FEDERAL ENERGY REGULATORY COMMISSION

OFFICE OF ENERGY POLICY AND INNOVATION

TECHNICAL CONFERENCE ON UNIT COMMITMENT SOFTWARE

Solving Hard Mixed Integer Programming Problems

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Agenda

» LP & MIP performance

» Solving problems faster

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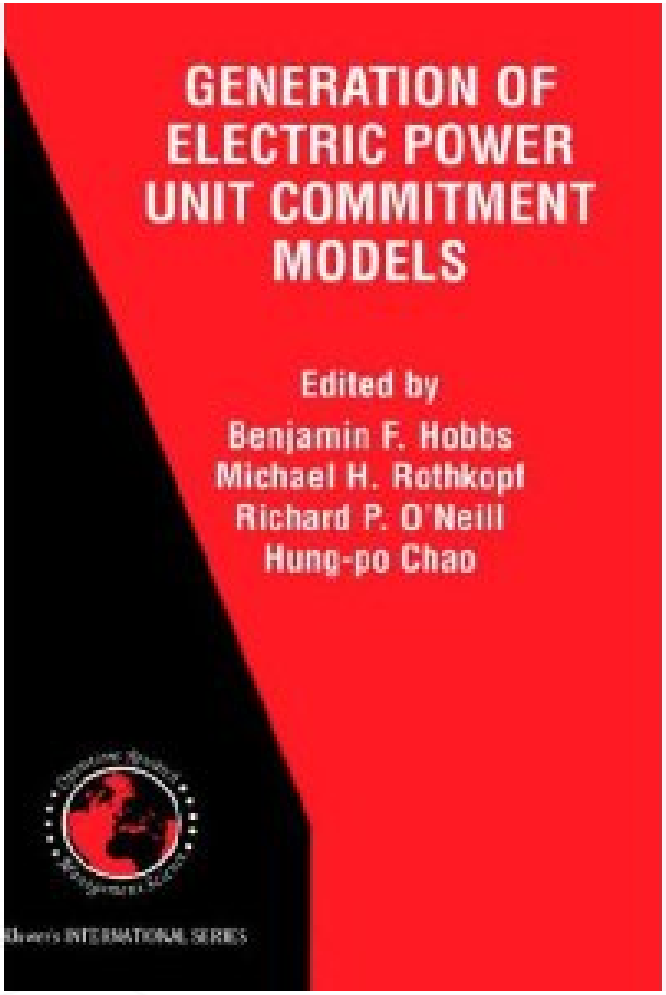
Shifting paradigm: From Heuristics to MIP



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Technologies

- » Linear Programming
- » Integer Programming
- » Heuristics
- » Constrained Programming
- » Business Rules

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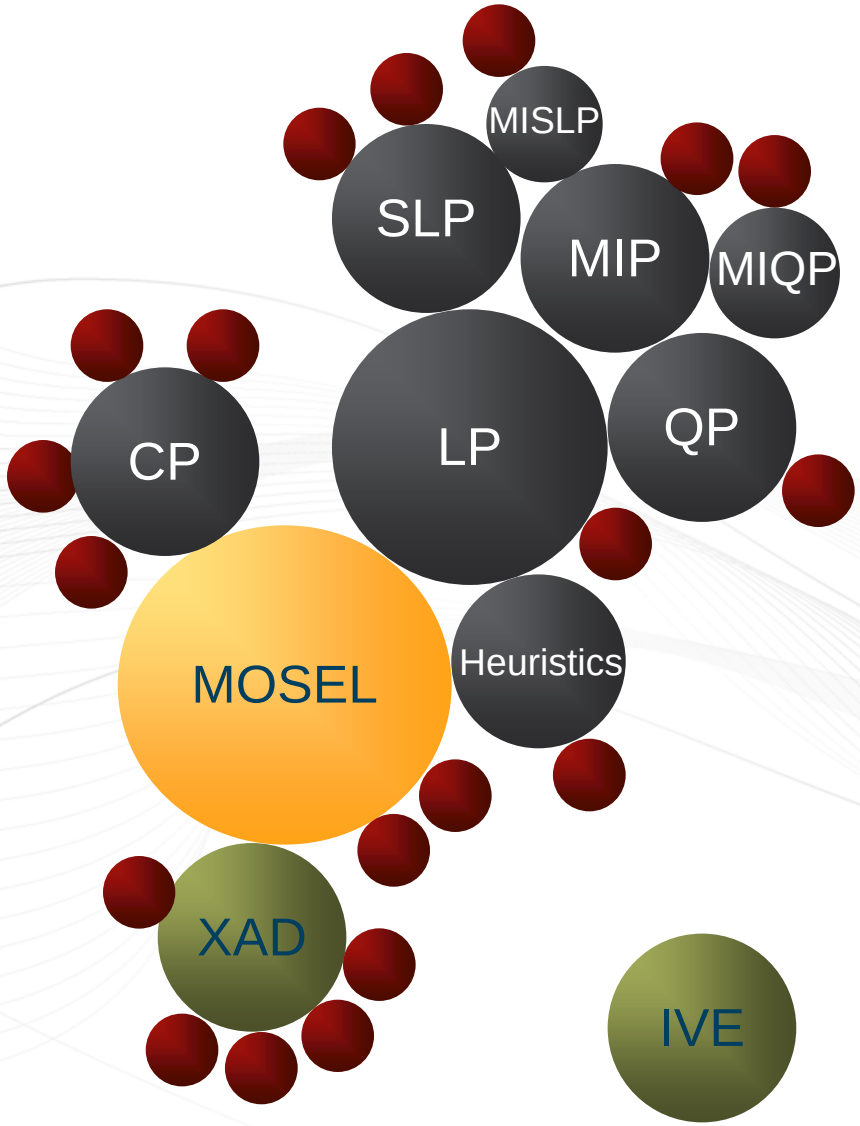
Xpress-MP: Modular Optimization Modeling Tools
Fast Optimization Engines

