2013

ACM SIGMETRICS

June 17-21

Carnegie Mellon University

Pittsburgh

SCHEDULE

	8:00am – 9:00am	9:00am - 10:30am	10:30-11:00	11:00am – 12:30pm	12:30–2:00	2:00pm – 3:30pm 14:00 – 15:30	3:30-4:00	4:00pm – 5:30pm 16:00 – 17:30	5:30pm – 7:00pm 17:30 – 19:00	7:00pm – 9:00pm 19:00 – 21:00
Monday **6/17**	Breakfast & Registration GHC 4405	Tutorial 1 GHC 4303	**BREAK 4405**	Tutorial 2: GHC 4303 Tutorial 3: GHC 4215	**LUNCH 12:30–1:30 GHC 6115**	GreenMetrics GHC 4303	**BREAK 4405 3:50–4:05**	GreenMetrics GHC 4303		Workshop & Tutorial Reception/food 6th Floor GHC Collaborative Commons
Tuesday **6/18**	Breakfast & Registration GHC 4405	Opening Remarks Keynote: Prabhakar Rashid Auditorium GHC 4401	**BREAK 4405**	Session 1 Rashid Auditorium GHC 4401	**LUNCH Rangos-UC**	Session 2 Rashid Auditorium GHC 4401	**BREAK hall 3:30 -4:00**	Session 3 Rashid Auditorium GHC 4401	Student Activities "Smart Interviewing Practices" Panel GHC 4307	Poster Session Wine & Cheese 6th Floor GHC Collaborative Commons
Wednesday **6/19**	Breakfast GHC 4405	Announcements Keynote: Maltz Rashid Auditorium GHC 4401	**BREAK 4405**	Session 4 Rashid Auditorium GHC 4401	**LUNCH Rangos- UC**	Session 5 Rashid Auditorium GHC 4401	**BREAK hall 3:00-3:30**	Session 6 Rashid Auditorium GHC 4401	Sigmetrics Rising Star Award Rashid Aud.	BANQUET 6:30 – 10pm Carnegie Museum
Thursday **6/20**	Breakfast GHC 4405	Sigmetrics Lifetime Achievement Award Rashid Aud.	**BREAK 4405**	Session 8 Rashid Auditorium GHC 4401	**LUNCH Rangos- UC**	Session 9 Rashid Auditorium GHC 4401	**BREAK hall 3:30 – 4:00**	Activity Options Phipps Conservatory Carnegie Museums Cathedral of Learning	Industrial Research Fair with pizza GHC 4307 6:00 – 9:00pm	
Friday **6/21**	Breakfast & Registration GHC 4405	W-PIN-NetEcon GHC 4303 Big Data Analytics Rashid Auditorium MAMA GHC 4215	**BREAK 4405**	W-PIN-NetEcon GHC 4303 Big Data Analytics Rashid Auditorium MAMA GHC 4215	**LUNCH 12:30-1:30 GHC 6115**	W-PIN-NetEcon GHC 4303 Big Data Analytics Rashid Auditorium MAMA GHC 4215	**BREAK hall 3:30 – 4:00**	W-PIN-NetEcon GHC 4303 Big Data Analytics Rashid Auditorium MAMA GHC 4215		Workshop Reception light dinner 6th Floor GHC Coll. Commons

Note: All rooms are in Gates Hillman Center (GHC) unless otherwise noted. Conference lunches T-W-TH are in Rangos Ballroom in the University Center Building.

ORGANIZERS

General Chair	Mor Harchol-Balter	Carnegie Mellon University
Program Chairs	John Douceur	Microsoft Research
	Jun Xu	Georgia Institute of Technology
Publicity Chairs	Jia Wang	AT&T Labs
	Marc Lelarge	INRIA
Workshop Chair	Cathy Xia	The Ohio State University
Tutorials Chair	Eno Thereska	Microsoft Research
Finance Chair	Alma Riska	EMC Corporation
Publications Chair	Ton Dieker	Georgia Institute of Technology
Registration Chair	Patrick Loiseau	EURECOM
Student Activities Chair	Urtzi Ayesta	CNRS
Local Arrangements Chairs	Nancy Conway	Carnegie Mellon University
	Nicole Stenger	Carnegie Mellon University
Webmaster	Anshul Gandhi	Carnegie Mellon University

Wireless Internet Access

You will receive a printed copy of Guidelines for Network Guest Accounts, with a user ID and password specifically for your use. These guidelines will walk you through the process of connecting to our wireless network. Please register your computer under the Computer Science Department by selecting 'SCS' from the drop-down menu for organization you're associated with. Assistance is available 9-5 at the CMU Helpdesk located in GHC 4203.

Two computers and a printer will be available for your use throughout the conference. They are located in Gates Hillman Centers 4102 – a helix room.

CHAIRS' WELCOME

It is my pleasure to welcome you to the 2013 SIGMETRICS Conference on Measurement and Modeling of Computer Systems. SIGMETRICS is the premier forum for the presentation of research on performance evaluation of computer systems. As computer systems become larger and more complex, the need for developing new performance evaluation techniques and applying these is greater than ever. SIGMETRICS brings together 200 professionals from academic and industrial backgrounds to discuss the development and application of state-of-the-art analytic, simulation, and measurement-based performance evaluation techniques.

This year SIGMETRICS is hosted by Carnegie Mellon University's School of Computer Science. The conference has grown to span 5 days, where the first and last day are devoted to tutorials and workshops. This year we have three tutorials, in the areas of distributed storage, database performance and heavy-tailed distributions. We also have 4 very timely workshops, including the first Big Data Analytics workshop and the first Joint Workshop on Pricing and Incentives in Networks and Systems, as well as workshops which have become SIGMETRICS regulars, like the GreenMetrics workshop, now in its 5th year, and the MAMA workshop, in its 15th year. The middle 3 days of the conference will include the presentation of 26 full papers and 28 posters, including a broad mix of performance evaluation techniques and applications. This year we will also have an Industrial Research Fair, expanding on the jobs fair idea introduced in recent years.

A team of people have joined together to bring you this conference. At the top of my list, I would like to thank the TPC Chairs, Jim Xu and John Douceur. They poured their heart and souls into planning the technical program and finding new ways to ensure the best possible selection of papers. First, they initiated a rebuttal process to allow authors to respond to reviews, reducing errors in the review process. Second, they orchestrated an entirely new method of ranking papers, based not on average scores but rather on each reviewer's total ordering of his/her set of papers. It has been pure joy working with and learning from Jim and John! I am also very grateful to Nancy Conway and Nicole Stenger, who together worked as Local Arrangement Chairs for the conference, and were tireless in their planning and organization of events. Cathy Xia, our workshop chair, was also the originator of the Big Data Analytics workshop. She worked hard to find fantastic chairs for each workshop and took charge of any problems that came up. Similarly Eno Thereska handled all the selection and management of tutorials, doing a great job of mixing theory and practice. Patrick Loiseau, our registration chair, was extremely efficient in setting up the regonline program and handling registration bugs. Likewise Ton Dieker was very expedient in managing all the publication materials. Thanks also to Alma Riska for her help in keeping our budget balanced. Many thanks to Urtzi Ayesta who managed the student travel grants and student activities and to the publicity chairs, Marc Lelarge and Jia Wang, for advertising the conference. Finally, I am extremely grateful to Anshul Gandhi, our Webmaster, who responded to every request for a website update within minutes, even while conducting a very busy job search.

We had an unusually high number of corporate supporters this year, underscoring the importance of performance evaluation in the computer industry today. Thanks for the generous support of Intel, Microsoft Research, Facebook, Akamai, Google, NetApp, IBM, VMWare, HP Labs, and Carnegie Mellon University. Thanks also to the NSF for funding our Student Travel Grants, which are very valuable in expanding the size of the SIGMETRICS community. Finally, I would like to thank ACM, in particular April Mosqus, for providing all the infrastructure to make the conference run.

I hope that you will have a great time at the conference. In addition to attending all the talks, posters, keynotes, and other events, we've left lots of time for socializing and enjoying the city of Pittsburgh. Looking forward to many interesting discussions on future directions for performance evaluation!

Mor Harchol-Balter
SIGMETRICS 2013 General Chair
Carnegie Mellon University, Pittsburgh, PA

PROGRAM CHAIRS' WELCOME

Welcome to SIGMETRICS 2013. SIGMETRICS is the flagship conference of the ACM special interest group for the computer systems performance evaluation community. This year marks the fortieth anniversary since SIGMETRICS (under its prior name, SIGME) held the First National SIGME Symposium on Measurement and Evaluation in 1973. The past four decades have seen enormous changes in the field of computer science, but the importance of measurement, modeling, and performance evaluation remains as critical as ever.

This year's conference includes papers on topics that have been a mainstay since the founding of our SIG, including queuing, scheduling, resource allocation, and performance measurement. Application areas that have emerged in recent years, such as multicore systems, cellular networks, and energy optimization, continue to be represented in our program. Papers on solid-state storage have seen a significant uptick this year, and we have papers on some topics that are new to SIGMETRICS, including crowdsourcing and RFID systems. Interestingly, the program also shows a drop-off in topics that were hot just a brief while ago, such as social networks, BitTorrent, swarms, peer-to-peer, and MapReduce.

We received 196 submissions to this year's conference, of which 26 appear in the program as full papers, which is a highly competitive acceptance ratio below 14%. An additional 28 submissions appear in the abbreviated form of poster presentations with brief summaries in the proceedings. As in some prior years, we performed reviews in two rounds. In the first round, each paper was assigned to four reviewers. In the second round, additional reviews were assigned to papers with fewer than three completed reviews and papers with highly divergent review opinions and fewer than two high-confidence reviews.

We experimented with two changes to the review process this year. The first change to the review process was the addition of a rebuttal phase between the first and second review rounds, to give authors an opportunity to respond to questions raised in first-round reviews. To impede the addition of new substantive material in the rebuttals, and instead reserve rebuttals for merely highlighting information already contained in the submission, we strictly limited each rebuttal to 500 characters. It is not easy to gauge the effectiveness of the rebuttal process: There were many occasions during the PC meeting when reviewers commented on items in authors' rebuttals, which suggests that the rebuttals provided additional information; however, reviewers mostly found that their opinions were unchanged by what they read in the rebuttals.

The second change to the review process was the use of rankings rather than ratings. Instead of rating their assigned papers with accept/reject recommendations, each PC member was asked to produce a list of assigned papers ordered by the reviewer's assessment of each paper's overall quality. Our intent was to eliminate the bias that is inherent in accept/reject recommendations because each reviewer has only a narrow view of the conference's submissions. Reviewers' individual rankings were combined into a global ranking using an algorithm similar to PageRank, and the top 60 papers were discussed at the PC meeting. During the PC meeting, whenever a paper was accepted, we identified any paper with global rank below 60 that at least one reviewer had ranked substantially higher than the accepted paper. The reviewer was given the option to add this other paper to the discussion list. About a dozen such additional papers were discussed, although none were accepted as full papers.

We are pleased to present three awards to two of this year's papers. The SIGMETRICS Best Paper Award honors the overall best paper in each year's conference, and the Kenneth C. Sevcik Outstanding Student Paper Award honors an outstanding paper whose primary author is a student. This year, both awards are presented to an outstanding student paper that is also the overall best paper in the conference: "Queueing System Topologies with Limited Flexibility," by John N. Tsitsiklis and Kuang Xu. We are inaugurating a new award this year, the SIGMETRICS Best Practical Paper Award, to honor the best paper from among those whose research has the most direct practical applicability. This award is presented to "Practical Conflict Graphs for Dynamic Spectrum Distribution," by Xia Zhou, Zengbin Zhang, Gang Wang, Xiaoxiao Yu, Ben Y. Zhao, and Haitao Zheng.

It was no mean feat to winnow a set of nearly two hundred submissions down to a set of appropriate size for a three-day conference. We offer tremendous thanks to the 56 members of the program committee and the 33

external reviewers who collectively performed this daunting task. We are grateful for the support of the SIGMETRICS board during the lengthy process of selecting this year's conference program.

