (UNSW and NICTA, Australia). Dr. Mahanti has taken a job as an Assistant Professor at University of Auckland, New Zeeland. Dr. Borghol is now a Data Analytics Manager at MediaCom, Australia. During the project, the PI has also helped supervise Benoy Varghese (NICTA) and Raoufeh Hashemian (University of Calgary), who both are working towards their PhDs but have yet to graduate. Both Youmna and Benoy have done internships at LiU, while the other students have been assisted remotely (with some shorter research visits). During the project, the PI have also supervised two postdocs (Tatiana Polishchuk and Ajay Gopinathan) and two researchers (Cyriac James and Vengatanathan Krishnamoorthi). Finally, the PI has been external examiner for one PhD thesis at Simula Research Laboratory (Oslo University, Norway), been on the thesis committee for a PhD thesis at Delft University of Technology (Netherlands), one at Umea University (Sweden), one at Linkoping University (Sweden), and has been the external examiner for two Licentiates at Lund University (Sweden).

Master thesis works: During the project, the PI has had the pleasure to work with some very good MSc and BSc students. The number of MSc theses during this time is estimated to 13 and the number of BSc theses are estimated to be roughly 16. Out of these, at least seven has resulted in research publications, and we have other works in the pipeline related to these projects. This includes a very interesting paper in PAM 2017 about certification transparency, which we believe can result in some very interesting follow-up studies.

People funded through the project: We have hosted two visiting PhD students (Benoy Varghese and Youmna Borghol; both from NICTA, Australia) for three and six months, respectively, hired a postdoc (Ajay Gopinathan) for three months, hired two hard-working researchers (Cyriac James and Vengatanthan Krishnamoorthi, the second of which was admitted as a PhD student in Nov. 2012). Within this project, we have also hosted senior researchers from NICTA (Australia), University of Calgary (Canada), and University of Auckland (New Zeeland). The remaining funding has covered conference travel expenses and some salary.

Industrial connections and technology exchange: During the project we have had many productive meetings and discussions with different companies (e.g., various groups at Ericsson, Spotify, Peerialism, .SE, Opera, IBM, HP, Google, NICTA, AT&T), which have helped identify projects and research questions of mutual interest. Some of these collaborations have also resulted in companies sharing data (e.g., Spotify, .SE, and AT&T) and help refine ideas and confirm the importance of many of the problems that we are working on. We are very appreciative for these connections and hope that some of these connections will result in long-term collaborations. Current research projects are primarily aligned with projects that we have discussed with Ericsson and AT&T, including a joint ongoing project with AT&T research in which we look closer at improving the quality of experience of video streaming services. We are very excited about these projects and believe that they will lead to strong long-term cooperation. We also have an EU grant application under submission together with companies from Sweden, Spain, UK, and Germany, which may result in new interesting industry collaborations.

Relation to other CENIIT projects: While some of our discussions with Ericsson, an SSF application, and a VR application have included Jose Pena (who in the past had a CENIIT project) and I have had some interesting discussions with Erik G. Larsson (who also had a CENIIT project in the past) that I hope will lead to future collaborations, thus far, our CENIIT projects never overlapped. In general, this project has been independent of the other CENIIT projects, and instead focused on collaboration with external partners in academia and industry.

The start of a new research group: One of the primary goals of the PI and this project is to build a strong, productive, and highly recognized research group that specializes in distributed systems and networks. As stated in previous reports, the group should (i) stay aligned with the most important problems, (ii) help educate the next generation of scientists, and (iii) produces high-quality research shared through publications in premier conferences/journals or more targeted high-profile venues. During the project, we have educated and graduated students, and have worked on problems that have allowed us to publish the works in the top-tier venues of different sub-fields, which have helped promote the work of the group. We have also obtained very competitive funding from the Swedish Research Council (VR) for the continuation of the project, showing that we are heading in the right direction. In the next few years, we hope to attract additional funding, further strengthen the research program, and continue to build a strong international research profile. To further strengthen the visibility of the group and stay up-to-date on recent research activities, the PI actively participate in the performance community. Since 2009, the PI has co-chaired and organized GreenMetrics, collocated with ACM SIGMETRICS. Since the start of the project, the PI has reviewed for roughly thirty different journals/magazines, has served on the program committee for roughly thirty conferences, including four years on the ACM SIGMETRICS program committees (2012, 2013, 2016, 2017) and two years at IEEE ICDCS (2016, 2017). The PI is also TPC co-chair for IEEE MASCOTS 2015, the elected secretary/treasurer for ACM SIGMETRICS (2015-2019), the chair for IEEE STC on Sustainable Computing (STCSC), which has over 600 members in both academia and industry, is on the steering committee of the IEEE Technical Community on Environmental Engineering, and is an Associate Editor for both ACM Transactions on Modeling and Performance Evaluation of Computing Systems (ToMPECS) and IEEE Transactions of Sustainable Computing (TSUSC). Finally, we continue to aim higher, will continue building a strong research group, and look forward to many more productive years.

