Peter Cramton is Professor of Economics at the University of Cologne and the University of Maryland. Since 1983, he has conducted research on auction theory and practice. This research appears in leading economics journals. The focus is the design of auction-based markets. Applications include communications, electricity, and financial markets. On the practical side, he is an independent director on the board of the Electric Reliability Council of Texas and an advisor and chief economist to several companies. Since 1993, he has advised 13 governments and 41 bidders in spectrum auctions. He is a co-inventor of the spectrum auction design used in Canada, Australia, and many European countries to auction spectrum. Since 2001, he has played a lead role in the design and implementation of electricity and gas auctions in North America, South America, and Europe. He has advised on the design of carbon auctions in Europe, Australia, and the United States, including conducting the world’s first greenhouse-gas auction held in the UK in 2002. He has led the development of innovative auctions in new applications, such as auctions for airport slots, wind rights, diamonds, medical equipment, and Internet top-level domains. He received his B.S. in Engineering from Cornell University in 1980 and his Ph.D. in Business from Stanford University in 1984.

The following pages present (1) Professor Cramton’s experience advising bidders in spectrum auctions, (2) his experience advising governments on the design and implementation of spectrum auctions, and (3) his research on spectrum auctions. His understanding of spectrum auctions is enhanced from the depth of his experience advising bidders, advising governments, and researching spectrum auctions.
Experience of Peter Cramton Advising Bidders in Spectrum Auctions

Since 1994, Peter Cramton has advised numerous bidders in spectrum auctions around the world. Evidence of the success of his advice is seen in the fact that his clients both have won the licenses they desired and generally paid less for the spectrum they have won than other bidders did in the same auction. The experience includes most of the largest spectrum auctions in the world, but also several smaller auctions. The bidders have ranged from small new entrants to the largest telecommunications companies in the world. Below is a list of this experience in chronological order, indicating the auction, the bidder, and a summary of the outcome.

He utilizes a state-of-the-art commercial auction platform, customized to a country’s particular setting, in a series of strategic mock auctions to illuminate the key strategic issues at work. These experiences are one key factor in the development of a robust auction strategy and an adaptive valuation model. He also makes use of powerful simulation techniques to further understand the auction dynamics and establish robustness of strategies.

1. **US Nationwide Narrowband auction, July 1994**
Paging Network, Inc. won three nationwide licenses (the maximum allowed). PageNet paid the same as the other bidders on two licenses, and paid $1 million less for the third license.

2. **US AB-block Broadband PCS auction, March 1995**
MCI Communications, Inc. decided not to participate in the auction at the last moment.

3. **US C-block Broadband PCS, May 1996**
Pocket Communication was the second largest bidder, spending $1.2 billion. Pocket paid significantly less than the other bidders for the spectrum it won. Pocket Communications has since ceased operations.

4. **US DARS auction, April 1997**
CD Radio, Inc. won one of the two identical licenses for $83 million. The other winner paid $7 million more.

5. **US 220 MHz auction, October 1998**
Sophia Communications won one of the three nationwide licenses, paying $.5 million less than the other winners.

6. **Canadian 24/38 GHz auction, November 1999**
Stream Intelligent Networks was the only firm to win a nationwide footprint. Paid less than the other bidders in many markets.

7. **Swiss Wireless Local Loop auction, April 2000**
Callino won one of the three nationwide licenses. Callino paid less than one-half the price (55 million francs) for twice the bandwidth of the other two nationwide winners (the next least expensive was 121 million francs).

8. **UK UMTS auction, May 2000**
One 2 One Communications paid over 27 million pounds less than the other two winners of a 2x10 MHz license.
9. **Dutch UMTS auction, July 2000**
Ben (3G-Blue) paid over 77 million guilders less than the other two winners of a 2x10 MHz licenses.

10. **Italy UMTS auction, October 2000**
Omnitel acquired one of the five identical licenses. Omnitel paid a few “ticks” above the party that paid the least (TIM). This was the result of Omnitel’s excellent bidding strategy, which rightly valued being above the weakest incumbent (Blu) and the two potential entrants. Indeed, TIM followed a poor strategy and paid the least, illustrating the point that good strategy can only reduce your expected payment, rather than guarantee that you pay the least. A good outcome depends on both good strategy and good luck. TIM was lucky. Omnitel paid essentially the same as TIM; TIM was lucky that it did not pay a bid increment (5%) more than Omnitel.

11. **Australia 3.4 GHz auction, October 2000**
Austar won its desired licenses in Sydney and Melbourne for $14 million.

12. **UK Broadband Fixed Wireless auction, November 2000**
FirstMark Communications withdrew from the auction without bidding, after a shift in corporate strategy. The FirstMark office in the UK is now closed.

13. **Austrian UMTS auction, November 2000**
T-Mobile won the licenses it desired.