There are many conference organizers whose efforts have been critical to pulling this event together, but as program chairs, we are most directly indebted to three of them: Our webmaster, Anshul Gandhi, was outstandingly responsive to every online update we requested. Our publications chair, Ton Dieker, completely offloaded the end game from us, which

PROGRAM CHAIRS' WELCOME

was a wonderful relief after the long slog leading up to the PC meeting. And most notably, it has been truly delightful to work with Mor Harchol-Balter, the most diligent, organized, and energetic general chair we could imagine.

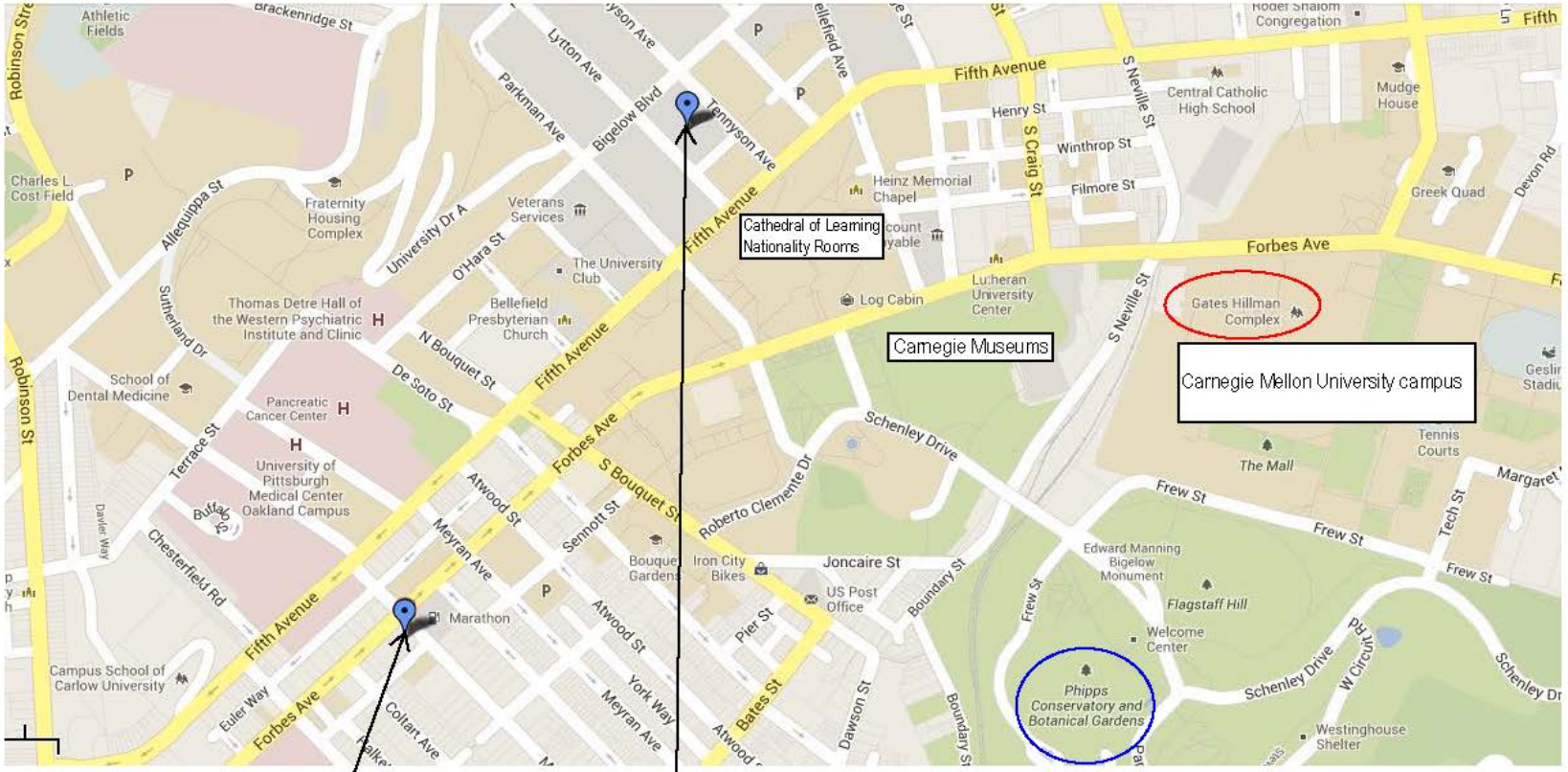
It has been our honor to serve as this year's program co-chairs. We look forward to an engaging, interactive, and productive conference.

John Douceur
SIGMETRICS'13 Program Co-chair
Microsoft Research, USA

Jun (Jim) Xu
SIGMETRICS'13 Program Co-chair
Georgia Tech, USA

MAPS – Oakland area

OAKLAND AREA MAP – HOTELS AND ACTIVITY OPTIONS



The Hilton Garden Inn
3454 Forbes Avenue
412-683-2040

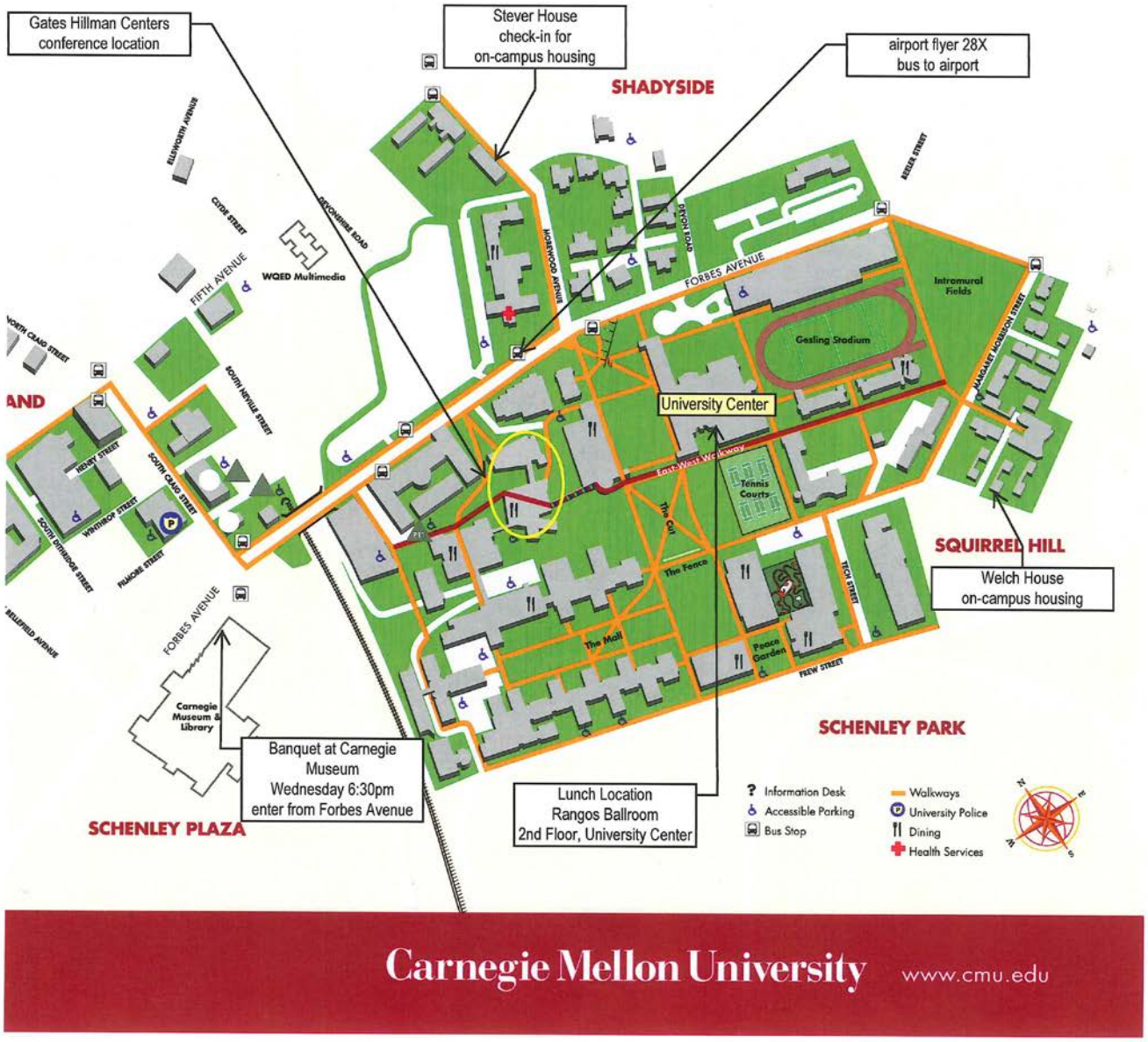
The Wyndham Pittsburgh
University Center
101 Lytton Avenue
412-682-6200

Cathedral of Learning, Nationality Rooms, University of Pittsburgh, 4200 Fifth Avenue

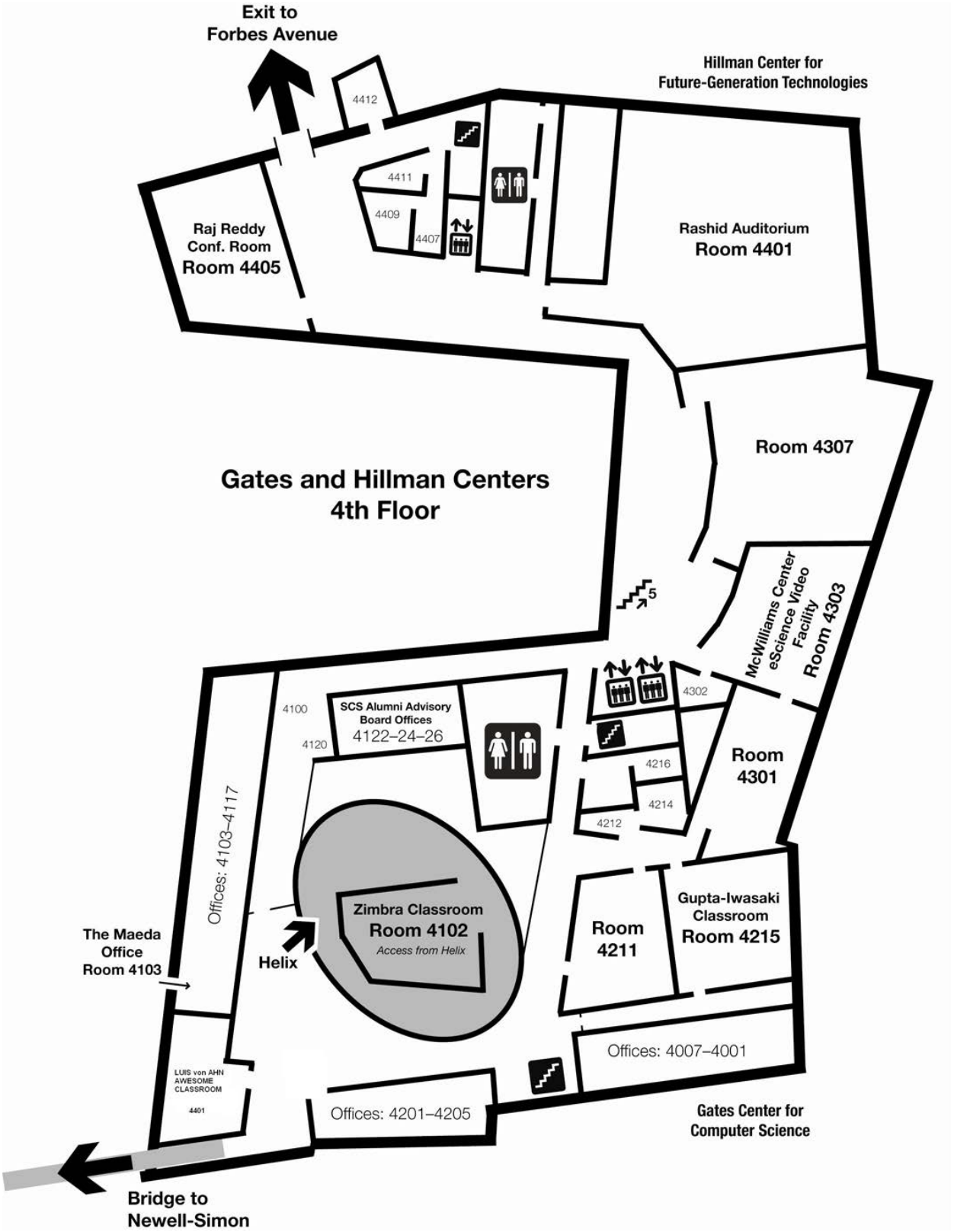
Carnegie Museum of Art, Carnegie Museum of Natural History, 4400 Forbes Avenue