- **Solvers**
- **GUI / studio**
- **Extensions / NI**
- **Vertical applications**
- **Modeling platform**



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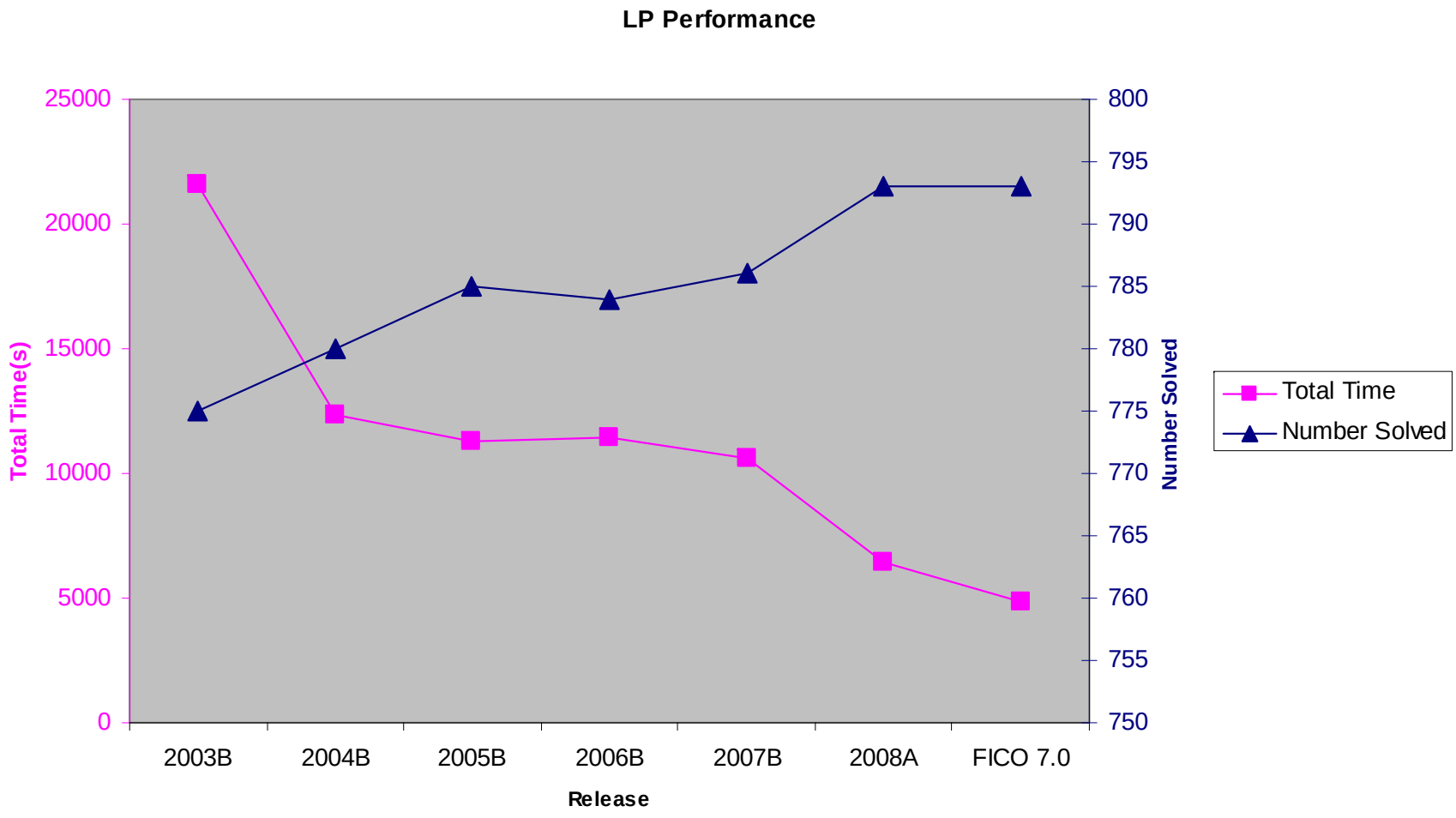
LP Performance across releases



