

Development of Open Source Software for Power Market Research: An Illustrative Case Study

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Presented by

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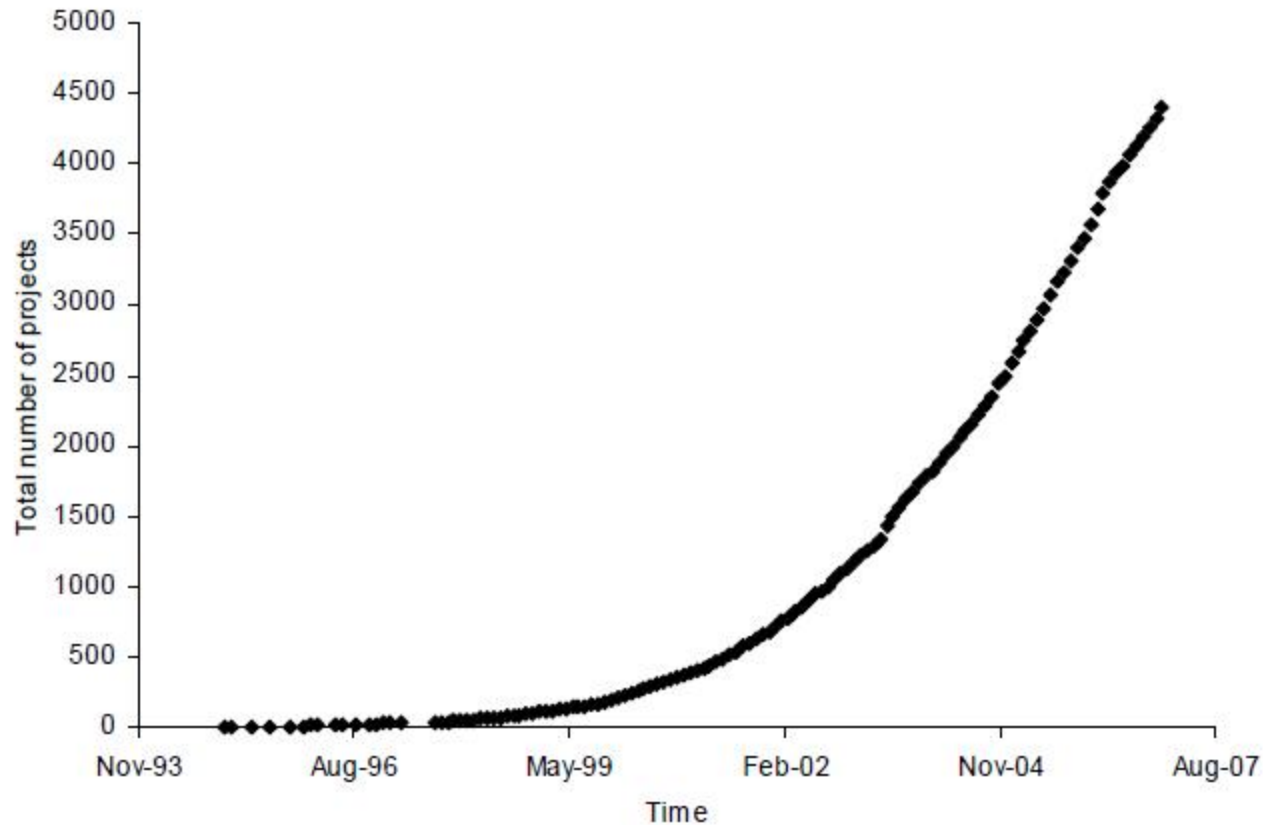
Presentation Slides:

<http://www.econ.iastate.edu/tesfatsi/OSSAMESTalk.2009IEEEPESGM.pdf>

Overview

- ◆ Introduction
- ◆ OSS for Power Market Research
- ◆ Illustrative OSS Application:
The AMES Wholesale Power Market Test Bed
- ◆ Conclusion

Open Source Software (OSS) Project Growth



OSS Project Growth from November 1993 through August 2007

Source: Deshpande and Riehle (2008)

Why OSS for Power Market Research?

- ◆ Traditionally, the power industry has relied on commercial software for SCADA, EMS, DMS, and other basic uses.
- ◆ Recent restructuring of power markets has led to complicated new kinds of customer service requirements:
 - ◆ Two settlement systems
 - ◆ Locational marginal pricing
 - ◆ Ancillary service markets
 - ◆ Advanced metering infrastructure
- ◆ These power market requirements continue to evolve.