14. **Swiss UMTS auction, November 2000**
T-Mobile decided not to participate in the auction one business-day before the auction began.

15. **US 700 MHz guard band auction, September 2000**
Access Spectrum acquired a desirable group of complementary licenses at attractive prices, typically significantly less than the other winner in each market.

16. **US 700 MHz guard band reauction, February 2001**
In the reauction, Access Spectrum was successful in winning two of the six major licenses up for auction.

17. **US C & F auction, January 2001**
Burst Wireless won one 2nd tier license and two 3rd tier licenses for $16 million. These licenses will enable Burst to deploy its technology in important test markets.

18. **Belgian UMTS auction, March 2001**
Belgacom Mobile (Proximus) won its preferred 3G license (block A) for €150.2 million, €0.2 million above the reserve price.

19. **Singapore UMTS auction, April 2001**
MobileOne won its preferred 3G license at the reserve price.

20. **Israeli LMDS auction, Summer 2001**
Cellcom won its desired licenses in LMDS.

21. **Israeli UMTS auction, Fall 2001**
Cellcom won its desired licenses in UMTS.
22. **US Narrowband auction, October 2001**
Space Data Corp. won 83% of the spectrum and paid less than $0.02/MHz-pop for the spectrum won.

23. **Taiwan UMTS auction, January 2002**
KGT decided at the last minute not to participate directly in the auction.

24. **UK 3.4 GHz Broadband Fixed Wireless auction, June 2003**
PCCW sought and won nationwide coverage.

25. **Mexico 800 MHz SMR auction, January 2005**
Nextel de Mexico won nearly all of the 800 MHz spectrum at prices close to the reserve.

26. **US Advanced Wireless Services auction, August 2006**
T-Mobile was the main winner in the AWS auction, acquiring much needed nationwide spectrum to complement its existing PCS spectrum. T-Mobile spent $4.2 billion. The work entailed developing an auction rule on information policy, which was adopted by the FCC, as well as two strategy meetings and advice throughout the auction. T-Mobile paid substantially less for the spectrum it won than its major rival, Verizon Wireless.

27. **US 700 MHz auction, January 2008**
Frontline Wireless, a major startup, sought a nationwide license adjacent to the public safety spectrum. Frontline Wireless intended to build a 4G nationwide network with unprecedented coverage in a private/public partnership in which the open access network is shared between public safety use and commercial use. I engaged in extensive regulatory work in the year leading up to the auction. In addition, I developed a bid tracking tool for Frontline Wireless, met with potential investors, and led a team to develop auction strategy. The financial crisis, as well as certain regulatory decisions, made it impossible for Frontline Wireless to raise the capital necessary to bid and follow through on its business plan.

28. **Netherlands 2.6 GHz auction, 2008-2009**
Advised T-Mobile Netherlands in preparation for the 2.6 GHz auction in the Netherlands.

Advised a potential bidder in preparation for the 3G and BWA auctions in India. On 19 Dec 2008, the bidder decided not to bid in the auction.

Advised T-Mobile on some preliminary research on a suitable design for the FCC’s AWS-3 auction.

Advised Tata in preparation for the 3G and BWA auctions in India. Developed and conducted mock auctions, led strategy sessions, and developed auction simulator to evaluate tradeoffs.

32. **German 4G auction, 2009-2010**
Advised Deutsche Telekom in preparation for and execution during the 4G auction of 360 MHz of spectrum in four bands. Developed and conducted mock auctions, led strategy sessions, and developed auction simulator and bid tracking tool.

33. **Mexican 1.9 (PCS) and 1.7/2.1 (AWS) auctions, 2010**
Advising Nextel in preparation for and execution during the auction of spectrum in two bands.
34. Italy 4G auction, 2011
Advised Wind in preparation for and execution during the auction of spectrum several bands. Developed and conducted mock auctions, led strategy sessions, and developed auction simulator and bid tracking tool.

35. Portugal 4G auction, 2011
Advised Portugal Telecom in preparation for and during the auction of spectrum several bands. Developed and conducted mock auctions, led strategy sessions, and developed auction simulator and bid tracking tool.

36. Brazil 2.5 GHz auction, 2012
Advised a major bidder in preparation for the auction of the 2.5 GHz band.

37. Taiwan 4G auction, 2013
Advised Taiwan Mobile in preparation for and during the auction of spectrum in the 700, 900 and 1800 MHz bands. Developed and conducted mock auctions, led strategy sessions, and developed auction simulator and bid tracking tool.

38. United States AWS-3 auction, 2014
Advised T-Mobile in preparation for and during the auction of the AWS-3 spectrum band. Advised on auction rules and conducted two bidding strategy workshops.