Internal test set of 796 public and customer models

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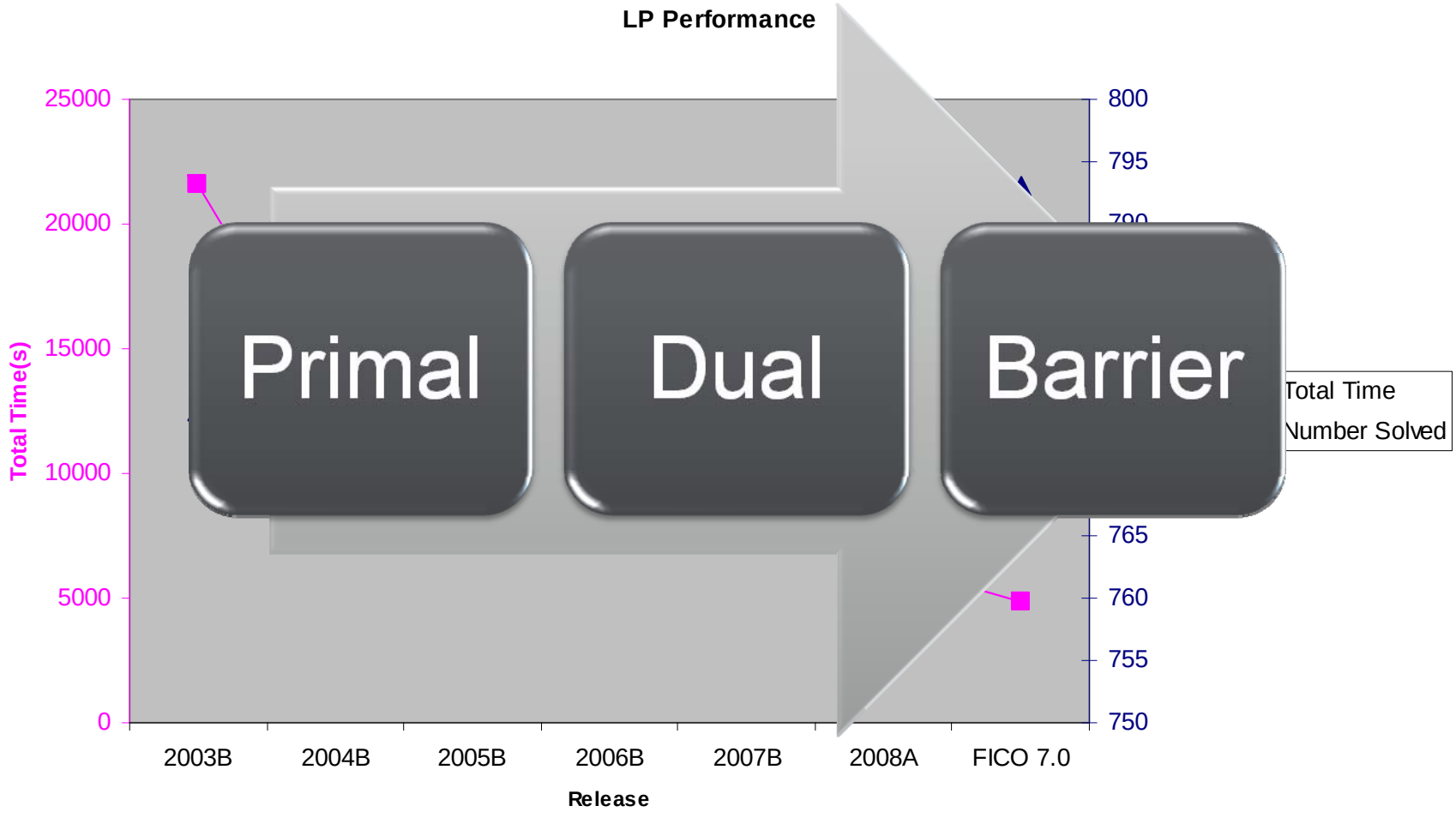
LP Performance across releases