Why OSS... Continued

◆ Pros:

- ❑ Permits accurate understanding of implementations
- ❑ Encourages more industry/academic collaborations
- ❑ Facilitates intensive experimentation with current implementations as well as testing of new proposals
- ❑ Highly useful for hands-on classroom instruction

◆ Cons:

- ❑ Market operators for restructured power markets could have legitimate security concerns regarding code release.
- ❑ Similar concerns could lead to restrictions on data release
- ➔ Could limit practical usefulness of OSS power market research

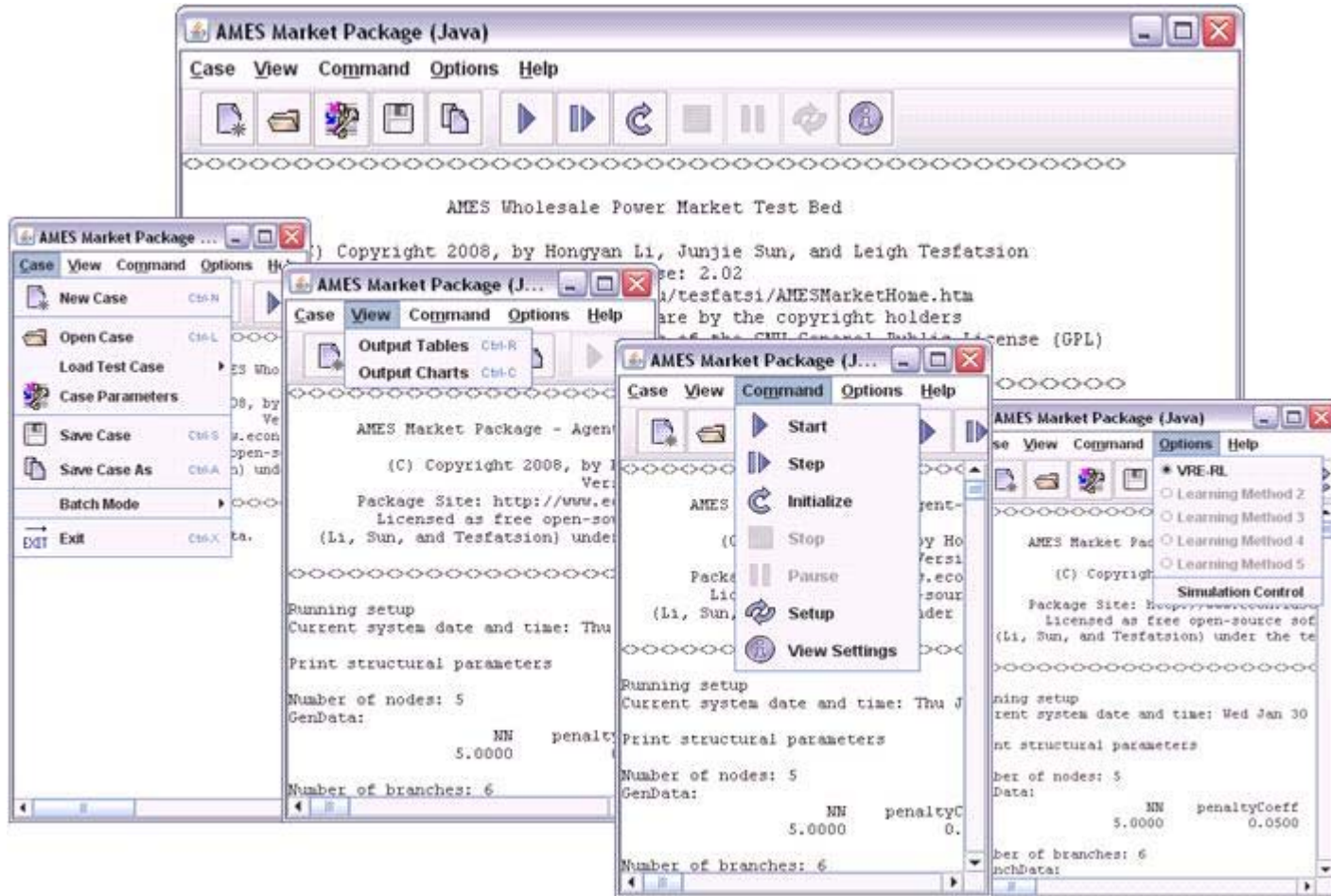
An Illustrative OSS Power Market Application: The AMES Wholesale Power Market Test Bed