Publications

Journal Publications (during project)

1. **Niklas Carlsson** and Derek Eager, Ephemeral Content Popularity at the Edge and Implications for On-Demand Caching, *IEEE Transactions on Parallel and Distributed Systems (IEEE TPDS)*, to appear.

2. Raoufehsadat Hashemian, Diwakar Krishnamurthy, Martin Arlitt and **Niklas Carlsson**, "Characterizing the Scalability of a Web Application on a Multi-core Server", *Concurrency and Computation Practice and Experience (CCPE)*, Wiley, vol. 26, no. 12 (Aug. 2014), pp. 2027--2052.

3. György Dan and **Niklas Carlsson**, "Centralized and Distributed Protocols for Tracker-based Dynamic Swarm Management", *IEEE/ACM Transactions on Networking (ToN)*, vol. 21, no. 1 (Feb. 2013), 297--310.

4. **Niklas Carlsson**, Carey Williamson, Andreas Hirt, and Michael Jacobson, "Performance Modeling of Anonymity Protocols", *Performance Evaluation*, vol. 69, no. 12 (Dec. 2012), pp. 643--661.

5. Nadim Parvez, Carey Williamson, Anirban Mahanti, and **Niklas Carlsson**, "Insights on Media Streaming Progress using BitTorrent-like Protocols for On-Demand Streaming", *IEEE/ACM Transactions on Networking (ToN)*, vol. 20, no. 3 (June 2012).

6. Phillipa Gill, Martin Arlitt, **Niklas Carlsson**, Anirban Mahanti, and Carey Williamson, "Characterizing Organizational Use of Web-based Services: Methodology, Challenges, Observations, and Insights", *ACM Transactions on the Web (TWEB)*, vol. 5, no. 4 (Oct. 2011), pp. 19:1--19:23.

7. Martin Arlitt, **Niklas Carlsson**, Phillipa Gill, Aniket Mahanti, and Carey Williamson, "Characterizing Friend, Foe and Frenemy Intelligence Gathering and Control on an Edge Network", *ACM Transactions on Internet Technology (TOIT)*, vol. 11, no. 1 (July 2011), pp. 2:1--2:26.

8. Siddharth Mitra, Mayank Agrawal, Amit Yadav, **Niklas Carlsson**, Derek Eager, and Anirban Mahanti, "Characterizing Web-based Video Sharing Workloads", *ACM Transactions on the Web (TWEB)*, vol. 5, no. 2 (May 2011), pp. 8:1--8:27.

Magazine Publications (during project)

9. Anna Vapen, **Niklas Carlsson**, Anirban Mahanti, and Nahid Shahmehri, "A Look at the Third-Party Identity Management Landscape", *IEEE Internet Computing*, Vol. 20, No. 2, Mar/Apr. 2016, pp. 18--25.

10. Aniket Mahanti, **Niklas Carlsson**, Anirban Mahanti, Martin Arlitt, and Carey Williamson, "A Tale of the Tails: Power-laws in Internet Measurements", *IEEE Network*, vol. 27, no. 1 (Jan/Feb. 2013), pp. 59--64.

Book chapters (during project)

11. **Niklas Carlsson**, "Broadening the Audience: Popularity Dynamics and Scalable Content Delivery Techniques", Advances in Secure and Networked Information Systems – The ADIT Perspective (Festschrift in honor of professor Nahid Shahmehri), LiU Press, Nov. 2012, pp. 139--144.

Conference Publications (during project)

12. Josef Gustafsson, Rahul Hiran, Vengatanathan Krishnamoorthi, and **Niklas Carlsson**, "The Hidden Mailman and His Mailbag: Routing Path Analysis from a European Perspective", *Proc. IEEE International Conference on Communications (IEEE ICC)*, Paris, France, May 2017.

