

Deploying Optimization Applications for Power Grid Operation

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Shaping the future

Agenda

- Current status of optimization deployment
- Path from research to deployment
- Research directions

Current Status of Optimization Applications

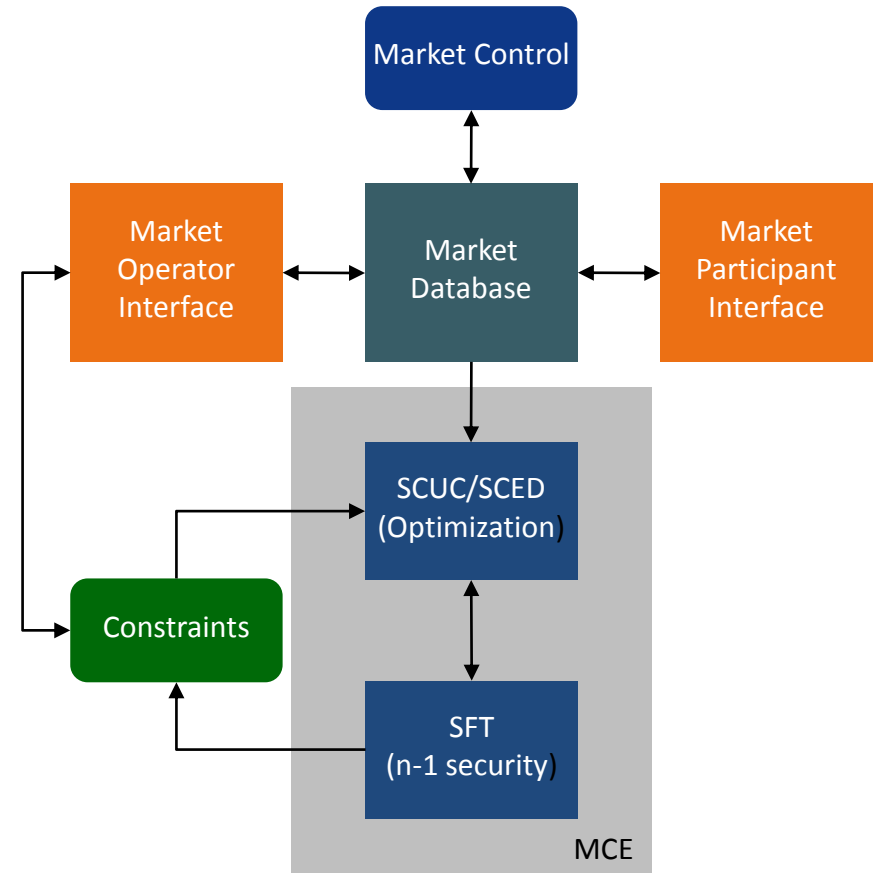
Overview

- Have gained acceptance; currently performing critical functions in Control Centers operations:
 - Bulk power grid (EMS): SE, OPF, UC,...
 - Wholesale market (MMS): Market Clearing (SCUC/ED, FTR)...
 - Distribution grid (DMS): VVC, Feeder Switching (AFR, FISR)...
- Have unrelenting demand for faster and smarter solutions
 - Problem definitions/characteristics
 - Solution technology: optimization + others