Phipps Conservatory and Botanical Gardens, 1 Schenley Drive

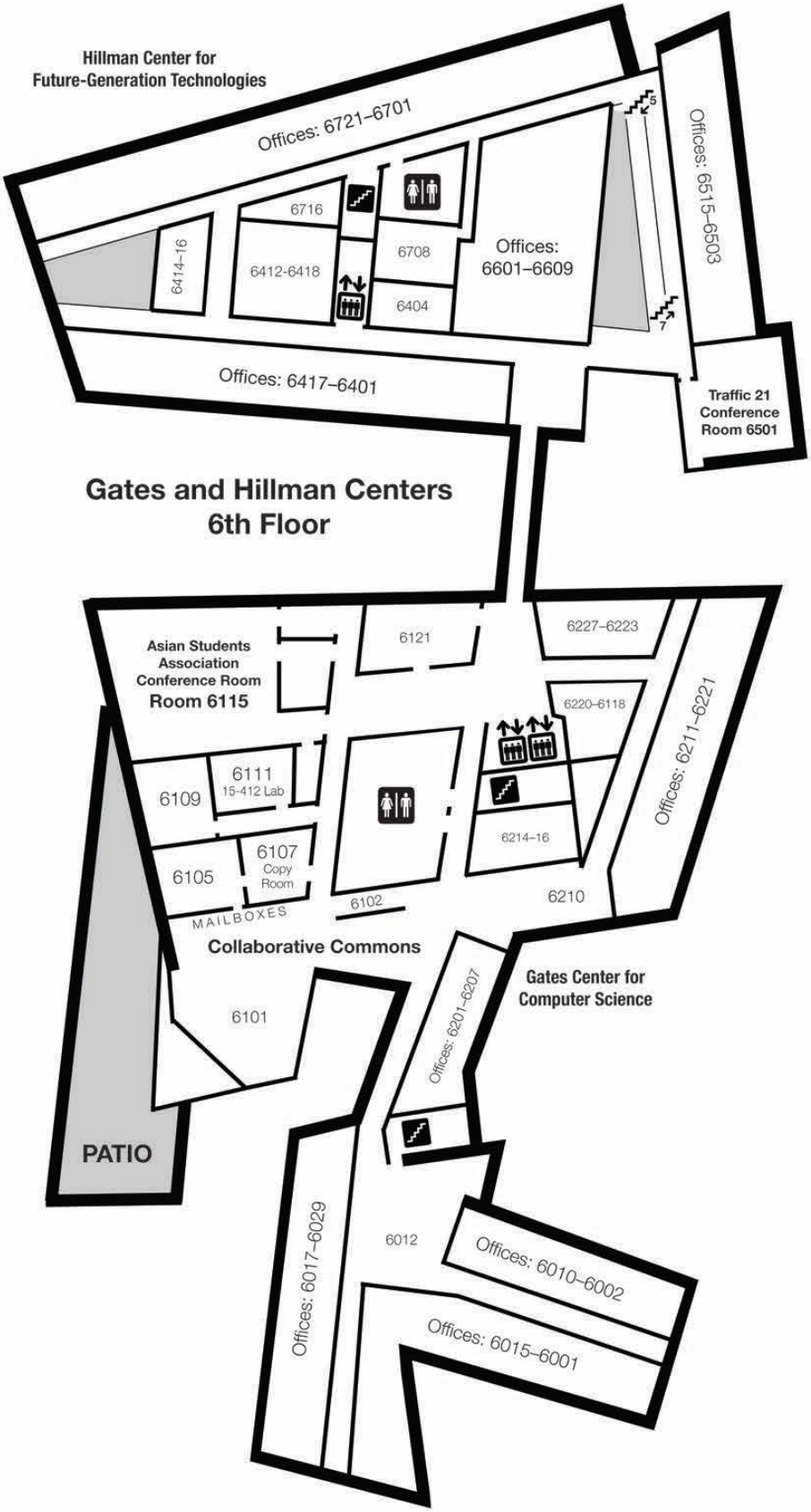
MAPS – CMU Campus



MAPS – Gates Hillman Center 4th Floor



MAPS – Gates Hillman Center 6th Floor



SCHEDULE – MONDAY – TUTORIALS

Monday, June 17th

8:00am – 9:00am	Breakfast & Registration	GHC 4405

9:00am - 10:30am, GHC 4303

Geo-Replication in Data Center Applications

Speaker: Marcos K. Aguilera, Microsoft Research Silicon Valley

Abstract: Data center applications increasingly require a storage system that is geo-replicated, that is, replicated across many geographic locations. Geo-replication can reduce access latency, improve availability, and provide disaster tolerance. It turns out there are many techniques for geo-replication with different trade-offs. In this talk, we give an overview of these techniques, organized according to two orthogonal dimensions: level of synchrony (synchronous and asynchronous) and type of storage service (read-write, state machine, transaction). We explain the basic idea of these techniques, together with their applicability and trade-offs.

10:30am – 11:00am	Break	GHC 4405

11:00am - 12:30pm, GHC 4303

The Fundamentals of Heavy-Tails: Properties, Emergence, and Identification

Speakers: Adam Wierman, Caltech; Jayakrishnan Nair, Caltech; Bert Zwart, CWI

Abstract: Heavy-tails are a continual source of excitement and confusion across disciplines as they are repeatedly "discovered" in new contexts. This is especially true within computer systems, where heavy-tails seemingly pop up everywhere -- from degree distributions in the internet and social networks to file sizes and interarrival times of workloads. However, despite nearly a decade of work on heavy-tails they are still treated as mysterious, surprising, and even controversial.

The goal of this tutorial is to show that heavy-tailed distributions need not be mysterious and should not be surprising or controversial. In particular, we will demystify heavy-tailed distributions by showing how to reason formally about their counter-intuitive properties; we will highlight that their emergence should be expected (not surprising) by showing that a wide variety of general processes lead to heavy-tailed distributions; and we will highlight that most of the controversy surrounding heavy-tails is the result of bad statistics, and can be avoided by using the proper tools.

11:00am - 12:30pm, GHC 4215

Profiling and Analyzing the I/O Performance of NoSQL DBs

Speaker: Jiri Schindler, NetApp

Abstract: The advent of the so-called NoSQL databases has brought about a new model of using storage systems. While traditional relational database systems took advantage of features offered by centrally-managed, enterprise-class storage arrays, the new generation of database systems with weaker data consistency models is content with using and managing locally attached individual storage devices and providing data reliability and availability through high-level software features and protocols.

This tutorial aims to review the architecture of selected NoSQL DBs to lay the foundations for understanding how these new DB systems behave. In particular, it focuses on how (in)efficiently these new systems use I/O and other resources to accomplish their work. The tutorial examines the behavior of several NoSQL DBs with an emphasis on Cassandra - a popular NoSQL DB system. It uses I/O traces and resource utilization profiles captured in private cloud deployments that use both dedicated directly attached storage as well as shared networked storage.

The material is geared specifically towards SIGMETRICS attendees who are familiar with system profiling and analysis both theoretically as well as through hands-on experiences as systems administrators. It does not assume any prior experience with NoSQL or relational DB systems. Nor does it require deep understanding of storage systems architecture. The necessary concepts are reviewed to establish a common ground and to relate the concepts of NoSQL DBs. The participant will be able to learn that NoSQL DB systems are not much different in their fundamentals from other systems for storing (semi)structured data even though their architecture (scale-out clustered shared-nothing model) and the use cases (with eventual consistency data models) are much different.

12:30 – 13:30	Lunch	GHC 6115

SCHEDULE – MONDAY – TUTORIALS/WORKSHOPS

Greenmetrics 2013
Technical Program
GHC 4303

13:30 - 15:50 SESSION 1: SMART GRID

13:30 - 14:10 KEYNOTE TALK

Prashant Shenoy
Professor, Computer Science, University of Massachusetts Amherst
"Demand Side Energy Management in Smart Buildings"

Today, buildings account for nearly 75% of the electricity usage and 40% of the total energy usage in modern economies. Consequently, techniques for reducing the energy and carbon footprint of buildings has emerged as an important research topic. Demand side energy management refers to techniques employed by smart buildings or its occupants to modulate the energy usage for various energy- or grid-level optimizations. In this talk, I will argue that modeling and prediction of electrical loads is a key ingredient of any demand-side energy management technique. I will describe opportunities and challenges in modeling these loads and describe our recent work in empirically characterizing and modeling common residential loads. I will also describe how better modeling can result in more effective demand side energy management and better energy efficiency improvements.

14:10 – 14:30 *"Monotonic Marginal Pricing Demand Response with Price Certainty"*
William G. Temple (Advanced Digital Sciences Center), Richard T. B. Ma (National University of Singapore)

14:30 – 14:50 *"Battery Provisioning and Scheduling for a Hybrid Battery-Diesel Generator System"*
Sahil Singla (University of Waterloo), Yashar Ghiassi-Farrokhfal (University of Waterloo), Srinivasan Keshav (University of Waterloo)

14:50 – 15:00 *"Real-Time Deferrable Load Control: Handling the Uncertainties of Renewable Generation"*
Lingwen Gan (California Institute of Technology), Adam Wierman (California Institute of Technology), Ufuk Topcu (University of Pennsylvania), Niangjun Chen (California Institute of Technology), Steven H. Low (California Institute of Technology)

15:00 – 15:10 *"Outage-Capacity Tradeoff for Smart Grid with Renewables"*
Kai Yang (Alcatel Lucent Bell Labs), Anwar Walid (Alcatel Lucent Bell Labs)

15:10 – 15:50 KEYNOTE TALK

Marija Ilić
Professor, Departments of Electrical & Computer Engineering and Engineering & Public Policy, Carnegie Mellon University
"Engineering IT-Enabled Sustainable Electricity Services: The Tale of Two Low-Cost Green Azores Islands"

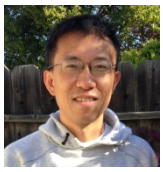
In this talk we present a preview of the upcoming Springer monograph. We use the islands of Sao Miguel and Flores to illustrate an end-to-end IT framework for enabling deployment of new hardware technologies into the existing electric power systems at value. We explain how the proposed IT framework could evolve in synchrony with the existing utility control centers and their Supervisory Control and Data Acquisition (SCADA). We illustrate how such an IT approach could transform the islands into green islands in which expensive diesel generation is replaced by a mix of wind and solar power plants, and fleets of electric vehicles. In particular, we show how carefully architected IT enables electricity service at value and according to choice. This is done without damaging continuity of services defined according to terms between the service providers and users. We illustrate dynamic deployment of wind and solar power, responsive demand, including PHEVs, according to the value they bring to those needing them. Most importantly, the overall operations and planning process becomes much more manageable and simpler when enabled by the right IT.

15:50 - 16:05	**Break**	**GHC 4405**

SCHEDULE – MONDAY – TUTORIALS/WORKSHOPS

16:05 - 19:15 SESSION 2: GREEN IT

16:05 – 16:45 KEYNOTE TALK



Yuan Chen
Senior Researcher, HP Labs
"Towards the Design and Operation of Net-Zero Energy Data Centers"

In this talk, we present a holistic end-to-end management solution - Net-Zero Energy Data Center - for optimizing the design and operation of data centers to minimize the life time energy cost and carbon footprint. We discuss several key techniques that have been developed: (1) optimizing the design and size of data center energy infrastructure; (2) scheduling IT workloads based on (renewable) resource availability and SLAs; (3) dynamically provisioning IT and cooling resources according to needs and integrated management of IT and cooling resources; and (4) improving the effective utilization of servers by managing the collocation of critical (e.g., interactive apps.) and non-critical (e.g., batch jobs) workloads on virtualized multi-core servers. We describe a prototype implementation of Net-Zero energy data center that achieves Net-Zero grid energy use while meeting all critical performance criteria and incurring minimal capital infrastructure expense - lowering the total data center power costs by 30% and dependence on a larger power grid by more than 80%.