13. Raoufeh Hashemian, **Niklas Carlsson**, Diwakar Krishnamurthy and Martin Arlitt, "IRIS: Iterative and Intelligent Experiment Selection", *Proc. ACM/SPEC International Conference on Performance Engineering (ACM/SPEC ICPE)*, L'Aquila, Italy, Apr. 2017.

14. Josef Gustafsson, Gustaf Overier, Martin Arlitt, and **Niklas Carlsson**, "A First Look at the CT Landscape: Certificate Transparency Logs in Practice", *Proc. Passive and Active Measurement Conference (PAM)*, Sydney, Australia, Mar. 2017. **(25% accept rate)**

15. Fredrik Säveros, Mingwei Gong, **Niklas Carlsson**, Aniket Mahanti, "An Energy-efficient Handover Algorithm for Wireless Sensor Networks", *Proc. IEEE International Performance Computing and Communications Conference (IEEE IPCCC)*, Las Vegas, NV, Dec. 2016. **(25% accept rate)**

16. Joel Purra and **Niklas Carlsson**, "Third-party Tracking on the Web: A Swedish Perspective", *Proc. IEEE Conference on Local Computer Networks (IEEE LCN)*, Dubai, Nov. 2016.

17. Georgios Rizothanasis, **Niklas Carlsson**, and Aniket Mahanti, "Identifying User Actions From HTTP(S) Traffic", *Proc. IEEE Conference on Local Computer Networks (IEEE LCN)*, Dubai, Nov. 2016.

18. Rahul Hiran, **Niklas Carlsson**, and Nahid Shahmehri, "Does Scale, Size, and Locality Matter? Evaluation of Collaborative BGP Security Mechanisms", *Proc. IFIP Networking*, Vienna, Austria, May 2016. (**29% accept rate**)

19. **Niklas Carlsson**, "Optimized eeeBond: Energy Efficiency with non-Proportional Router Network Interfaces", *Proc. ACM/SPEC International Conference on Performance Engineering (ACM/SPEC ICPE)*, Delft, the Netherlands, Mar. 2016. (**33% accept rate; Runner up for Best Research Paper**)

20. Anna Vapen, **Niklas Carlsson**, and Nahid Shahmehri, "Longitudinal Analysis of the Third-party Authentication Landscape", *Proc. NDSS Workshop on Understanding and Enhancing Online Privacy (UEOP@NDSS)*, San Diego, CA, Feb. 2016.

21. Ajay Gopinathan, **Niklas Carlsson**, Zongpeng Li, Chuan Wu, "Revenue-maximizing and Truthful Online Auctions for Dynamic Spectrum Access", *Proc. IEEE/IFIP Wireless On-demand Network systems and Services Conference (IEEE/IFIP WONS)*, Cortina d'Ampezzo, Italy, Jan. 2016. (**31% accept rate**)

22. Tova Linder, Pontus Persson, Anton Forsberg, Jakob Danielsson, and **Niklas Carlsson**, "On Using Crowd-sourced Network Measurements for Performance Prediction", *Proc. IEEE/IFIP Wireless On-demand Network systems and Services Conference (IEEE/IFIP WONS)*, Cortina d'Ampezzo, Italy, Jan. 2016. (**31% accept rate**)

23. Vengatanathan Krishnamoorthi, **Niklas Carlsson**, Derek Eager, Anirban Mahanti, and Nahid Shahmehri, "Bandwidth-aware Prefetching for Proactive Multi-video Preloading and Improved HAS Performance", *Proc. ACM International Conference on Multimedia (ACM Multimedia)*, Brisbane, Australia, Oct. 2015. (**20.6% accept rate**)

24. Rahul Hiran, **Niklas Carlsson**, and Nahid Shahmehri, "Crowd-based Detection of Routing Anomalies on the Internet", *Proc. IEEE Conference on Communications and Network Security (IEEE CNS)*, Florence, Italy, Sept. 2015. (**28% accept rate**)

25. Anna Vapen, **Niklas Carlsson**, Anirban Mahanti, and Nahid Shahmehri, "Information Sharing and User Privacy in the Third-party Identity Management Landscape", *Proc. IFIP International Information Security and Privacy Conference (IFIP SEC)*, Hamburg, Germany, May 2015. (**19.8% accept rate**)