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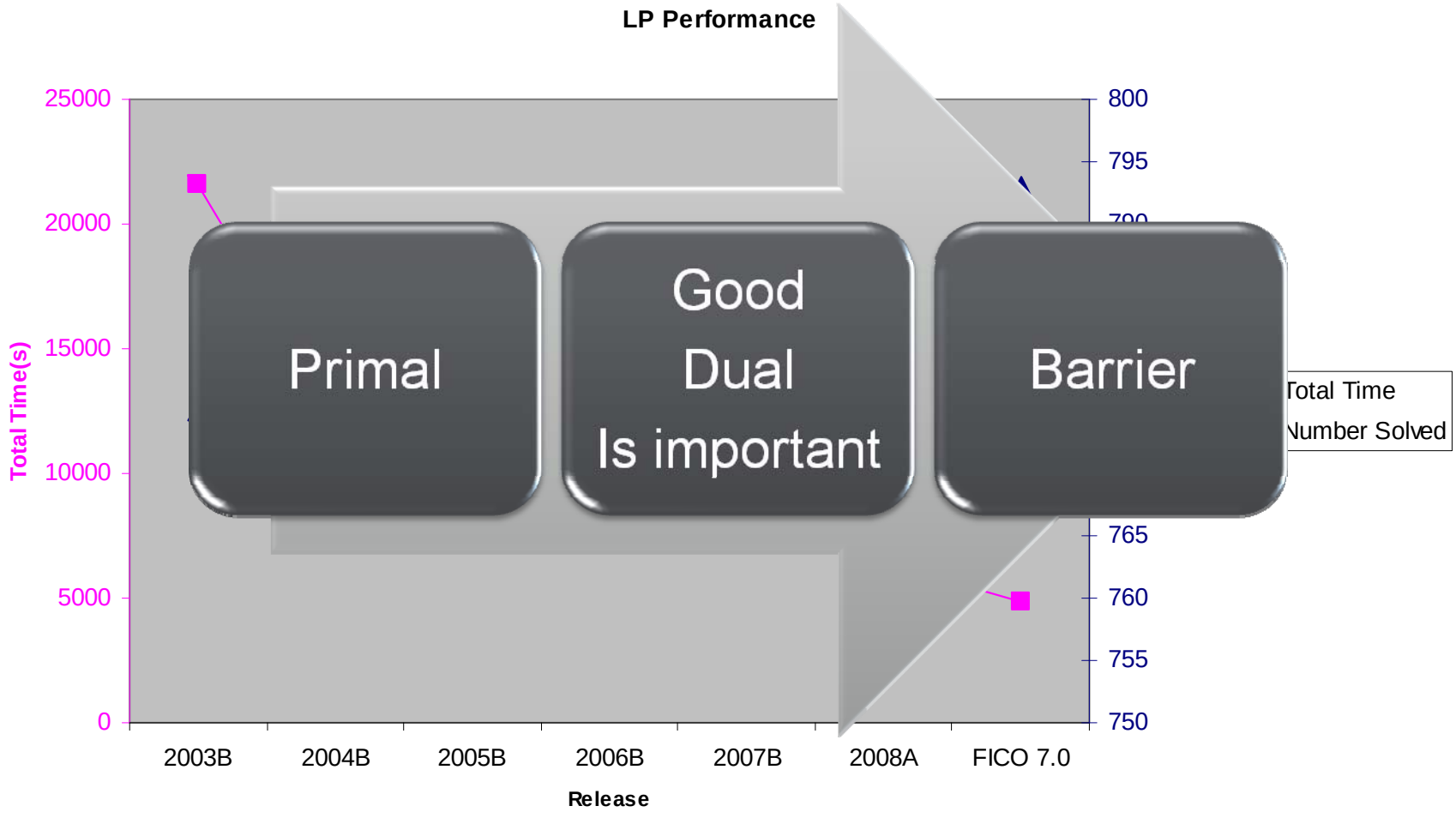
LP Performance across releases