- ◆ **Research/teaching/training-grade test bed** (2-500 pricing nodes)
- ◆ **Operational validity** ("simple but not too simple")
- ◆ Permits **dynamic** testing with **learning traders**
- ◆ Permits intensive experimentation with **alternative scenarios**
- ◆ Free open-source **Java** implementation (full access to code)
- ◆ **Flexible & modular** (easy to modify test bed features)
- ◆ V1.31 released (IEEE PES GM, 2007)
- ◆ **V2.02 released** (IEEE PES GM, 2008)
- ◆ **V3.0 in progress** (fuller modeling of SCUC & risk management)

AMES Homepage (downloads/manuals/pubs):

www.econ.iastate.edu/tesfatsi/AMESMarketHome.htm

AMES Graphical User Interface (GUI): Tool Bar and Menus

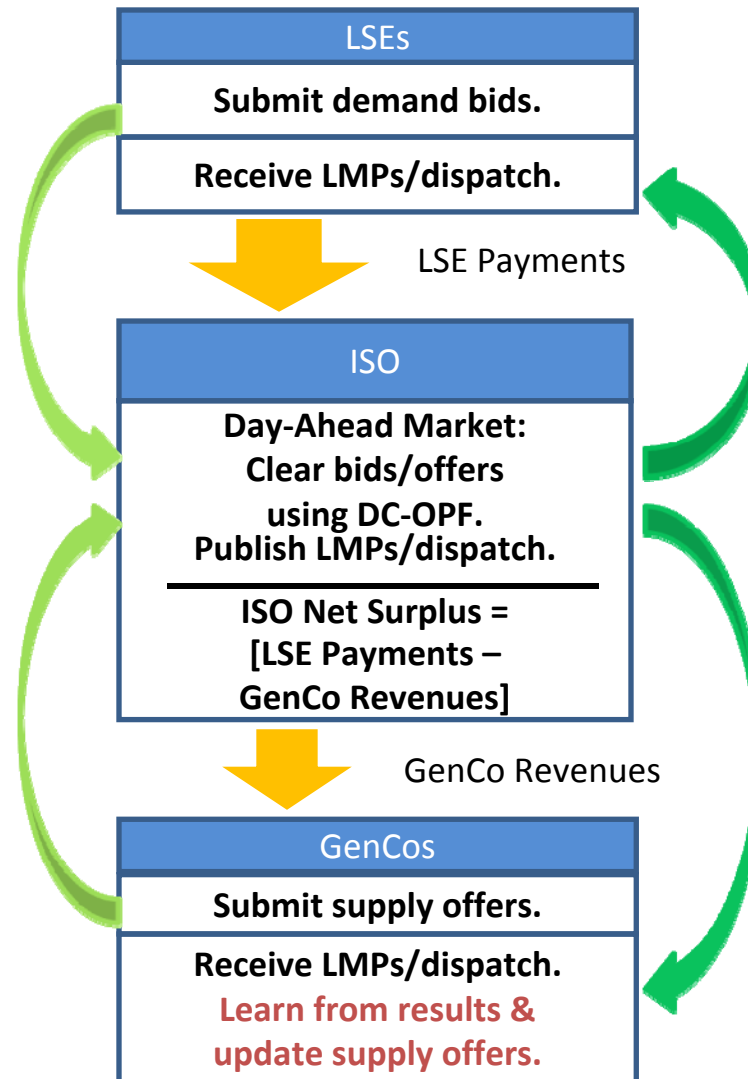


AMES Architecture: Current Implementation

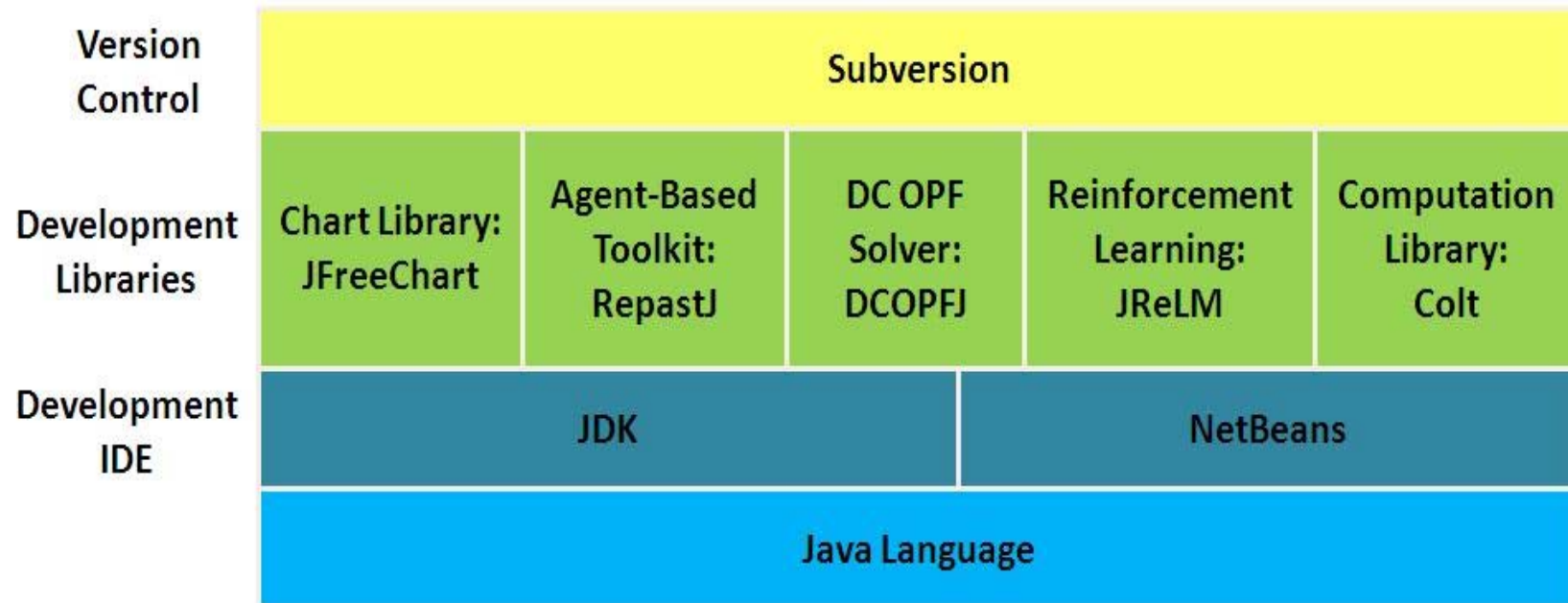
(Based on business practices manuals for MISO/ISO-NE)

- **Traders**
 - ❑ LSEs (bulk-power buyers)
 - ❑ GenCos (bulk-power sellers with *learning capabilities*)
- **Independent System Operator (ISO)**
 - ❑ Day-ahead hourly scheduling via *bid/offer-based DC OPF*
 - ❑ System reliability assessments
- **Two-settlement process**
 - ❑ *Day-ahead market* (double auction, financial contracts)
 - ❑ *Real-time market* (settlement of differences)
- **AC transmission grid**
 - ❑ LSEs & GenCos located at user-specified buses across the *transmission grid*
 - ❑ Congestion managed via *Locational Marginal Pricing (LMP)*, i.e., the pricing of power by the location and timing of its injection into, or withdrawal from, the transmission grid.