26. Anna Vapen, **Niklas Carlsson**, Anirban Mahanti, and Nahid Shahmehri, "Information Sharing and User Privacy in the Third-party Identity Management Landscape", *Proc. ACM Conference on Data and Application Security and Privacy (ACM CODASPY)*, San Antonio, TX, Mar. 2015. (poster paper, **outstanding poster award**)

27. Cyriac James and **Niklas Carlsson**, "Green Domino Incentives: Impact of Energy-aware Adaptive Link Rate Policies in Routers", *Proc. ACM/SPEC International Conference on Performance Engineering (ACM/SPEC ICPE)*, Austin, TX, Jan/Feb. 2015. (**27% accept rate**)

28. Vengatanathan Krishnamoorthi, **Niklas Carlsson**, Derek Eager, Anirban Mahanti, and Nahid Shahmehri, "Quality-adaptive Prefetching for Interactive Branched Video using HTTP-based Adaptive Streaming", *Proc. ACM International Conference on Multimedia (ACM Multimedia)*, Orlando, FL, Nov. 2014. (**20% accept rate**)

29. Rahul Hiran, **Niklas Carlsson**, and Nahid Shahmehri, "PrefiSec: A Distributed Alliance Framework for Collaborative BGP Monitoring and Prefix-based Security", *Proc. ACM CCS Workshop on Information Sharing and Collaborative Security (ACM WISCS @CCS)*, Scottsdale, AZ, Nov. 2014

30. Benoy Varghese, **Niklas Carlsson**, Guillaume Jourjon, Anirban Mahanti, and Prashant Shenoy, "Greening Web Servers: A Case for Ultra Low-power Web Servers", *Proc. International Green Computing Conference (IGCC)*, Dallas, TX, Nov. 2014.

31. **Niklas Carlsson**, Derek Eager, Ajay Gopinathan, and Zongpeng Li, "Caching and Optimized Request Routing in Cloud-based Content Delivery Systems", *Proc. IFIP International Symposium on Computer Performance, Modeling, Measurements and Evaluation (IFIP Performance)*, Turin, Italy, Oct. 2014. (**27% accept rate**)
** Note: This paper appears in *Performance Evaluation*, Vol. 79 (Sept. 2011), pp. 38--55.

32. György Dán and **Niklas Carlsson**, "Dynamic Content Allocation for Cloud-assisted Service of Periodic Workloads", *Proc. IEEE International Conference on Computer Communications (IEEE INFOCOM)*, Toronto, Canada, Apr/May 2014. (**19.4% accept rate**)

33. Alberto García Estévez and **Niklas Carlsson**, "Geo-location-aware Emulations for Performance Evaluation of Mobile Applications", *Proc. IEEE/IFIP Conference on Wireless On-demand Network Systems and Services (IEEE/IFIP WONS)*, Obergurgl, Austria, Apr. 2014. (**29% accept rate**)

34. Anna Vapen, **Niklas Carlsson**, Anirban Mahanti, and Nahid Shahmehri, "Third-party Identity Management Usage on the Web", *Proc. Passive and Active Measurement Conference (PAM)*, Los Angeles, CA, Mar. 2014. (**32% accept rate**)

35. Vengatanathan Krishnamoorthi, Patrik Bergström, **Niklas Carlsson**, Derek Eager, Anirban Mahanti, and Nahid Shahmehri, "Empowering the Creative User: Personalized HTTP-based Adaptive Streaming of Multi-path Nonlinear Video", *Proc. ACM SIGCOMM Workshop on Future Human-Centric Multimedia Networking (ACM FhMN)*, Hong Kong, Aug. 2013, pp. 53--58. (**Best paper award**!)
** Note: This paper is also published in *ACM SIGCOMM Computer Communication Review (ACM CCR)*, Volume 43, Issue 4, Oct. 2013, pp. 53--58.