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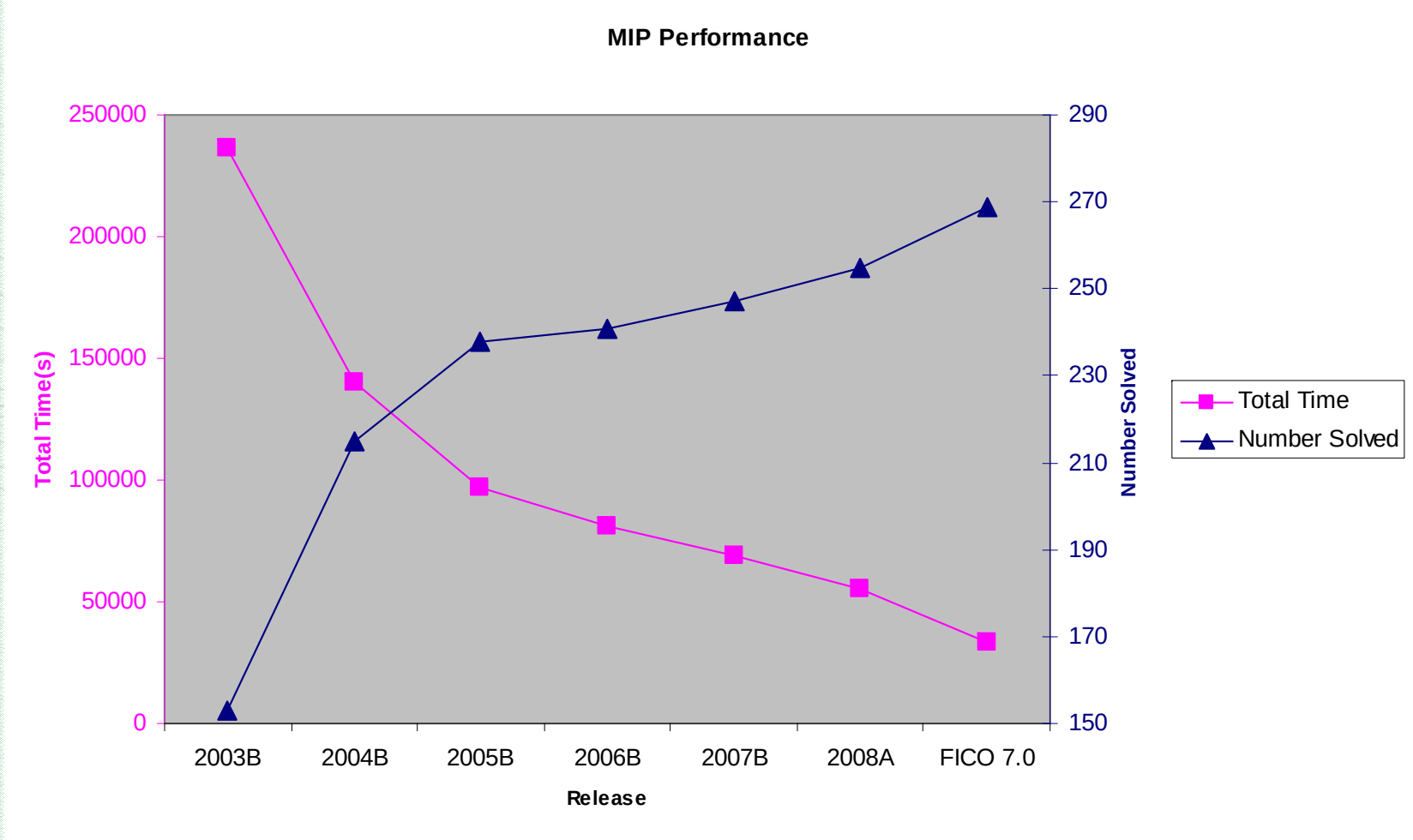
MIP Performance across releases