39. United States incentive auction, 2015-2017
Advising OTA Broadcasting, a major bidder in the incentive auction of the 600 MHz band. The work has involved extensive analysis of the reverse auction to acquire TV broadcast spectrum and then the forward auction to repurpose the spectrum for mobile broadband. The analysis has overcome computational challenges through the use of highly efficient algorithms run on clusters of computational servers (cloud computing). The analysis was used to advise the FCC on auction design and implementation details. It also was an essential aid in developing and executing a successful bidding strategy.

40. Taiwan auction, 2015
Advised Taiwan Mobile in preparation for and during the auction of spectrum in multiple bands. Advised on auction rules and developed auction simulator and bid tracking tool.

41. Taiwan auction, 2017
Advised Taiwan Mobile in preparation for and during the auction of spectrum in multiple bands. Advised on auction rules and strategy and developed auction simulator and bid tracking tool.

42. Canadian 600 MHz auction, 2018
Advised Freedom Mobile in preparation for and during the auction of the 600 MHz auction. Advised on auction rules and strategy.
Experience of Peter Cramton Advising Governments in Spectrum Auctions

Since 1994, Peter Cramton has advised governments in nine countries on the design and implementation of spectrum auctions. His advice for an auction is always exclusive; that is, he advises the government or a bidder, but never both in the same auction. His experience includes both large developed countries as well as small developing countries. Below is a list each country and the auctions in chronological order.

1. United States Federal Communications Commission, 1995 to 2005
Advised on the design and implementation of several spectrum auctions, including the regional narrowband auction and the first broadband auction (the AB block auction). Most recently, he has advised the FCC on its next generation of spectrum auctions with package bids. A clock auction with package bids was tested.

Advised on the design of Mexico’s early paging auctions.

3. Australian Communications Authority, 1997
Advised on the design of Australia’s mobile wireless auction.

4. Austrian Telekom Control, 1998
Advised on the design of Austria’s early spectrum auctions.

5. Industry Canada, 2000
Advised on the design of Canada’s PCS spectrum auction.

Advised on the design of Nigeria’s first spectrum auction.

7. Trinidad and Tobago Telecommunications Authority, 2005
Designed and implemented Trinidad and Tobago’s first spectrum auction, introducing two new entrants to compete with the government monopoly. The auction was a variation of the clock-proxy design.

8. Ofcom, United Kingdom, 2006 to 2016
Multi-day workshop on spectrum auction design and strategy. Design and development of the L-Band and 10-40 GHz auctions conducted in 2008. Design and development of the proposed 2.6 GHz auction. Developed, conducted, and analyzed mock auctions to test the design of the L-Band, 10-40 GHz, and 2.6 GHz auctions. Together with Bob Day, developed optimization software to determine the assignment and prices given the bids. Design and development of the combined auction of the 800 MHz spectrum and other bands to be conducted in 2011.

Member of a panel of economists providing advice to Singapore on spectrum allocation policy, especially spectrum auction design.

10. Competition Bureau, Canada, 2007
Advised on competition issues in preparation for Canada’s AWS auction to be held in 2008. Recommended the use of a set-aside for new entrants to encourage competition in both the AWS auction and in the downstream market for wireless services.
11. **Industry Canada, Canada, 2007**
Participated in a one-day workshop advising Industry Canada on spectrum auction design and competition issues for Canada’s AWS auction to be held in 2008.

12. **Industry Canada, Canada, 2008**
Advise Industry Canada on spectrum auction design and implementation for Canada’s upcoming spectrum auctions.

13. **Industry Canada, Canada, 2010 to 2016**
Advise Industry Canada on spectrum auction design and implementation for Canada’s upcoming spectrum auctions for the 700 MHz and 2.5 GHz bands.

14. **Infocom Development Authority, Singapore, 2011**
Advise Singapore on spectrum auction design for 700 MHz, 2.3 GHz, and 2.5 GHz bands.

15. **ACMA, Australia, 2011 to 2013**
Advise ACMA on spectrum auction design and implementation for Australia’s upcoming 4G spectrum auction.

16. **Rivada, March 2014 to present**
As Chief Economist of Rivada Networks, developed an open access wireless market to transform trading and competition in mobile communications. The open access market is now being refined for potential implementation in the United States, Mexico, and other countries.

17. **ACMA, Australia, 2015 to present**
Advise ACMA on spectrum auction design and implementation for Australia’s upcoming spectrum auctions.

18. **Dutch Ministry of Economic Affairs, Netherlands, 2018 to present**
Advise on the design of 5G auctions.
Research of Peter Cramton on Spectrum Auctions

Professor Cramton is among the most widely cited authors on spectrum auctions. Five of the top-ten articles in the Google Scholar search “spectrum auctions” point to articles he has authored.
Professor Cramton has written 51 papers on or closely related to spectrum auctions. This work appears below. The full text of all papers is available at www.cramton.umd.edu.