36. Vengatanathan Krishnamoorthi, **Niklas Carlsson**, Derek Eager, Anirban Mahanti, and Nahid Shahmehri, "Helping Hand or Hidden Hurdle: Proxy-assisted HTTP-based Adaptive Streaming Performance", *Proc. IEEE International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems (IEEE MASCOTS)*, San Francisco, Aug. 2013. (**27% accept rate**)

37. Carey Williamson and **Niklas Carlsson**, "On Zipf Models for Probabilistic Piece Selection in P2P Stored Media Streaming", *Proc. IEEE International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems (IEEE MASCOTS)*, San Francisco, Aug. 2013. (**27% accept rate**)

38. M. Aminul Islam, **Niklas Carlsson**, Derek Eager, and Anirban Mahanti, "Revisiting Popularity Characterization and Modeling for User-generated Videos", *Proc. IEEE International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems (IEEE MASCOTS)*, San Francisco, Aug. 2013. (short paper)

39. Klara Stokes and **Niklas Carlsson**, "A Peer-to-Peer Agent Community for Digital Oblivion in Online Social Networks", *Proc. International Conference on Privacy, Security and Trust (PST)*, Tarragona, Spain, July 2013. (**29% accept rate**)

40. Raoufehsadat Hashemian Harandi, Diwakar Krishnamurthy, Martin Arlitt, **Niklas Carlsson**, "Improving the Scalability of a Multi Core Web Server", *Proc. ACM/SPEC International Conference on Performance Engineering (ACM/SPEC ICPE), Industry and Experience Track*, Prague, Czech Republic, Apr. 2013. (**37% accept rate**)

41. Rahul Hiran, **Niklas Carlsson**, and Phillipa Gill, "Characterizing Large-scale Routing Anomalies: A Case Study of the China Telecom Incident", *Proc. Passive and Active Measurement Conference (PAM)*, Hong Kong, China, Mar. 2013. **(32% accept rate)**

42. Song Zhang, **Niklas Carlsson**, Derek Eager, Zongpeng Li, and Anirban Mahanti, "Dynamic File Bundling for Large-scale Content Distribution", *IEEE Conference on Local Computer Networks (IEEE LCN)*, Clearwater, FL, Oct. 2012. **(29% accept rate)**

43. Aniket Mahanti, **Niklas Carlsson**, Martin Arlitt, and Carey Williamson, "Characterizing Cyberlocker Traffic Flows", *IEEE Conference on Local Computer Networks (IEEE LCN)*, Clearwater, FL, Oct. 2012. **(29% accept rate)**

44. **Niklas Carlsson**, György Dan, Derek Eager, Anirban Mahanti, "Tradeoffs in Cloud and Peer-assisted Content Delivery Systems", *Proc. IEEE International Conference on Peer-to-Peer Computing (IEEE P2P)*, Tarragona, Spain, Sept. 2012, pp. 249--260. (**19% accept rate**)

45. Youmna Borghol, Sebastien Ardon, **Niklas Carlsson**, Derek Eager, and Anirban Mahanti, "The Untold Story of the Clones: Content-agnostic Factors that Impact YouTube Video Popularity", *Proc. ACM SIGKDD Conference on Knowledge Discovery and Data Mining (ACM KDD)*, Beijing, China, Aug. 2012, pp. 1186--1194. **(17.6% accept rate)**

46. Aniket Mahanti, **Niklas Carlsson**, and Carey Williamson, "Content Sharing Dynamics in the Global File Hosting Landscape", *Proc. IEEE International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems (IEEE MASCOTS)*, Arlington, VA, Aug. 2012, pp. 219--228. **(36% accept rate)**

47. Martin Arlitt, **Niklas Carlsson**, Carey Williamson, and Jerry Rolia, "Passive Crowd-based Monitoring of World Wide Web Infrastructure and its Performance", *Proc. IEEE International Conference on Communications (IEEE ICC)*, Ottawa, Canada, June 2012. (**37% accept rate**)

48. **Niklas Carlsson**, György Dán, Martin Arlitt, Anirban Mahanti, "A Longitudinal Characterization of Local and Global BitTorrent Workload Dynamics", *Proc. Passive and Active Measurement Conference (PAM)*, Vienna, Austria, Mar. 2012, pp. 252--262. (**30% accept rate**)

49. Youmna Borghol, Siddharth Mitra, Sebastien Ardon, **Niklas Carlsson**, Derek Eager, Anirban Mahanti, "Characterizing and Modeling Popularity Evolution of User-generated Videos", *Proc. IFIP International Symposium on Computer Performance, Modeling, Measurements and Evaluation (IFIP Performance)*, Amsterdam, Netherlands, Oct. 2011. (**20% accept rate**)
   ** Note: This paper appears in *Performance Evaluation*, vol. 68, no. 11 (Nov. 2011), pp. 1037--1055.