Internal test set of 320 public and customer models

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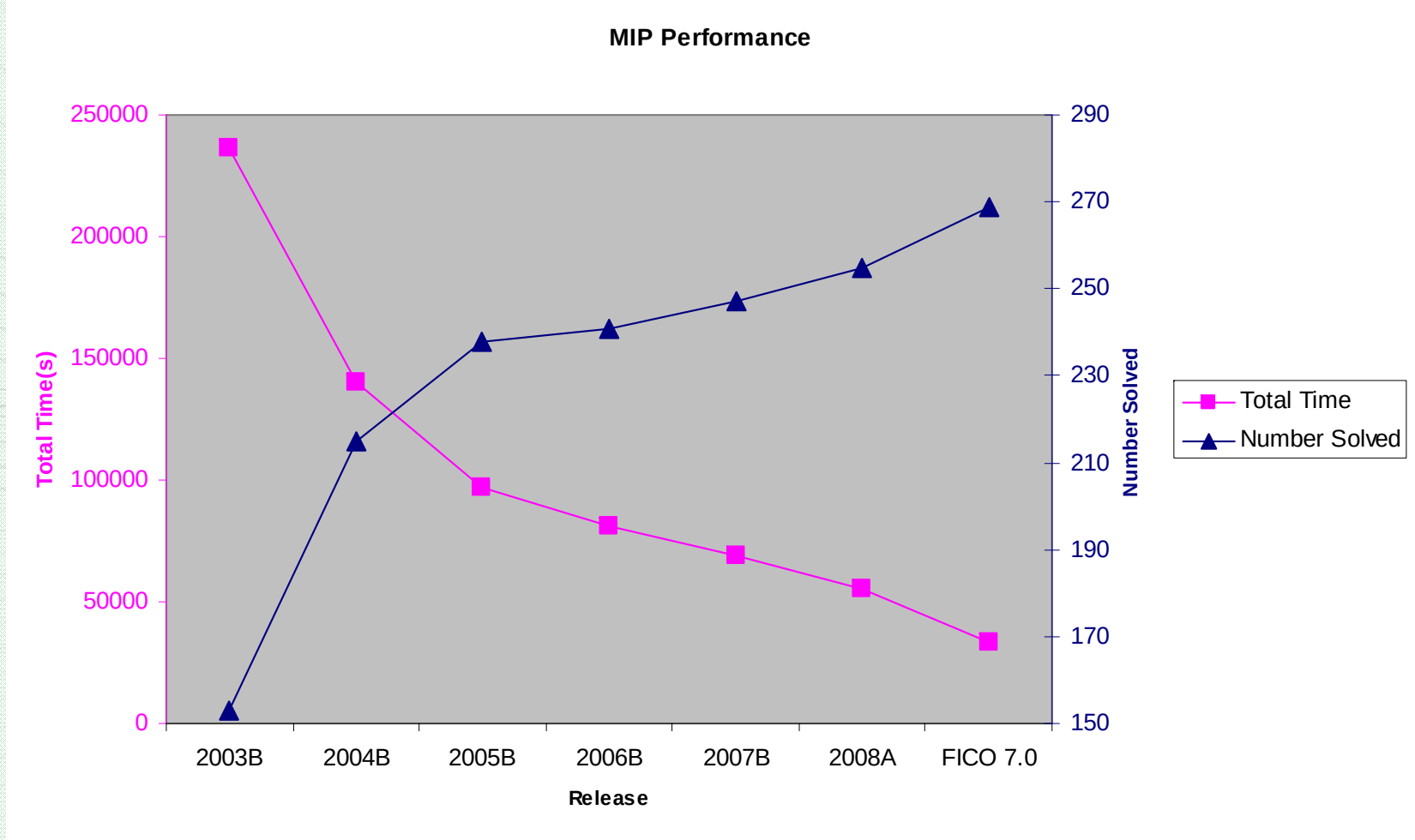
MIP Performance across releases