16:45 – 17:05 *"Correcting Vibration-Induced Performance Degradation in Enterprise Servers"*
Christine S Chan (University of California, San Diego), Boxiang Pan (University of California, San Diego), Kenny Gross (Oracle Physical Sciences Research Center), Kalyan Vaidyanathan (Oracle Physical Sciences Research Center), Tajana Šimunić Rosing (University of California, San Diego)

17:05 – 17:25 *"Joint Virtual Machine Assignment and Traffic Engineering for Green Data Center Networks"*
Lin Wang (Institute of Computing Technology, Chinese Academy of Sciences) , Fa Zhang (Institute of Computing Technology, Chinese Academy of Sciences), Athanasios V. Vasilakos (University of Western Macedonia), Chenying Hou (Institute of Computing Technology, Chinese Academy of Sciences), Zhiyong Liu (Institute of Computing Technology, Chinese Academy of Sciences)

17:25 – 17:35 *"Harvesting Heat in an Urban Greenhouse"*
Mikko Pervilä (University of Helsinki, Department of Computer Science), Lassi Remes (University of Helsinki, Department of Agricultural Sciences), Jussi Kangasharju (Helsinki Institute for Information Technology)

17:35 – 17:45 *"Switch Sizing for Energy-Efficient Datacenter Networks"*
Indra Widjaja (Bell Labs), Anwar Walid (Bell Labs), Yanbin Luo (New York Polytechnic), Yang Xu (New York Polytechnic), H. Jonathan Chao (New York Polytechnic)

Intermission (10 min)

17:55 – 18:15 *"A Hop-by-Hop Energy Efficient Distributed Routing Scheme"*
Chenying Hou (Institute of Computing Technology, CAS), Fa Zhang (Institute of Computing Technology), Antonio Fernandez Anta (Institute IMDEA Networks), Lin Wang (Institute of Computing Technology, CAS), Zhiyong Liu (Institute of Computing Technology)

18:15 – 18:35 *"Exploring Smart Grid and Data Center Interactions for Electric Power Load Balancing"*
Hao Wang (The Chinese University of Hong Kong), Jianwei Huang (The Chinese University of Hong Kong), Xiaojun Lin (Purdue University), Hamed Mohsenian-Rad (University of California, Riverside)

18:35 – 19:15 KEYNOTE TALK

Ricardo Bianchini
Professor, Computer Science, Rutgers University
"Leveraging Renewable Energy in Datacenters: Present and Future"

Interest has been growing in powering datacenters (at least partially) with renewable or "green" sources of energy, such as solar or wind. However, it is challenging to use these sources because, unlike the "brown" (carbon-intensive)

energy drawn from the electrical grid, they are not always available. In this talk, I will first discuss the tradeoffs involved in leveraging green energy today and the prospects for the future. I will then discuss the main research challenges and questions involved in managing the use of green energy in datacenters. Next, I will describe some of the software and hardware that researchers are building to explore these challenges and questions. Specifically, I will overview systems that match a datacenter's computational workload to the green energy supply. I will also describe Parasol, the solar-powered micro-datacenter we have recently built at Rutgers University. Finally, I will discuss some potential avenues for future research on this topic.

19:00 – 21:00	**Workshop & Tutorial Reception** **light dinner**	**GHC 6th Floor (6101)** **Collaborative Commons**

SCHEDULE – TUESDAY – CONFERENCE

Tuesday, June 18th

8:00am – 9:00am	Breakfast & Registration	GHC 4405

9:00 – 9:30 OPENING REMARKS – RASHID AUDITORIUM, GHC 4401
9:30 – 10:30 KEYNOTE SPEAKER

Balaji Prabhakar
Professor, Electrical Engineering and Computer Science, Stanford University
"Designing Large-Scale Nudge Engines"

In many of the challenges faced by the modern world, from overcrowded transportation systems to overstretched healthcare systems, large benefits for society come about from small changes by very many individuals. We survey the problems and the cost they impose on society, and describe a framework for designing "nudge engines"---algorithms, incentives and technology for influencing human behavior. We present a model for analyzing their effectiveness and results from transportation pilots conducted in Bangalore, at Stanford and in Singapore, and a wellness program for the employees of Accenture-USA.

10:30am – 11:00am	Break	GHC 4405

11:00 – 12:30 SESSION 1: WIFI AND CELLULAR NETWORKS
Session Chair: Carey Williamson (University of Calgary)

11:00 – 11:30 *"Practical Conflict Graphs for Dynamic Spectrum Distribution"*
Xia Zhou (UC Santa Barbara), Zengbin Zhang (UC Santa Barbara), Gang Wang (UC Santa Barbara), Xiaoxiao Yu (Tsinghua University), Ben Y. Zhao (UC Santa Barbara), Haitao Zheng (UC Santa Barbara)

11:30 – 12:00 *"A First Look at Cellular Network Performance during Crowded Events"*
M. Zubair Shafiq (Michigan State University), Lusheng Ji (AT&T Labs -- Research), Alex X. Liu (Michigan State University), Jeffrey Pang (AT&T Labs -- Research), Shobha Venkataraman (AT&T Labs -- Research), Jia Wang (AT&T Labs -- Research)

12:00 – 12:30 *"Characterizing and Modeling the Impact of Signal Strength on Smartphone Energy Consumption"*
Ning Ding (Purdue University), Daniel Wagner (Cambridge University), Xiaomeng Chen (Purdue University), Abhinav Pathak (Purdue University), Y. Charlie Hu (Purdue University), Andrew Rice (Cambridge University)

12:30 – 14:00	Lunch	Rangos Ballroom, University Center Bldg., 2nd Floor

14:00 – 15:30 SESSION 2: RESOURCE ALLOCATION AND GENERATION
Session Chair: Ton Dieker (Georgia Institute of Technology)

14:00 – 14:30 *"A Large-Scale Service System with Packing Constraints: Minimizing the Number of Occupied Servers"*
Alexander L. Stolyar (Bell Labs, Alcatel-Lucent), Yuan Zhong (University of California, Berkeley)

14:30 – 15:00 *"Online Energy Generation Scheduling for Microgrids with Intermittent Energy Sources and Co-Generation"*
Lian Lu (Department of Information Engineering, The Chinese University of Hong Kong),

SCHEDULE – TUESDAY – CONFERENCE

Jinlong Tu (Department of Information Engineering, The Chinese University of Hong Kong), Chi-Kin Chau (Masdar Institute), Minghua Chen (Department of Information Engineering, The Chinese University of Hong Kong), Xiaojun Lin (School of Electrical and Computer Engineering, Purdue University)

15:00 – 15:30 "*Defragmenting the Cloud Using Demand-based Resource Allocation*"
Ganesha Shanmuganathan (VMware Inc.), Ajay Gulati (VMware Inc.), Peter Varman (Rice University)

15:30 - 16:00	**Break**	**GHC hall outside Rashid Auditorium**

16:00 – 17:30 SESSION 3: APPLICATIONS OF MACHINE LEARNING
Session Chair: Anwar Walid (Bell Labs)

16:00 – 16:30 "*Efficient Crowd-Sourcing*"
David R. Karger (MIT), Sewoong Oh (UIUC), Devavrat Shah (MIT)

16:30 – 17:00 "*Root Cause Detection in a Service-Oriented Architecture*"
Myunghwan Kim (Stanford University), Roshan Sumbaly (LinkedIn Corp), Sam Shah (LinkedIn)

17:00 – 17:30 "*The Design Space of Probing Algorithms for Network-Performance Measurement*"
Aaron D. Jaggard (Rutgers University), Swara Kopparty (Harvard University), Vijay Ramachandran (Colgate University), Rebecca N. Wright (Rutgers University)

17:30 – 19:00 STUDENT ACTIVITIES: "SMART INTERVIEWING PRACTICES" PANEL
Gates Hillman Center 4307

Urtzi Ayesta, Student Activities Chair
Carey Williamson (University of Calgary)
John C.S. Lui (Chinese University of Hong Kong)
Gil Zussman (Columbia University)

19:00 – 21:00	**Poster Session with Wine & Cheese reception**	**GHC 6th Floor (6101) Collaborative Commons**

TUESDAY - POSTERS

A Stochastic Network Calculus with Martingales
Florin Ciucu (T-Labs / TU Berlin), Felix Poloczek (T-Labs / TU Berlin), Jens Schmitt (University of Kaiserslautern)

A tale of Two Metrics: Simultaneous Bounds on Competitiveness and Regret
Minghong Lin (Caltech), Alan Roytman (UCLA), Adam Wierman (Caltech), Adam Meyerson (Google Inc), Lachlan L. H. Andrew (Swinburne University of Technology)

Accelerating GPGPU Architecture Simulation
Zhibin Yu (Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China), Lieven Eeckhout (ELIS Department,Ghent University, Belgium), Nilanjan Goswami (Intelligent Design of Efficient Architecture Lab, University of Florida, Ganiesville, Florida, USA), Tao Li (Intelligent Design of Efficient Architecture Lab, University of Florida, Ganiesville, Florida, USA), Lizy K. John (Department of Electrical and Computer Engineering, University of Texas at Austin, USA), Hai Jin (Service Computing Technologies and System Lab/Cluster and Grid Computing Lab, CS of HUST, Wuhan, China), Chengzhong Xu (Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China/Department of Electrical and Computer Engineering, Wayne State University, USA)

ACE: Abstracting, Characterizing and Exploiting Peaks and Valleys in Datacenter Power Consumption
Di Wang (The Pennsylvania State University), Chuangang Ren (The Pennsylvania State University), Sriram Govindan (Microsoft), Anand Sivasubramaniam (The Pennsylvania State University), Bhuvan Urgaonkar (The Pennsylvania State University), Aman Kansal (Microsoft Research), Kushagra Vaid (Microsoft)

An Empirical Analysis of Intra- and Inter-Datacenter Network Failures for Geo-Distributed Services
Rahul Potharaju (Purdue University), Navendu Jain (Microsoft Research)

Web Performance Bottlenecks in Broadband Access Networks
Srikanth Sundaresan (Georgia Institute of Technology), Nazanin Magharei (Georgia Institute of Technology), Nick Feamster (Georgia Institute of Technology), Renata Teixeira (CNRS/UPMC Sorbonne Universites), Sam Crawford (SamKnows)

Understanding Internet Video Viewing Behavior in the Wild
Athula Balachandran (CMU), Vyas Sekar (Stony Brook University), Aditya Akella (University of Wisconsin, Madison), Srinivasan Seshan (CMU)

Elastic Paging
Enoch Peserico (Univ. Padova)

Computational Analysis of Cascading Failures in Power Networks
Dorian Mazauric (Columbia University), Saleh Soltan (Columbia University), Gil Zussman (Columbia University)

Data Center Asset Tracking Using a Mobile Robot
John C. Nelson (IBM CIO Office), Jonathan Connell (IBM T.J. Watson Research Center), Canturk Isci (IBM T.J. Watson Research Center), Jonathan Lenchner (IBM T.J. Watson Research Center)

Data Center Demand Response: Avoiding the Coincident Peak via Workload Shifting and Local Generation
Zhenhua Liu (California Institute of Technology), Adam Wierman (California Institute of Technology), Yuan Chen (HP Labs), Benjamin Razon (California Institute of Technology)

Delivering Fairness and Priority Enforcement on Asymmetric Multicore Systems via OS Scheduling
Juan Carlos Saez (Complutense University of Madrid), Fernando Castro (Complutense University of Madrid), Daniel Chaver (Complutense University of Madrid), Manuel Prieto (Coplutense University of Madrid)

Detecting User Dissatisfaction and Understanding the Underlying Reasons
Åke Arvidsson (Ericsson Research), Ying Zhang (Ericsson Research)

Discriminant Malware Distance Learning on Structural Information for Automated Malware Classification
Deguang Kong (University of Texas at Arlington), Guanhua Yan (Los Alamos National Lab)

Exact Convex Relaxation for Optimal Power Flow in Distribution Networks
Lingwen Gan (California Institute of Technology), Ufuk Topcu (University of Pennsylvania), Na Li (California Institute of Technology), Steven H. Low (California Institute of Technology)