50. Aniket Mahanti, Carey Williamson, **Niklas Carlsson**, Martin Arlitt, Anirban Mahanti, "Characterizing the File Hosting Service Ecosystem: A View from the Edge", *Proc. IFIP International Symposium on Computer Performance, Modeling, Measurements and Evaluation (IFIP Performance)*, Amsterdam, Netherlands, Oct. 2011. (**20% accept rate**)
   ** Note: This paper appears in *Performance Evaluation*, vol. 68, no. 11 (Nov. 2011), pp. 1085--1102.

51. György Dan, **Niklas Carlsson,** and Ilias Chatzidrossos, "Efficient and Highly Available Peer Discovery: A Case for Independent Trackers and Gossiping", *Proc. IEEE International Conference on Peer-to-Peer Computing (IEEE P2P)*, Kyoto, Japan, Aug/Sept. 2011, pp. 290--299. (**30% accept rate**)

52. Song Zhang, **Niklas Carlsson**, Derek Eager, Zongpeng Li, and Anirban Mahanti, "Design of a Dynamic File Bundling System for Large-scale Content Distribution", *Proc. IEEE/ACM International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems (IEEE/ACM MASCOTS)*, Singapore, August 2011. (short paper)

53. **Niklas Carlsson** and Martin Arlitt, "Towards More Effective Utilization of Computer Systems", *Proc. ACM/SPEC International Conference on Performance Engineering (ACM/SPEC ICPE)*, Karlsruhe, Germany, Mar. 2011, pp. 235--246. (**30% accept rate**)

Journal Publications (before project)

54. **Niklas Carlsson** and Derek L. Eager, "Server Selection in Large-scale Video-on-Demand Systems", *ACM Transactions on Multimedia Computing, Communications, and Applications (TOMCCAP)*, vol. 6, no. 1 (Feb. 2010), pp. 1--26.

55. **Niklas Carlsson**, Anirban Mahanti, Zongpeng Li, and Derek L. Eager, "Optimized Periodic Broadcast of Non-linear Media", *IEEE Transactions on Multimedia*, vol. 10, no. 5 (Aug. 2008), pp. 871--884.

56. **Niklas Carlsson** and Derek L. Eager, "Non-Euclidian Geographic Routing in Wireless Networks", *Ad Hoc Networks*, vol. 5, no. 7 (Sept. 2007), pp. 1173--1193.

57. **Niklas Carlsson**, Derek L. Eager, and Mary K. Vernon, "Multicast Protocols for Scalable On-demand Download", *Performance Evaluation*, vol. 63, no. 9/10 (Oct. 2006), pp. 864--891.

Conference Publications (before project)

58. Aniket Mahanti, Carey Williamson, and Niklas Carlsson, "Characterizing the File Hosting Service Ecosystem", *Proc. ACM CoNEXT Student Workshop (CoNEXT)*, Philadelphia, PA, Nov/Dec. 2010, pp. 3:1--3:2. (poster paper)

59. **Niklas Carlsson**, and Derek Eager, "Content Delivery using Replicated Digital Fountains", *Proc. IEEE/ACM International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems (MASCOTS)*, Miami Beach, FL, August 2010, pp. 338--348. (**16% accept rate**, extended paper)

60. Martin Arlitt, and **Niklas Carlsson**, "Leveraging Organizational Etiquette to Improve Internet Security", *Proc. IEEE International Conference on Computer Communication Networks (ICCCN)*, Zurich, Switzerland, August 2010, pp. x:1--x:6. (**34% accept rate**)

61. Nissan Lev-tov, **Niklas Carlsson**, Zongpeng Li, Carey Williamson, Song Zhang, "Dynamic File-selection Policies for Bundling in BitTorrent-like Systems", *Proc. IEEE International Workshop on Quality of Service (IWQoS)*, Beijing, China, June 2010, pp. x:1--x:9. (**25% accept rate**)