Internal test set of 320 public and customer models

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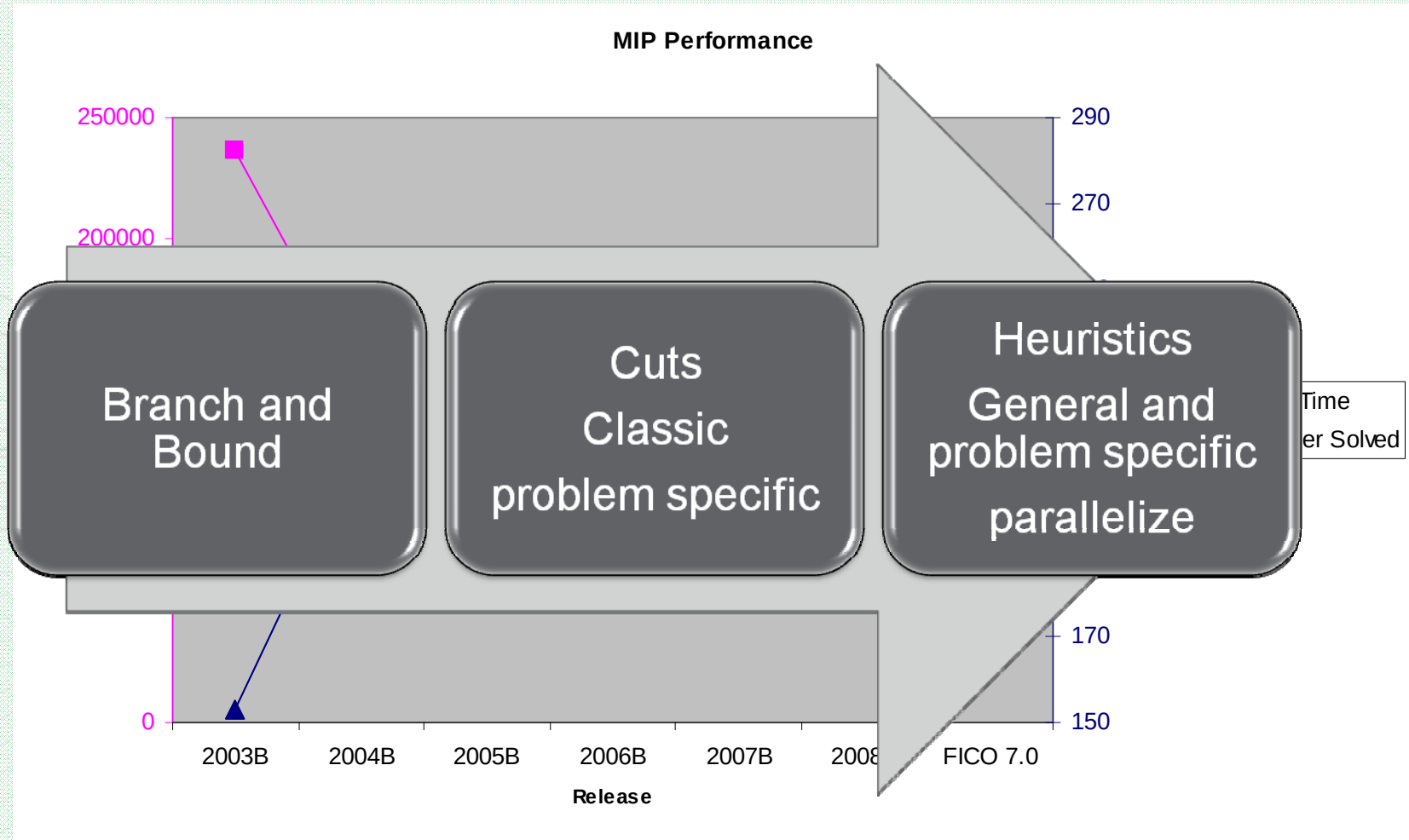
MIP Performance across releases