Exploiting the Past to Reduce Delay in CSMA Scheduling
Jaewook Kwak (North Carolina State University), Chul-Ho Lee (North Carolina State University), Do Young Eun (North Carolina State University)

FaRNet: Fast Recognition of High Multi-Dimensional Network Traffic Patterns
Ignasi Paredes-Oliva (UPC BarcelonaTech), Pere Barlet-Ros (UPC BarcelonaTech), Xenofontas Dimitropoulos (ETH Zurich)

Firming Solar Power
Yashar Ghiassi-Farrokhfal (University of Waterloo), Srinivasan Keshav (University of Waterloo), Catherine Rosenberg (University of Waterloo), Florin Ciucu (T-Labs / TU Berlin)

Greedy Name Lookup for Named Data Networking
Yi Wang (Tsinghua University), Dongzhe Tai (Tsinghua University), Ting Zhang (Tsinghua University), Jianyuan Lu (Tsinghua University), Boyang Xu (Tsinghua University), Huichen Dai (Tsinghua University), Bin Liu (Tsinghua University)

Online Load Balancing Under Graph Constraints
Sharayu Moharir (University of Texas at Austin), Sujay Sanghavi (University of Texas at Austin), Sanjay Shakkottai (University of Texas at Austin)

How Does Energy Accounting Matter for Energy Management?
Mian Dong (Samsung Telecommunications America), Tian Lan (George Washington University), Lin Zhong (Rice University)

Stable and Scalable Universal Swarms
Ji Zhu (University of Illinois at Urbana-Champaign), Stratis Ioannidis (Technicolor), Nidhi Hegde (Technicolor), Laurent Massoulie (MSR-INRIA)

TUESDAY - POSTERS

Sustainability of Service Provisioning Systems under Attack
Georgios Paschos (CERTH-ITI/MIT), Leandros Tassiulas (University of Thessaly)

Temperature Aware Workload Management in Geo-distributed Datacenters
Hong Xu (University of Toronto), Chen Feng (University of Toronto), Baochun Li (University of Toronto)

Tolerating Path Heterogeneity in Multipath TCP with Bounded Receive Buffers
Ming Li (Department of Computer Science and Engineering, Aalto University, Finland), Andrey Lukyanenko (Department of Computer Science and Engineering, Aalto University, Finland), Sasu Tarkoma (Department of Computer Science, University of Helsinki, Finland), Yong Cui (Department of Computer Science and Technology, Tsinghua Unversity, China), Antti Ylä-Jääski (Department of Computer Science and Engineering, Aalto University, Finland)

Parallel Scaling Properties from a Basic Block View
Melanie Kambadur (Columbia University), Kui Tang (Columbia University), Joshua Lopez (Columbia University), Martha Kim (Columbia University)

Understanding Architectural Characteristics of Multimedia Retrieval Workloads
Chen Dai (Fudan University), Jiaxin Li (Fudan University), Chaolv (Fudan University), Weihua Zhang (Fudan University), Binyu Zang (Fudan University)

Understanding SMS Spam in a Large Cellular Network
Nan Jiang (University of Minnesota), Yu Jin (AT&T Labs), Ann Skudlark (AT&T Labs

SCHEDULE – WEDNESDAY – CONFERENCE

Wednesday, June 19th

8:00am – 9:00am	Breakfast & Registration	GHC 4405

9:00 – 9:15 ANNOUNCEMENTS – RASHID AUDITORIUM, GHC 4401
9:15 – 10:30 KEYNOTE SPEAKER

David Maltz
Networking Research Group, Microsoft Research
"Challenges in Cloud Scale Data Centers"

Datacenters are fascinating places, where the massive scale required to deliver on-line services like web search and cloud hosting turns minor issues into major challenges that must be addressed in the design of the physical infrastructure and the software platform. In this talk, I'll briefly overview the kinds of applications that run in mega-datacenters and the workloads they place on the infrastructure. I'll then describe a number of challenges seen in Microsoft's datacenters, with a goal of posing questions more than describing solutions. The audience will leave with a better understanding of how economic factors, technology issues, and software design interact when creating low-latency, low-cost, high availability services.

10:30am – 11:00am	Break	GHC 4405

SESSION 4: MAC AND WIRELESS ACCESS NETWORKS
Session Chair: Gil Zussman (Columbia University)

11:00 – 11:30 "*Delays and Mixing Times in Random-Access Network*"
Niek Bouman (Eindhoven University of Technology), Sem Borst (Eindhoven University of Technology & Alcatel-Lucent Bell Labs), Johan van Leeuwaarden (Eindhoven University of Technology)

11:30 – 12:00 "*Scheduling of Users with Markovian Time-Varying Service Rates*"
Fabio Cecchi (University of Pisa and BCAM), Peter Jacko (BCAM - Basque Center for Applied Mathematics)

12:00 – 12:30 "*Lingering Issues in Distributed Scheduling*"
Florian Simatos (Eindhoven University of Technology), Niek Bouman (Eindhoven University of Technology), Sem Borst (Eindhoven University of Technology & Alcatel-Lucent Bell Labs)

12:30 – 14:00	Lunch	Rangos Ballroom, University Center Bldg., 2nd Floor

SESSION 5: QUEUEING THEORY
Session Chair: Urtzi Ayesta (LAAS-CNRS)

14:00 – 14:30 "*Exact Analysis of the M/M/k/setup Class of Markov Chains via Recursive Renewal Reward*"
Anshul Gandhi (Carnegie Mellon University), Sherwin Doroudi (Carnegie Mellon University), Mor Harchol-Balter (Carnegie Mellon University), Alan Scheller-Wolf (Carnegie Mellon University)

14:30 – 15:00 "*Queueing System Topologies with Limited Flexibility*"
John N. Tsitsiklis (Massachusetts Institute of Technology), Kuang Xu (Massachusetts Institute of Technology)

SCHEDULE – WEDNESDAY – CONFERENCE

15:00 – 15:30	**Break**	**GHC hall outside Rashid Auditorium**

SESSION 6: NONVOLATILE MEMORIES
Session Chair: Christopher Stewart (Ohio State University)

15:30 – 16:00 "*Stochastic Modeling of Large-Scale Solid-state Storage Systems: Analysis, Design Tradeoffs and Optimization*"
Yongkun Li (The Chinese University of Hong Kong), Patrick P.C. Lee (The Chinese University of Hong Kong), John C.S. Lui (The Chinese University of Hong Kong)

16:00 – 16:30 "*A Mean Field Model for a Class of Garbage Collection Algorithms in Flash-Based Solid State Drives*"
Benny Van Houdt (University of Antwerp)

16:30 – 17:00 "*Revisiting Widely Held SSD Expectations and Rethinking System-Level Implications*"
Myoungsoo Jung (The Pennsylvania State University), Mahmut Kandemir (The Pennsylvania State University)

17:00 – 17:30 "*Characterizing the Impact of Process Variation on Write Endurance Enhancing Techniques for Non-Volatile Memory Systems*"
Marcelo Cintra (Intel), Niklas Linkewitsch (Intel)

17:30 – 18:15 SIGMETRICS RISING STAR AWARD RASHID AUDITORIUM, GHC 4401

Augustin Chaintreau
Computer Science Department, Columbia University
"Information Highway Revisited"

Social media claims the significant fraction of time - and revenue - that was once dedicated to TV and newspapers, and they also keep our scientists busy. Surprisingly, although we learned a lot about social networks, we still have little formal understanding of why they can indeed be useful; some of us even discuss why researching about them is. To answer both questions positively, this talk follows a natural hypothesis - that social networks can naturally enforce efficient communications - but it claims this vision needs to be revisited. In contrast with a series of classical results, as we quickly reached information abundance, and loss of privacy, we desperately need our friends and communities not to receive more, but to receive less.

In an attempt to overview what makes this new research challenge special, this talk presents two recent research results dealing with filtering and privacy in information sharing. Our main results highlight in very different scenarios the need for a potential function that allows the network to stabilize and its users to gain approximately optimal utility. As users greediness and collusions increase, we show a transition where complexity suddenly increases before even the convergence to an equilibrium is jeopardized. We finally motivate more work to be done on the performance evaluation of social networks.

SCHEDULE – WEDNESDAY – CONFERENCE

18:30 – 22:00	**Banquet and Dinosaur Hall**	**Carnegie Museum, 4400 Forbes Ave.** **enter glass doors at fountain (Craig Street)**

SIGMETRICS TEST OF TIME AWARD — PRESENTED AT BANQUET, CARNEGIE MUSEUM

"FAST ACCURATE COMPUTATION OF LARGE-SCALE IP TRAFFIC MATRICES FROM LINK LOADS"

BY YIN ZHANG, MATTHEW ROUGHAN, NICK DUFFIELD, AND ALBERT GREENBERG, SIGMETRICS 2003

SCHEDULE – THURSDAY – CONFERENCE

Thursday, June 20th

8:00am – 8:30am	Breakfast & Registration	GHC 4405

8:30 – 9:15 SIGMETRICS LIFETIME ACHIEVEMENT AWARD RASHID AUDITORIUM

Jean Walrand
UC Berkeley
"Sharing Network Resources"

Networking is about sharing resources, from sharing links with packet-switching to sharing servers in the cloud with virtual machines and parallel algorithms. Progress is driven mostly by clever inventions. In many cases, modeling and analysis lead to improved schemes. The time and space scales of networks necessitate distributed algorithms. Analyzing these algorithms often requires new methods for approximating the complex random dynamics and simplifying the objectives of the control schemes. The demand and available resources are determined by users and businesses. Thus, an economic layer interacts with the technology layer. These interactions are governed by relationships between demand, quality, and prices. These relationships may result from strategic behavior. As the technology evolves, new problems emerge that raise new challenges for researchers. In this talk, I review some of the problems that have fascinated me.

SESSION 7: ON CO-OPTIMIZING CONTENT PLACEMENT AND TRAFFIC ROUTING
Session Chair: Y. C. Tay (National University of Singapore)

9:30 – 10:00 "*Distributing Content Simplifies ISP Traffic Engineering*"
Abhigyan Sharma (University of Massachusetts Amherst), Arun Venkataramani (University of Massachusetts Amherst), Ramesh Sitaraman (University of Massachusetts Amherst and Akamai Technologies)

10:00 – 10:30 "*Quantifying the Benefits of Joint Content and Network Routing*"
Vytautas Valancius (Georgia Tech), Bharath Ravi (Georgia Tech), Nick Feamster (Georgia Tech), Alex C. Snoeren (UC San Diego)

10:30am – 11:00am	Break	GHC 4405

SESSION 8: COMPUTER ARCHITECTURES AND SYSTEMS
Session Chair: Bhuvan Urgaonkar (The Pennsylvania State University)

11:00 – 11:30 "*High-Throughput Low-Latency Fine-Grained Disk Logging*"
Dilip Simha (Stony Brook University and Industrial Technology Research Institute), Ganesh Karuppur Rajagopalan (Stony Brook University), Pallav Bose (Stony Brook University), Tzi-cker Chiueh (Stony Brook University and Industrial Technology Research Institute)

11:30 – 12:00 "*On Understanding the Energy Consumption of ARM-based Multicore Servers*"
Bogdan Marius Tudor (National University of Singapore), Yong Meng Teo (National University of Singapore)

12:00 – 12:30 "*Reuse-based Online Models for Caches*"
Rathijit Sen (University of Wisconsin-Madison), David A. Wood (University of Wisconsin-Madison)

SCHEDULE – THURSDAY – CONFERENCE

12:30 – 14:00	Lunch	Rangos Ballroom, University Center Bldg., 2nd Floor

SESSION 9: OPTIMIZING PATHS DOWN A TREE OR A NETWORK

Session Chair: Florin Ciucu (TU Berlin)

14:00 – 14:30 *"Probabilistic Optimal Tree Hopping for RFID Identification"*
Muhammad Shahzad (Department of Computer Science and Engineering, Michigan State University), Alex X. Liu (Department of Computer Science and Engineering, Michigan State University)