62. **Niklas Carlsson**, Derek Eager, and Anirban Mahanti, "Using Torrent Inflation to Efficiently Serve the Long Tail in Peer-assisted Content Delivery Systems", *Proc. IFIP/TC6 Networking*, (Lecture Notes in Computer Science 6091, M. Crovella *et al*. Eds., Springer), Chennai, India, May 2010, pp. 1--14. (**24% accept rate**)

63. Aniket Mahanti, **Niklas Carlsson**, Carey Williamson, and Martin Arlitt, "Ambient Interference Effects in Wi-Fi Networks", *Proc. IFIP/TC6 Networking*, (Lecture Notes in Computer Science 6091, M. Crovella *et al*. Eds., Springer), Chennai, India, May 2010, pp. 160--173. (**24% accept rate**)

64. Youmna Borghol, Sebastien Ardon, **Niklas Carlsson**, and Anirban Mahanti, "Toward Efficient On-demand Streaming with BitTorrent", *Proc. IFIP/TC6 Networking*, (Lecture Notes in Computer Science 6091, M. Crovella *et al*. Eds., Springer), Chennai, India, May 2010, pp. 53--66. (**24% accept rate**)

65. György Dan, and **Niklas Carlsson**, "Power-law Revisited: A Large Scale Measurement Study of P2P Content Popularity, *Proc. International Workshop on Peer-to-Peer Systems (IPTPS)*, San Jose, CA, Apr. 2010, pp. x:1--x:5. (**20% accept rate**)

66. Sanchit Garg, Trinabh Gupta, **Niklas Carlsson**, and Anirban Mahanti, "Evolution of an Online Social Aggregation Network: An Empirical Study", *Proc. Internet Measurement Conference (IMC)*, Chicago, IL, Nov. 2009, pp. 315--321. (**22% accept rate**)

67. **Niklas Carlsson**, Derek L. Eager, and Anirban Mahanti, "Peer-assisted On-demand Video Streaming with Selfish Peers", *Proc. IFIP/TC6 Networking,* (Lecture Notes in Computer Science 6091, L. Fratta *et al*. Eds., Springer), Aachen, Germany, May 2009, pp. 586--599. (**20% accept rate**)

68. Trinabh Gupta, Sanchit Garg, Anirban Mahanti, **Niklas Carlsson**, and Martin Arlitt, "Characterization of FriendFeed – A Web-based Social Aggregation Service", *Proc. AAAI*

International Conference on Weblogs and Social Media (ICWSM), San Jose, CA, May 2009, pp. 218--221.

69. György Dan and **Niklas Carlsson**, "Dynamic Swarm Management for Improved BitTorrent Performance", *Proc. International Workshop on Peer-to-Peer Systems (IPTPS)*, Boston, MA, Apr. 2009, pp. x:1--x:6. (**20% accept rate**)

70. Siddharth Mitra, Mayank Agrawal, Amit Yadav, **Niklas Carlsson**, Derek Eager, and Anirban Mahanti, "Characterizing Web-based Video Sharing Workloads", *Proc. International World Wide Web Conference (WWW)*, Madrid, Spain, Apr. 2009, pp. 1191--1192. (poster paper)

71. Amit Dvir and **Niklas Carlsson**, "Power-aware Recovery for Geographic Routing", *Proc. IEEE Wireless Communications and Networking Conference (WCNC)*, Budapest, Hungary, Apr. 2009, pp. 2851--2856..

72. Nadim Parvez, Carey Williamson, Anirban Mahanti, and **Niklas Carlsson**, "Analysis of BitTorrent-like Protocols for On-demand Stored Media Streaming", *Proc. ACM SIGMETRICS*, Annapolis, MD, June 2008, pp. 301--312. (**18% accept rate**)

73. **Niklas Carlsson** and Derek L. Eager, "Modeling Priority-based Incentive Policies for Peer-assisted Content Delivery Systems", *Proc. IFIP/TC6 Networking*, (Lecture Notes in Computer Science 4982, A. Das *et al.* Eds., Springer), Singapore, May 2008, pp. 421--432. (**27% accept rate**)

74. **Niklas Carlsson** and Derek L. Eager, "Peer-assisted On-demand Streaming of Stored Media using BitTorrent-like Protocols", *Proc. IFIP/TC6 Networking*, (Lecture Notes in Computer Science 4479, I.F. Akyildiz *et al.* Eds., Springer), Atlanta, GA, May 2007, pp. 570--581. (**22.5% accept rate**)

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