Data Flow for Key AMES Agents in Day-Ahead Market



OSS Development Tools Used



Research Findings to Date

- ◆ Effects on LMPs, dispatch levels, GenCo/LSE net earnings, and ISO net surplus (congestion rents) from changes in
 - GenCo learning methods
 - Price-sensitivity of demand
 - Supply offer price caps
- ◆ GenCo economic/physical capacity withholding (market power)
- ◆ Spatial correlations among GenCo supply offers and LMPs
- ◆ Security issues – Security-Constrained Unit Commitment (SCUC) using mixed integer linear programming (MILP)

Conclusion

◆ Desirability of OSS for Power Market Research:

- ❑ Permits accurate understanding & verification of implementations
- ❑ Facilitates more industry/academic collaborations
- ❑ Facilitates intensive experimentation with current implementations as well as testing of new proposals
- ❑ Highly useful for hands-on classroom instruction

On-Line Resources

- ◆ H. Li and L. Tesfatsion, “Development of OSS for Power Market Research: The AMES Test Bed,” *Journal of Energy Markets*, Vol. 2, No. 2, Summer 2009, pp. 111-128.
<http://www.journalofenergymarkets.com/>
- ◆ AMES Wholesale Power Market Test Bed Homepage (OSS Downloads/Manuals/Pubs)
www.econ.iastate.edu/tesfatsi/AMESMarketHome.htm
- ◆ OSS for Electricity Market Research, Teaching, and Training
www.econ.iastate.edu/tesfatsi/ElectricOSS.htm
- ◆ IEEE Task Force on OSS for Power Systems
http://ewh.ieee.org/cmte/psace/CAMS_taskforce/index.htm