Current Status of Optimization Applications

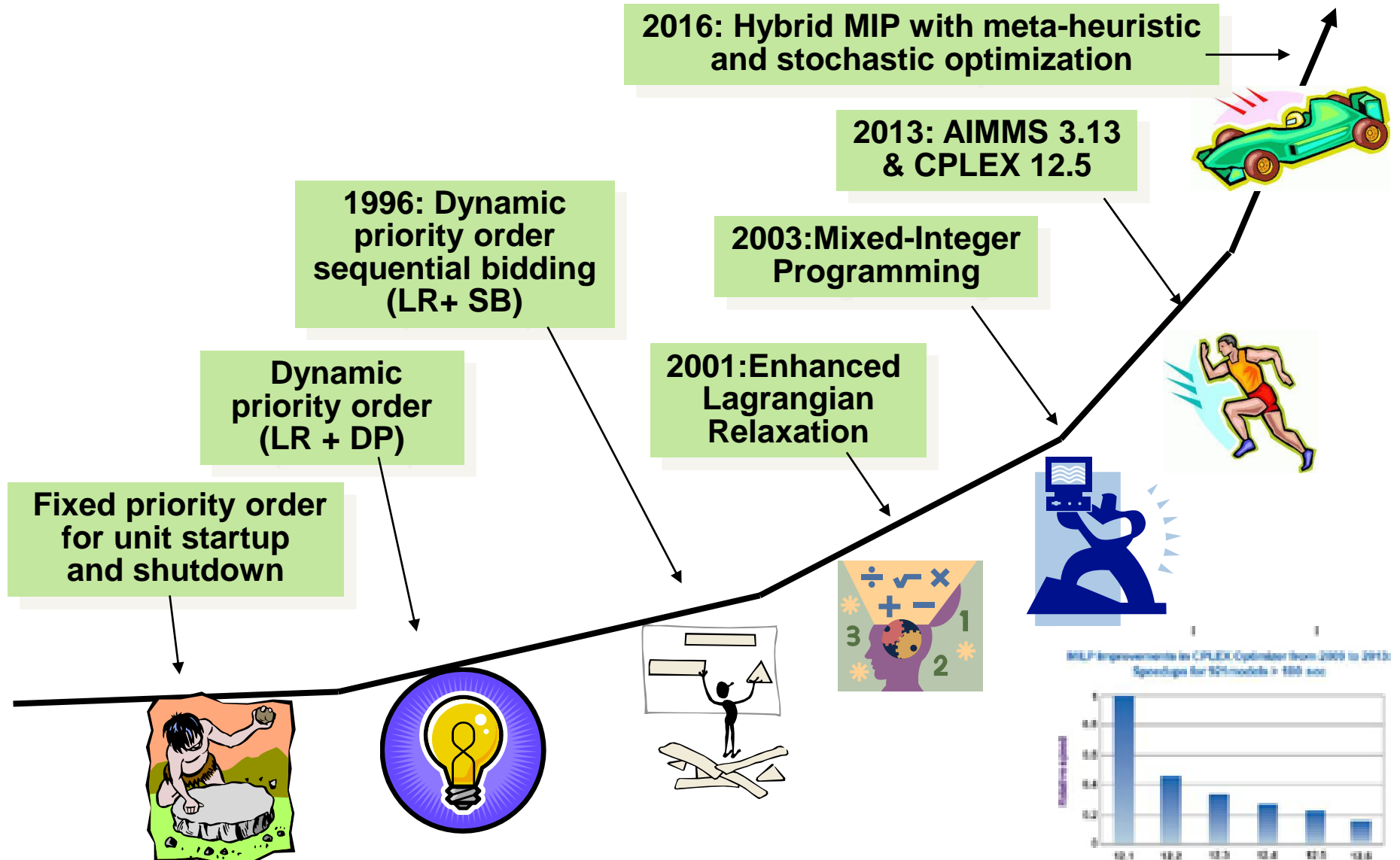
Active Set Strategy via SFT

- Market Clearing Engines (MCE)
- Market Control
- Market Database (MDB)
- Market Operator Interface (MOI)
- Market Participant Interface (MPI)
- Simultaneous Feasibility Test (SFT)



Current Status of Optimization Applications

Evolution of SCUC Optimization



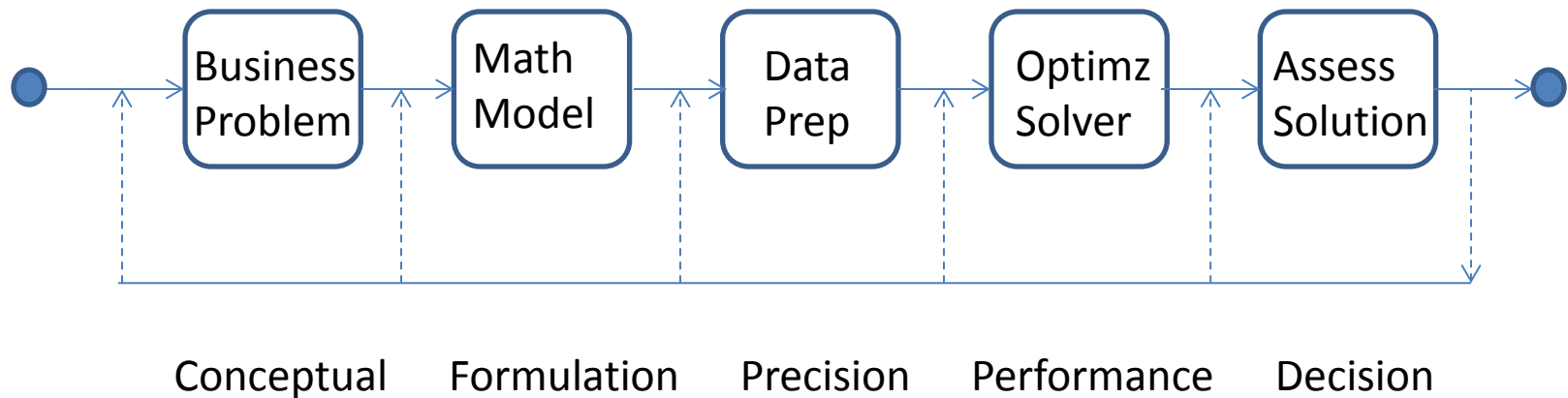
Current Status of Optimization Applications

