Traffic-Driven Dynamic Spectrum Auctions

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Increasing Traffic Dynamics

- Spectrum usage should adapt to traffic demands
- Crowded unlicensed spectrum band......
- Utilize unused spectrum pieces from legacy spectrum owners

From Dartmouth Campus WiFi Traces
What if Add One More Channel?

Auctioneer

One extra channel

Spectrum Auction

- Pricing based on market demands
- Good for distributing scarce resources

Dynamic Spectrum Auctions
Goal:
Investigate the System Performance

- Dynamic spectrum auctions based on real traffic traces
- Examining various bidding strategies
- Investigating the choice of auction cycles
Outline

- Motivation
- Dynamic spectrum auction design
- Experiments
- Conclusion
- Related work
Design of Dynamic Spectrum Auctions

The Channel for Auctioning

Auctioneer

Periodic Bidding

Determine winners to maximize revenue

Greedy Approximate Clearing Algorithm

Winners: B, D, E

Bidders

Uniform Budget

Traffic-driven Budget

Interference Constraints
Experiments

- 28 APs
- One baseline channel, one channel for auctioning (2Mbps)
- CRAWDAD traces (Feb. 12, 2004) for simulating traffic dynamics
  - Aggregate the packets within each 5 minute-Interval based on the auction cycle

Evaluation metrics
- Bidder satisfaction $S(i)$ at auction interval $i$

$$S(i) = \frac{\text{#Packets sent}}{\text{#Total traffic demand}}$$

**Satisfaction per price** for cost-effectiveness: $S(i) / Price(i)$

- Throughput
Impact of Bidding Strategies

- **Bidding strategy**
  - Uniform bidding
  - Random bidding
  - Traffic-aware bidding

- **Uniform budget**
  - Traffic-aware bidding
  - Random bidding
  - Uniform bidding

- **Traffic-driven budget**
  - Traffic-aware bidding
  - Random bidding
  - Uniform bidding

Traffic-aware bidding achieves better cost-effectiveness.
Auction Efficiency

- Option 1: Share baseline channel
- Option 2: Add one channel through auction
- Option 3: Add one channel through sharing

Spectrum auctions consider economics with minimum degradation in spectrum utilization.
Large vs. Short Auction Cycles

We need to choose auction interval carefully to utilize spectrum efficiently with affordable complexity.
Conclusion

- Evaluate the *performance* of dynamic spectrum auctions using *real traces*

**Findings**
- Dynamic spectrum auctions consider economics without loss in spectrum utilization
- Traffic-aware bidding is cost-effective particularly for users with bursty traffic
- Auction cycles should be chosen carefully to efficiently utilize spectrum with affordable complexity
Related work

- **Spectrum auctions**
  - Transmission power auction [Huang04,05]
  - Spectrum channels auction [Gandhi07]

- **Spectrum pricing**
  - Demand responsive pricing [Ileri05]
  - Cellular networks [Buddhikot05]
  - Hybrid pricing [Ryan06]
Thank you