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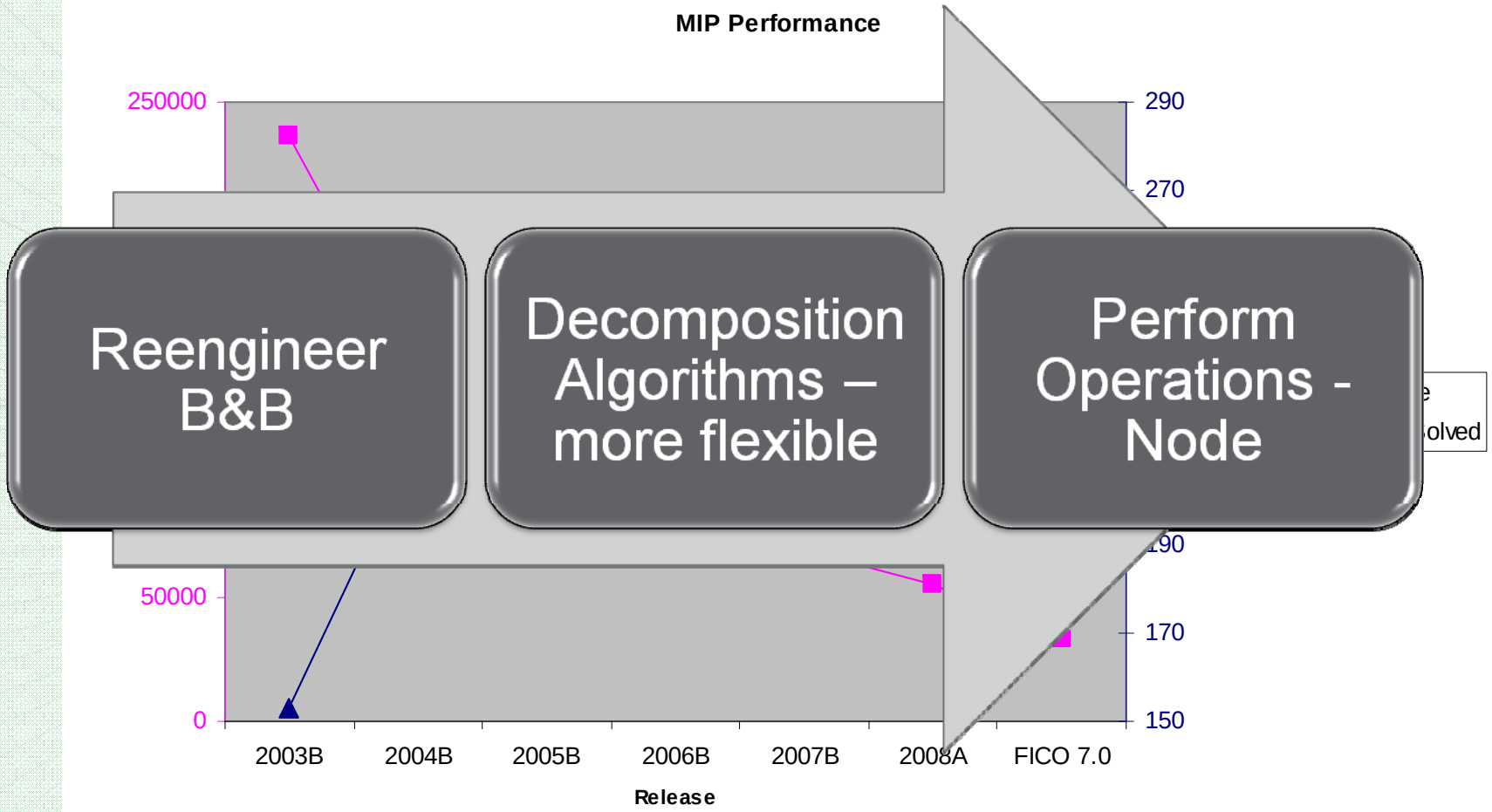
Feedback Loop



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Xpress 7 parallel speed ups

	Xpress 7 1 thread	Xpress 7 4 thread	Improvement
"Internal" deterministic	25,724	17,447	-47%
"Internal" opportunistic	25,724	13,067	-96%
Coral deterministic	24,484	16,129	-52%
Coral opportunistic	24,484	11,137	-120%

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Xpress 7 parallel speed ups

	Xpress 7 1 thread	Xpress 7 4 thread	Improvement
"Internal" determin			47%
"Internal" opportun			06%
Coral deterministic			-52%
Coral opportunistic	24,484	,137	-120%

Parallel processors on a Newtwork

Parallel MIP (same computer) P-MIP

Deterministic P-MIP

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Concurrent LP solver

» Efficient LP method parallelization

	Primal	Dual	Barrier	Concurrent	Overall Speedup
1 thread	19,940	13,459		-	-
2 threads	19,940	13,459		6,193 (B+D)	23%
4 threads	19,940	13,459	7,540	7,491	70%

Time(concurrent) ~ min(Time(dual), Time(primal), Time(barrier))

Controls: LPTHREADS and DETERMINISTIC
(concurrent is nondeterministic!)

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Concurrent LP solver

» Efficient LP method parallelization

	Primal	Dual	Ba	Concurrent	Overall Speedup
1 thread					-
2 threads					23%
4 threads					70%

P-Barrier

P-D-B Combinations

Time(concurrent) ~ min(Time(dual), T imal), Time(barrier))

Controls: LPTHREADS and DETERMINISTIC
(concurrent is nondeterministic!)

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Customers want multiple alternative solutions
Example: air04

» Set partitioning problem for airline crew scheduling

» Available from MIPLIB 2003

	Default Solver	5-Best Solution Solver
1st Solution	56137	56137
2nd Solution	56166	56137
3rd Solution	56307	56137
4th Solution	56854	56137
5th Solution	57562	56137
Total B&B Nodes	141	15 981
Total Time	26 sec	29 sec

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