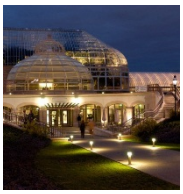
14:30 – 15:00 *"Multipath TCP Algorithms: Theory and Design"*
Qiuyu Peng (EE, California Institute of Technology), Anwar Walid (Bell Labs, Alcatel-Lucent), Steven H. Low (CMS & EE, California Institute of Technology)

15:00 – 15:30 *"Trap Array: A Unified Model for Scalability Evaluation of Geometric Routing"*
Guang Tan (SIAT, Chinese Academy of Sciences, China), Zhimeng Yin (Huazhong University of Science and Technology, China), Hongbo Jiang (Huazhong University of Science and Technology, China)

15:30 – 16:00	Break	GHC hall outside Rashid Auditorium

16:00 – 18:00 **ACTIVITY OPTIONS** (MARKED ON OAKLAND AREA MAP)

$17.95 CARNEGIE MUSEUMS – NATURAL HISTORY, ART
4400 FORBES AVENUE



$15 PHIPPS CONSERVATORY & BOTANICAL GARDENS
1 SCHENLEY DRIVE

$4 CATHEDRAL OF LEARNING
NATIONALITY ROOMS
UNIVERSITY OF PITTSBURGH
4200 FIFTH AVENUE

SCHEDULE – THURSDAY – CONFERENCE

18:00 – 21:00	**INDUSTRIAL RESEARCH FAIR** WITH PIZZA	GATES HILLMAN CENTER 4307 BREAKOUT ROOMS

SCHEDULE – FRIDAY – WORKSHOPS - W-PIN+NetEcon

Friday, June 21st

8:00am – 8:50am	Breakfast & Registration	GHC 4405

W-PIN+NetEcon 2013: The Joint Workshop on
Pricing and Incentives in Networks and Systems
Technical Program
GHC 4303

8:50 - 9:00 Opening remarks

9:00 - 9:30 Invited talk: Mung Chiang (Princeton University, USA)
"*SDP: Smart Data Pricing from Theorems to Trials*"

9:30 - 10:30 Paper session: "Security Games"

"*Multi-Defender Security Games on Networks*"
Yevgeniy Vorobeychik (Sandia National Labs, USA); Andrew Smith (Sandia National Labs, USA); Joshua Letchford (Duke University, USA)

"*Quantifying All-to-One Network Topology Robustness Under Budget Constraints*"
Aron Laszka (Budapest University of Technology and Economics, Hungary); Assane Gueye (National Institute of Standards and Technology, USA)

"*A Game of Clicks: Economic Incentives to Fight Click Fraud in Ad Networks*"
Lemonia Dritsoula (University of California, Santa Cruz, USA); John Musacchio (University of California, Santa Cruz, USA)

10:30am – 11:00am	Break	GHC 4405

11:00 - 11:30 Invited talk: Adam Wierman
"*The Economics of the Cloud: Price Competition and Congestion*"
Jonathan Anselmi (BCAM - Basque Center for Applied Mathematics, Spain); Danilo Ardagna (Politecnico de Milano, Italy); John Chi Shing Lui (The Chinese University of Hong Kong, Hong Kong); Adam Wierman (Caltech, USA); Yunjian Xu (MIT, USA); Zichao Yang (The Chinese University of Hong Kong, Hong Kong)

11:30 - 12:30 Paper session: "Pricing and Neutrality"

"*Demand-Insensitive Price Relationships in Competitive Private Commons*"
Emir Kavurmacioglu (Boston University, USA); Murat Alanyali (Boston University, USA); David Starobinski (Boston University, USA)

"*Revenue Models, Price Differentiation and Network Neutrality Implications in the Internet*"
Costas Courcoubetis (Athens University of Economics and Business, Greece); Kostas Sdrolias (Athens University of Economics and Business, Greece); Richard Weber (University of Cambridge, United Kingdom)

"*ISP and CP Revenue Sharing and Content Piracy*"
Jiwon Park (Yonsei University, Korea); Jeonghoon Mo (Yonsei University, Korea)

SCHEDULE – FRIDAY – WORKSHOPS - **W-PIN+NetEcon**

12:30 – 14:00	Lunch and Posters	GHC 6115

List of Posters

- "*Bundling Strategies in Online Service Markets*"
  Weijie Wu (The Chinese University of Hong Kong, Hong Kong); John Chi Shing Lui (The Chinese University of Hong Kong, Hong Kong); Richard T. B. Ma (National University of Singapore, Singapore)
- "*Computational Asymmetry in Strategic Bayesian Networks*"
  Sebastian Benthall (UC Berkeley School of Information, USA); John Chuang (UC Berkeley, USA)
- "*Mathematical Modeling of Product Rating*"
  Hong Xie (The Chinese University of Hong Kong, Hong Kong); John Chi Shing Lui (The Chinese University of Hong Kong, Hong Kong)
- "*Adoption of bundled services with network externalities and correlated affinities*"
  Roch Guérin (University of Pennsylvania, USA); Jaudelice C. de Oliveira (Drexel University, USA); Steven Patrick Weber (Drexel University, USA)
- "*Incentive-Compatible Online VM Provisioning and Allocation in Clouds*"
  Lena Mashayekhy (Wayne State University, USA); Mahyar Movahed Nejad (Wayne State University, USA); Daniel Grosu (Wayne State University, USA)
- "*Task Allocation in Volunteer Computing Networks under Monetary Budget Constraints*"
  Huseyin Guler (Koc University, Turkey); Berkant Barla Cambazoglu (Yahoo! Research, Spain); Oznur Ozkasap (Koc University, Turkey)
- "*A Cost/Benefit Analysis of Network Vulnerability Reduction: Element Hardening vs. Adding Redundancy*"
  Assane Gueye (National Institute of Standards and Technology, USA); Vladimir Marbukh (National Institute of Standards and Technology, USA)

14:00 - 14:30 Invited talk: Adrian Vetta
"Pricing Mechanisms for a Durable Good Monopolist"
Gerardo Berbeglia (Melbourne Business School, Canada); Peter Sloany (McGill University, Canada); Adrian Vetta (McGill University, Canada)

14:30 - 15:00 Invited talk: Ramesh Johari
"Pricing a Bestseller: Sales and Visibility in the Marketplace for Mobile Apps"
Bar Ifrach (Stanford University, USA); Ramesh Johari (Stanford University, USA)

15:00 - 15:40 Paper session: "Learning and Coordination"

"Bayesian Social Learning with Consumer Reviews"
Bar Ifrach (Stanford University, USA); Costis Maglaras (Columbia University, USA); Marco Scarsini (Singapore University of Technology and Design, Singapore)

"Coordination with Local Information"
Munther Dahleh (MIT, USA); Alireza Tahbaz-Salehi (Columbia Business School, USA); John N. Tsitsiklis (MIT, USA); Spyros Zoumpoulis (MIT, USA)

15:40 – 16:10	Break	GHC hall outside Rashid Auditorium

16:10 - 17:30 Paper session: "Content, Auctions and Advertisement"

"Distributed Content Curation on the Web"
Zeinab Abbassi (Columbia University, USA); Nidhi Hegde (Technicolor, France); Laurent Massoulié (Microsoft Research - INRIA Joint Center, France)

"Incentive Design for Heterogeneous User-Generated Content Networks"
Jie Xu (University of California, Los Angeles, USA); Mihaela van der Schaar (University of California, Los Angeles, USA)

SCHEDULE – FRIDAY – WORKSHOPS - **W-PIN+NetEcon**

"Bidding with Limited Statistical Knowledge in Online Auctions"
Chong Jiang (University of Illinois at Urbana-Champaign, USA); Carolyn Beck (University of Illinois-Urbana Champaign, USA); R. Srikant (University of Illinois at Urbana-Champaign, USA)

"Modeling the Value of Information Granularity in Targeted Advertising"
Swati Rallapalli (University of Texas at Austin, USA); Qiang Ma (Rutgers University, USA); Han Hee Song (NARUS INC., USA); Mario Baldi (Politecnico di Torino, Italy); S Muthu Muthukrishnan (Rutgers University, USA); Lili Qiu (University of Texas at Austin, USA)

17:30 - 17:40 Closing remarks

19:00 – 21:00	**Workshop Reception** **light dinner**	**GHC 6th Floor (6101)** **Collaborative Commons**

SCHEDULE – FRIDAY – WORKSHOPS - **Big Data**

Friday, June 21st

8:00am – 9:00am	**Breakfast & Registration**	**GHC 4405**

Big Data Analytics Workshop
Technical Program
Rashid Auditorium

09:00 *"Device Analyzer: Large-scale Mobile Data Collection"*
Daniel Wagner, Andrew Rice and Alastair Beresford

09:20 *"Optimizing Cloud Utilization via Switching Decisions"*
Eugene Feinberg and Xiaoxuan Zhang

09:40 *"A Fast Derivation of Karhunen-Loeve Transform Kernel for First-Order Autoregressive Discrete Process"*
Onur Yilmaz, Mustafa U. Torun and Ali N. Akansu

10:00 *"Attack Tolerant Big Data File System"*
Bharat Madan

10:30am – 11:00am	**Break**	**GHC 4405**

11:00 *"Big Data Classification: Problems and Challenges in Network Intrusion Prediction with Machine"*
Shan Suthaharan

11:20 *"Modeling and Analytics for Cyber-Physical Systems in the Age of Big Data"*
Abhishek Sharma, Franjo Ivancic, Alexandru Niculescu-Mizil, Haifeng Chen and Guofei Jiang

11:40 *"Analysis of Influence Maximization in Large-Scale Social Networks"*
Jie Hu, Kun Meng, Xiaomin Chen, Chuang Lin and Jiwei Huang

12:00 *"Security Problems and Challenges in a Machine learning-based Hybrid Big Data Processing Network Systems"*
Jeff Whitworth and Shan Suthaharan

12:30 – 13:30	**Lunch**	**GHC 6115**

13:30 – 14:50 KEYNOTE SPEAKER

Rayid Ghani
Computation Institute & Harris School of Public Policy, University of Chicago
"Data, Analytics and the Presidential Elections"

This talk will describe how the Obama Campaign used analytics to help win the presidential elections. We'll talk about how data from a variety of sources was used to improve fundraising, volunteer recruiting and mobilization, and voter targeting across all channels. We will cover what kind of data was available to the campaign, what tools we built on top of it, and how those tools were used to help win the presidential elections.

SCHEDULE – FRIDAY – WORKSHOPS - **Big Data**

14:50 *"Tactical Big Data Analytics: Challenges, Use Cases, and Solutions"*
Onur Savas, Yalin Sagduyu, Julia Deng and Jason Li

15:10 *"A Fast Online Learning Algorithm for Distributed Mining of Big Data"*
Yu Zhang, Daby Sow, Deepak Turaga and Mihaela van der Schaar

15:30 – 16:00	**Break**	**GHC hall outside Rashid Auditorium**

16:00 *"Beyond Graphs: Toward Scalable Hypergraph Analysis Systems"*
Benjamin Heintz and Abhishek Chandra

16:20 *"Dual Direction Big Data Download and Analysis"*
Jameela Al-Jaroodi, Nader Mohamed and Abdulla Eid

16:40 *"Locality Analysis: A Nonillion Time Window Problem"*
Jacob Brock, Hao Luo and Chen Ding

17:00 Closing remarks

19:00 – 21:00	**Workshop Reception** **light dinner**	**GHC 6th Floor (6101)** **Collaborative Commons**

SCHEDULE – FRIDAY – WORKSHOPS - **MAMA**

Friday, June 21st

8:00am – 8:30am	Breakfast & Registration	GHC 4405

MAMA 2013
Technical Program
GHC 4215

08:30 *"Analysis of the GSTF Disk Scheduling Algorithm"*
E. Bachmat, I. Elhanan

09:00 *"Joint Optimization of Overlapping Phases in MapReduce"*
M. Lin, L. Zhang, A. Wierman, J. Tan

09:30 *"Random Access in Wireless Networks: How Much Aggressiveness Can Cause Instability?"*
J. Ghaderi, S. Borst, P. Whiting

10:00 *"Queues with Skill Based Parallel Servers and a FCFS Infinite Matching Model"*
I. Adan, M. Boon, A. Busic, J. Mairesse, G. Weiss

10:30am – 11:00am	Break	GHC 4405

11:00 *"Dynamic Price Optimization for an M/M/k/N Queue with Several Customer Types"*
E.A. Feinberg, F. Yang

11:30 *"Pricing of Service in Clouds: Optimal Response and Strategic Interactions"*
B. Urgaonkar, G. Kesidis, U.V. Shanbhag, C. Wang

12:00 *"Phase Transition of Multi-State Diffusion Model in Networks"*
S. Lim, K. Jung, J.C.S. Lui

12:30 – 13:30	Lunch	GHC 6115

13:30 *"Probing a M/G/1 Queue with General Input and Service Times"*
N. Antunes, G. Jacinto, A. Pacheco

14:00 *"Sojourn Time Distributions in Tandem Batch-Networks at Heavy Traffic: A Product-Form"*
P. Harrison

14:30 *"Queueing with Future Information"*
J. Spencer, M. Sudan, K. Xu

15:00 *"A Martingale-Envelope and Applications"*
F. Poloczek, F. Ciucu

SCHEDULE – FRIDAY – WORKSHOPS - **MAMA**

15:30 – 16:00	Break	GHC hall outside Rashid Auditorium

16:00 *"Fluid Approximations of Many-Server Queues with Delayed Feedback and Heterogeneous Service and Patience Times"*
W. Kang, H. Lu, G. Pang

16:30 *"Diffusion Approximations for Large-Scale Buffered Systems"*
A.B. Dieker, T. Suk

17:00 *"Asymptotics of a Class of Resource Planning Problems"*
Y. Lu, M.S. Squillante, D.D. Yao

17:30 5-Minute Break

17:35 *"Interchange of Limits in Heavy Traffic Analysis under a Moment Condition"*
H.-Q. Ye, D.D. Yao

18:05 *"A Particle Process Underlying SSD Storage Structures"*
E.G. Coffman, P. Momcilovic

18:35 *"Rewards, Costs and Flexibility in Dynamic Resource Allocation: A Stochastic Optimal Control Approach"*
X. Gao, Y. Lu, M. Sharma, M.S. Squillante, J.W. Bosman

19:00 – 21:00	Workshop Reception light dinner	GHC 6th Floor (6101) Collaborative Commons

LOCAL GUIDE – ACTIVITY OPTIONS INFO

ACTIVITY OPTIONS are marked on the Oakland Area map

Carnegie Museum of Natural History
http://www.carnegiemnh.org/

Carnegie Museum of Art
http://web.cmoa.org/

4400 Forbes Avenue
M–Sat 10 am–5 pm, Th 10 am–8 pm
Sun noon–5 pm
Admission includes same-day access to both
Regular Admission: Adults $17.95
Group rate: One complimentary admission for groups of 10–20 people.
Tel: 412.622.3131

Phipps Conservatory & Botanical Gardens
http://phipps.conservatory.org/
1 Schenley Drive
Sat-Th 9:30am – 5pm
F 9:30am – 10pm
Admission $15
10% discount for groups of 15 or more
Tel: 412.622.6914

LOCAL GUIDE – ACTIVITY OPTIONS INFO

CATHEDRAL OF LEARNING, NATIONALITY ROOMS
HTTP://WWW.NATIONALITYROOMS.PITT.EDU/
UNIVERSITY OF PITTSBURGH
4200 FIFTH AVENUE
M-SAT 9AM-4PM
SUN 11AM-4PM
ADMISSION $4
TEL: 412.624.6000

LOCAL GUIDE – TRANSPORTATION

Transportation to and from airport:

Pittsburgh is not a very "cab friendly" city like many other large cities. Our bus service is the best method of transportation to and from the airport. We ***highly*** recommend using the 28X Airport Flyer as your means of transportation. ***All return arrangements to the airport for shuttle, sedan and taxi services need to be made in advance.*** There are not taxis readily available at the conference site.

Bus (Cost: $3.75 one-way, Time: 60-70 mins)
The 28X Airport Flyer bus connects Pittsburgh International Airport directly to Wyndham Pittsburgh University Center, and leaves every half hour, starting from 5:30am and ending with the last bus at 12:00am. Board the bus (first stop) from the lower level of the airport, the Arrivals level, and get down at Forbes Avenue and Bigelow Blvd. From here, you can walk to Wyndham Pittsburgh University Center in about 5 minutes. Here are the complete directions for this trip:http://goo.gl/maps/udFdj

For bus service from Oakland to the Airport, simply walk across the street to the bus terminal on Forbes Avenue across from the Gates-Hillman Center. CMU is the first stop, so there should be plenty of room on the bus. Please see the 28X Airport Flyer schedule for exact times.
***PLEASE NOTE: This is by far the easiest, most convenient method of transportation.**

SuperShuttle (Cost: approx. $25 one-way + tip, Time: approx. 1 hr)
SuperShuttle operates 24 X 7, and is conveniently located on the landside of the airport, lower level, in the baggage claim area, near the car rental counters. This is behind the escalators by Door 4. No reservation is required for service from the airport, but reservation is required for service to the airport. Call 1-800-BLUEVAN (258-3826) for reservations.

Yellow Cab (Cost: approx. $50-$60 one-way + tip, Time: 45 mins)
The Yellow Cab taxi service is the most convenient way of getting to Wyndham Pittsburgh University Center from the airport. Cabs are located in the taxi stand area on the lower level of the airport. No reservation is required for service from the airport, but reservation is required for service to the airport. Call 412-321-8100 for reservations.

Gateway Limousine and Sedan Service (Cost: approx. $50-$60 one-way + tip, Time: 45 mins) 412-782-5800 for reservations.

First Class Limousine and Sedan Service (Cost: approx. $50-$60 one-way + tip, Time: 45 mins) 412-855-4484 for reservations.

Airport Sedan Service (Cost: approx. $50-$60 one-way + tip, Time: 45 mins) 412-401-5466 for reservations.

Classy Cab (Cost: approx. $50-$60 one-way + tip, Time: 45 mins) 412-322-5080 for reservations.

28X AIRPORT FLYER

MONDAY THROUGH FRIDAY SERVICE

To Downtown Pittsburgh and Oakland

Pgh Intl Airport Arrivals-Lower Level Door #6	Robinson Town Ctr Park Manor Blvd at IKEA	Carnegie Bell Station Stop C	Downtown Liberty Ave at Wood St	Blvd of the Allies at Duquesne University	Oakland Forbes Ave at Atwood St	Oakland-CMU Forbes Ave past Meyerwood Ave
5:30	5:44	5:54	6:10	6:14	6:20	6:27
6:00	6:14	6:24	6:40	6:44	6:50	6:57
6:30	6:45	6:57	7:15	7:21	7:28	7:35
7:00	7:15	7:27	7:45	7:51	7:58	8:05
7:30	7:45	7:57	8:15	8:21	8:28	8:35
8:00	8:15	8:27	8:45	8:51	8:58	9:05
8:30	8:45	8:57	9:15	9:21	9:28	9:35
9:00	9:15	9:27	9:45	9:51	9:58	10:05
9:30	9:45	9:57	10:15	10:21	10:28	10:35
10:00	10:14	10:25	10:42	10:48	10:54	11:01
10:30	10:44	10:55	11:12	11:18	11:24	11:31
11:00	11:14	11:25	11:42	11:48	11:54	12:01
11:30	11:44	11:55	12:12	12:18	12:24	12:31
12:00	12:14	12:25	12:42	12:48	12:54	1:01
12:30	12:44	12:55	1:12	1:18	1:24	1:31
1:00	1:14	1:26	1:44	1:50	1:56	2:03
1:30	1:44	1:56	2:14	2:20	2:26	2:33
2:00	2:14	2:26	2:44	2:50	2:56	3:03
2:30	2:44	2:56	3:14	3:20	3:26	3:33
3:00	3:14	3:26	3:44	3:50	3:56	4:03
3:30	3:44	3:56	4:14	4:20	4:26	4:33
4:00	4:15	4:29	4:48	4:55	5:02	5:10
4:35	4:50	5:04	5:23	5:30	5:37	5:45
5:10	5:25	5:38	5:58	6:02	6:09	6:16
5:40	5:55	6:08	6:28	6:32	6:39	6:46
6:10	6:25	6:38	6:58	7:02	7:09	7:16
6:40	6:55	7:08	7:28	7:32	7:39	7:46
7:10	7:25	7:38	7:58	8:02	8:09	8:16
7:35	7:50	8:03	8:21	8:27	8:34	8:41
8:00	8:14	8:25	8:40	8:44	8:50	8:57
8:30	8:44	8:55	9:10	9:14	9:20	9:27
9:00	9:14	9:25	9:40	9:44	9:50	9:57
9:30	9:44	9:55	10:10	10:14	10:20	10:27
10:00	10:13	10:23	10:39	10:43	10:48	10:54
10:30	10:43	10:53	11:09	11:13	11:18	11:24
11:00	11:13	11:23	11:39	11:43	11:48	11:54
11:30	11:43	11:53	12:09	12:13	12:18	12:24
12:00	12:13	12:23	12:39	12:43	12:48	12:54

To Robinson Town Centre - Pittsburgh International Airport

Oakland-CMU Forbes Ave past Meyerwood Ave	Oakland Fifth Ave at Bigelow Blvd	Duquesne University Blvd of the Allies at Marion St	Downtown Seventh Ave at Smithfield St	Sheraden Sheraden Station Stop B	Robinson Town Ctr Park Manor Blvd at IKEA	Pgh Intl Airport Arrivals-Lower Level Door #6
4:25	4:30	4:36	4:40	4:50	5:04	5:17
4:55	5:00	5:06	5:10	5:20	5:34	5:47
5:25	5:30	5:36	5:40	5:50	6:04	6:17
5:55	6:00	6:06	6:10	6:20	6:34	6:47
6:25	6:30	6:36	6:40	6:50	7:04	7:17
6:55	7:00	7:06	7:10	7:20	7:34	7:47
7:25	7:31	7:39	7:43	7:54	8:10	8:24
7:55	8:01	8:09	8:13	8:24	8:40	8:54
8:25	8:31	8:39	8:43	8:54	9:10	9:24
8:55	9:01	9:09	9:13	9:24	9:40	9:54
9:25	9:31	9:39	9:43	9:54	10:10	10:24
9:55	10:01	10:09	10:13	10:24	10:40	10:54
10:25	10:31	10:37	10:41	10:52	11:10	11:23
10:55	11:01	11:07	11:11	11:22	11:40	11:53
11:25	11:31	11:37	11:41	11:52	12:10	12:23
11:55	12:01	12:07	12:11	12:22	12:40	12:53
12:25	12:31	12:37	12:41	12:52	1:10	1:23
12:55	1:01	1:07	1:11	1:22	1:40	1:53
1:25	1:31	1:37	1:41	1:52	2:10	2:23
1:55	2:01	2:07	2:11	2:22	2:40	2:53
2:25	2:31	2:37	2:41	2:52	3:10	3:23
2:55	3:01	3:07	3:11	3:22	3:40	3:53
3:25	3:31	3:40	3:46	4:00	4:20	4:34
3:55	4:01	4:10	4:16	4:30	4:50	5:04
4:25	4:31	4:40	4:46	5:00	5:20	5:34
4:55	5:01	5:10	5:16	5:30	5:50	6:04
5:25	5:31	5:40	5:46	6:00	6:20	6:34
5:55	6:01	6:10	6:16	6:30	6:50	7:04
6:25	6:31	6:40	6:46	7:00	7:20	7:34
6:55	7:00	7:06	7:09	7:20	7:36	7:49
7:25	7:30	7:36	7:39	7:50	8:06	8:19
7:55	8:00	8:06	8:09	8:20	8:36	8:49
8:25	8:30	8:36	8:39	8:50	9:06	9:19
8:55	9:00	9:06	9:09	9:20	9:36	9:49
9:25	9:30	9:36	9:39	9:49	10:03	10:16
9:55	10:00	10:06	10:09	10:19	10:33	10:46
10:25	10:30	10:36	10:39	10:49	11:03	11:16
10:55	11:00	11:06	11:09	11:19	11:33	11:46

SATURDAY SERVICE

To Downtown Pittsburgh and Oakland

Pgh Intl Airport Arrivals-Lower Level Door #6	Robinson Town Ctr Park Manor Blvd at IKEA	Carnegie Bell Station Stop C	Downtown Liberty Ave at Wood St	Blvd of the Allies at Duquesne University	Oakland Forbes Ave at Atwood St	Oakland-CMU Forbes Ave past Meyerwood Ave
5:30	5:44	5:54	6:11	6:15	6:20	6:26
6:00	6:14	6:24	6:41	6:45	6:50	6:56
6:30	6:44	6:54	7:11	7:15	7:20	7:26
7:00	7:14	7:24	7:41	7:45	7:50	7:56
7:30	7:44	7:54	8:11	8:15	8:20	8:26
8:00	8:14	8:24	8:41	8:45	8:50	8:56
8:30	8:44	8:54	9:11	9:15	9:20	9:26
9:00	9:14	9:24	9:41	9:45	9:50	9:56
9:30	9:44	9:54	10:11	10:15	10:20	10:26
10:00	10:14	10:24	10:41	10:45	10:50	10:56
10:30	10:45	10:59	11:17	11:21	11:27	11:34
11:00	11:15	11:29	11:47	11:51	11:57	12:04
11:30	11:45	11:59	12:17	12:21	12:27	12:34
12:00	12:15	12:29	12:47	12:51	12:57	1:04
12:30	12:45	12:59	1:17	1:21	1:27	1:34
1:00	1:15	1:29	1:47	1:51	1:57	2:04
1:30	1:45	1:59	2:17	2:21	2:27	2:34
2:00	2:15	2:29	2:47	2:51	2:57	3:04
2:30	2:45	2:59	3:17	3:21	3:27	3:34
3:00	3:15	3:29	3:47	3:51	3:57	4:04
3:30	3:45	3:59	4:17	4:21	4:27	4:34
4:00	4:15	4:29	4:47	4:51	4:57	5:04
4:30	4:45	4:59	5:17	5:21	5:27	5:34
5:00	5:15	5:29	5:47	5:51	5:57	6:04
5:30	5:45	5:59	6:17	6:21	6:27	6:34
6:00	6:15	6:29	6:47	6:51	6:57	7:04
6:30	6:45	6:59	7:17	7:21	7:27	7:34
7:00	7:14	7:25	7:43	7:47	7:52	7:58
7:30	7:44	7:55	8:13	8:17	8:22	8:28
8:00	8:14	8:25	8:43	8:47	8:52	8:58
8:30	8:44	8:55	9:13	9:17	9:22	9:28
9:00	9:14	9:25	9:43	9:47	9:52	9:58
9:30	9:44	9:55	10:13	10:17	10:22	10:28
10:00	10:13	10:23	10:39	10:43	10:48	10:54
10:30	10:43	10:53	11:09	11:13	11:18	11:24
11:00	11:13	11:23	11:39	11:43	11:48	11:54
11:30	11:43	11:53	12:09	12:13	12:18	12:24
12:00	12:13	12:23	12:39	12:43	12:48	12:54

To Robinson Town Centre - Pittsburgh International Airport

Oakland-CMU Forbes Ave past Meyerwood Ave	Oakland Fifth Ave at Bigelow Blvd	Duquesne University Blvd of the Allies at Marion St	Downtown Seventh Ave at Smithfield St	Sheraden Sheraden Station Stop B	Robinson Town Ctr Park Manor Blvd at IKEA	Pgh Intl Airport Arrivals-Lower Level Door #6
4:25	4:31	4:36	4:40	4:50	5:04	5:17
4:55	5:01	5:06	5:10	5:20	5:34	5:47
5:25	5:31	5:36	5:40	5:50	6:04	6:17
5:55	6:01	6:06	6:10	6:20	6:34	6:47
6:25	6:31	6:36	6:40	6:50	7:04	7:17
6:55	7:01	7:06	7:10	7:20	7:34	7:47
7:25	7:31	7:36	7:40	7:50	8:04	8:17
7:55	8:01	8:06	8:10	8:20	8:34	8:47
8:25	8:31	8:36	8:40	8:50	9:04	9:17
8:55	9:01	9:06	9:10	9:20	9:34	9:47
9:25	9:31	9:36	9:40	9:50	10:04	10:17
9:55	10:01	10:06	10:10	10:20	10:34	10:47
10:25	10:31	10:37	10:41	10:52	11:11	11:25
10:55	11:01	11:07	11:11	11:22	11:41	11:55
11:25	11:31	11:37	11:41	11:52	12:11	12:25
11:55	12:01	12:07	12:11	12:22	12:41	12:55
12:25	12:31	12:37	12:41	12:52	1:11	1:25
12:55	1:01	1:07	1:11	1:22	1:41	1:55
1:25	1:31	1:37	1:41	1:52	2:11	2:25
1:55	2:01	2:07	2:11	2:22	2:41	2:55
2:25	2:31	2:37	2:41	2:52	3:11	3:25
2:55	3:01	3:07	3:11	3:22	3:41	3:55
3:25	3:31	3:37	3:41	3:52	4:11	4:25
3:55	4:01	4:07	4:11	4:22	4:41	4:55
4:25	4:31	4:37	4:41	4:52	5:11	5:25
4:55	5:01	5:07	5:11	5:22	5:41	5:55
5:25	5:31	5:37	5:41	5:52	6:11	6:25
5:55	6:01	6:07	6:11	6:22	6:41	6:55
6:25	6:31	6:37	6:41	6:52	7:11	7:25
6:55	7:01	7:06	7:10	7:21	7:36	7:49
7:25	7:31	7:36	7:40	7:51	8:06	8:19
7:55	8:01	8:06	8:10	8:21	8:36	8:49
8:25	8:31	8:36	8:40	8:51	9:06	9:19
8:55	9:01	9:06	9:10	9:21	9:36	9:49
9:25	9:30	9:35	9:38	9:48	10:02	10:15
9:55	10:00	10:05	10:08	10:18	10:32	10:45
10:25	10:30	10:35	10:38	10:48	11:02	11:15
10:55	11:00	11:05	11:08	11:18	11:32	11:45

Light type indicates AM times. **Bold type indicates PM times.**

28X AIRPORT FLYER

SUNDAY AND HOLIDAY SERVICE

To Downtown Pittsburgh and Oakland

Pgh Intl Airport Arrivals-Lower Level Door #6	Robinson Town Ctr Park Manor Blvd at IKEA	Carnegie Bell Station Stop C	Downtown Liberty Ave at Wood St	Uptown Blvd of the Allies at Duquesne University	Oakland Forbes Ave at Atwood St	Oakland-CMU Forbes Ave past Meyerwood Ave
5:30	5:44	5:54	6:11	6:15	6:20	6:26
6:00	6:14	6:24	6:41	6:45	6:50	6:56
6:30	6:44	6:54	7:11	7:15	7:20	7:26
7:00	7:14	7:24	7:41	7:45	7:50	7:56
7:30	7:44	7:54	8:11	8:15	8:20	8:26
8:00	8:14	8:24	8:41	8:45	8:50	8:56
8:30	8:44	8:54	9:11	9:15	9:20	9:26
9:00	9:14	9:24	9:41	9:45	9:50	9:56
9:30	9:44	9:54	10:11	10:15	10:20	10:26
10:00	10:14	10:24	10:41	10:45	10:50	10:56
10:30	10:45	10:59	11:17	11:21	11:27	11:34
11:00	11:15	11:29	11:47	11:51	11:57	12:04
11:30	11:45	11:59	12:17	12:21	12:27	12:34
12:00	12:15	12:29	12:47	12:51	12:57	1:04
12:30	12:45	12:59	1:17	1:21	1:27	1:34
1:00	1:15	1:29	1:47	1:51	1:57	2:04
1:30	1:45	1:59	2:17	2:21	2:27	2:34
2:00	2:15	2:29	2:47	2:51	2:57	3:04
2:30	2:45	2:59	3:17	3:21	3:27	3:34
3:00	3:15	3:29	3:47	3:51	3:57	4:04
3:30	3:45	3:59	4:17	4:21	4:27	4:34
4:00	4:15	4:29	4:47	4:51	4:57	5:04
4:30	4:45	4:59	5:17	5:21	5:27	5:34
5:00	5:15	5:29	5:47	5:51	5:57	6:04
5:30	5:45	5:59	6:17	6:21	6:27	6:34
6:00	6:15	6:29	6:47	6:51	6:57	7:04
6:30	6:45	6:59	7:17	7:21	7:27	7:34
7:00	7:14	7:25	7:43	7:47	7:52	7:58
7:30	7:44	7:55	8:13	8:17	8:22	8:28
8:00	8:14	8:25	8:43	8:47	8:52	8:58
8:30	8:44	8:55	9:13	9:17	9:22	9:28
9:00	9:14	9:25	9:43	9:47	9:52	9:58
9:30	9:44	9:55	10:13	10:17	10:22	10:28
10:00	10:13	10:23	10:39	10:43	10:48	10:54
10:30	10:43	10:53	11:09	11:13	11:18	11:24
11:00	11:13	11:23	11:39	11:43	11:48	11:54
11:30	11:43	11:53	12:09	12:13	12:18	12:24
12:00	12:13	12:23	12:39	12:43	12:48	12:54

To Robinson Town Centre - Pittsburgh International Airport

Oakland-CMU Forbes Ave past Meyerwood Ave	Oakland Fifth Ave at Bigelow Blvd	Duquesne University Blvd of the Allies at Marion St	Downtown Seventh Ave at Smithfield St	Sheraden Sheraden Station Stop B	Robinson Town Ctr Park Manor Blvd at IKEA	Pgh Intl Airport Arrivals-Lower Level Door #6
4:25	4:31	4:36	4:40	4:50	5:04	5:17
4:55	5:01	5:06	5:10	5:20	5:34	5:47
5:25	5:31	5:36	5:40	5:50	6:04	6:17
5:55	6:01	6:06	6:10	6:20	6:34	6:47
6:25	6:31	6:36	6:40	6:50	7:04	7:17
6:55	7:01	7:06	7:10	7:20	7:34	7:47
7:25	7:31	7:36	7:40	7:50	8:04	8:17
7:55	8:01	8:06	8:10	8:20	8:34	8:47
8:25	8:31	8:36	8:40	8:50	9:04	9:17
8:55	9:01	9:06	9:10	9:21	9:36	9:49
9:25	9:30	9:35	9:38	9:48	10:02	10:15
9:55	10:00	10:05	10:08	10:18	10:32	10:45
10:25	10:30	10:35	10:38	10:48	11:02	11:15
10:55	11:00	11:05	11:08	11:18	11:32	11:45

Welcome Aboard the Airport Flyer!

- The fare is **$3.75** between Oakland, Downtown Pittsburgh, Robinson Town Centre and Pittsburgh International Airport.
- The fare is **$2.50** between the West Busway, Downtown Pittsburgh and Oakland.
- Operators do not carry change. Exact change is required when paying your fare.
- Port Authority transfers, Weekly and Monthly passes, and 12-month subscription annual passes are also accepted. Fares are paid when boarding.
- You are responsible for handling your bags both on and off the vehicle. Because this is public transportation, tipping operators is not permitted.

WEST BUSWAY SERVICE

West Busway Stops

All **inbound** 28X trips will both pick up and discharge at **Stop C** at Bell, Idlewood, Crafton, Ingram and Sheraden stations.

All **outbound** 28X trips will **pick up only** at **Stop B** at Sheraden, Ingram, Crafton, Idlewood and Bell stations.

Riders returning to the West Busway from Oakland may take any 61 or 71 series route from Oakland and transfer in Downtown Pittsburgh to **G2 West Busway-All Stops**. See G2 timetable for schedule and Downtown bus stop locations.

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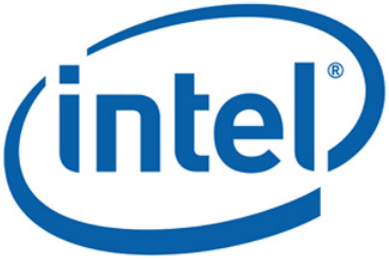
LOCAL GUIDE – TRANSPORTATION

Thanks for your support

Gold-level



Silver-level

Microsoft Research

Bronze-level