Optimization problem characteristics & solution requirements

- Mildly non-linear AC powerflow
- Many inequality constraints ($N_{br} \times N_{ctg}$), very few binding
- Binding inequalities for (contingency) grid security have dense constraint rows
- Require primal (MW) and dual (price) solutions
- Integer constraints often critical (e.g. SCUC, AFR)
- Special handling : e.g. infeasibility, tie-breaking (price & quantity)
- Close-loop automation for 5-min RT Dispatch cycles
- Complex problems typically analyzed with human-in-the-loop , e.g. interactive scenario definition and analysis
- Consistency, transparency, auditability are critical
- IT/OT Integration required for production deployment

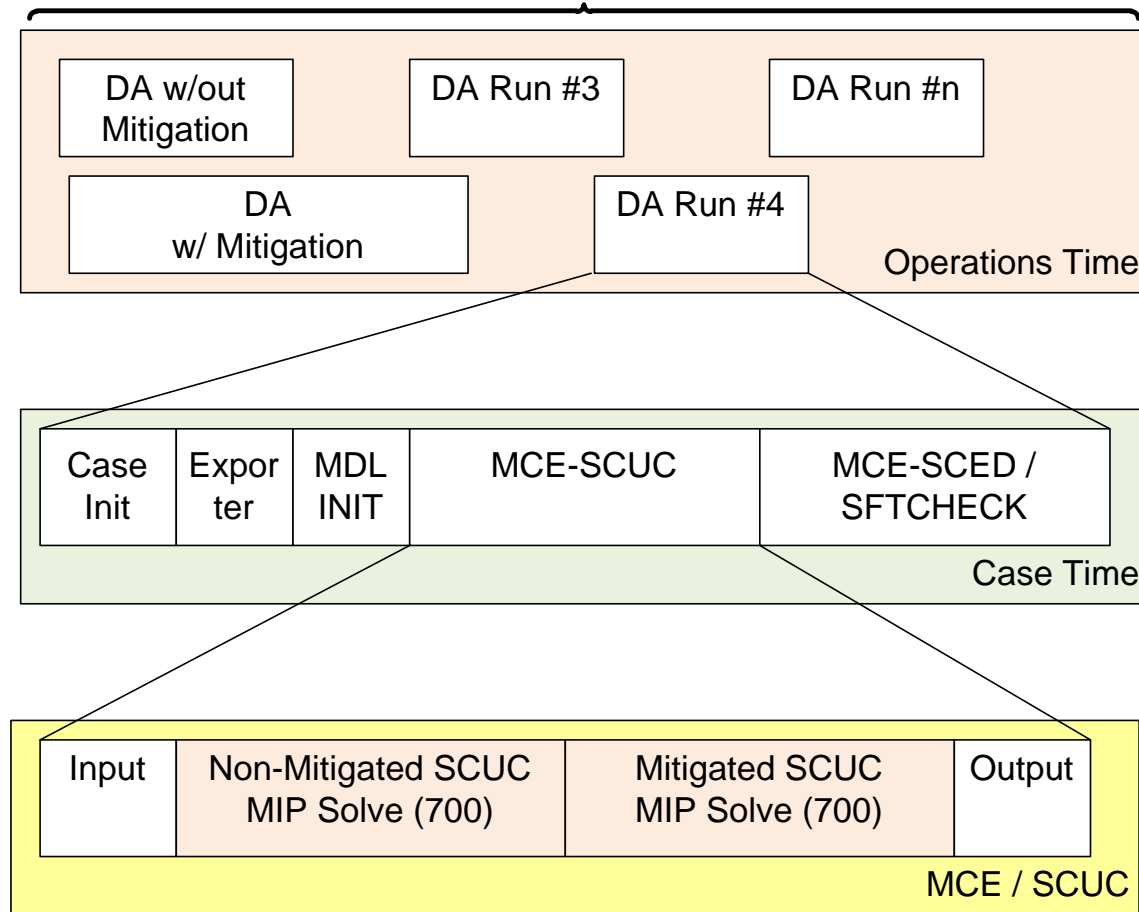
Path From Research to Deployment:

The art and science of grid optimization



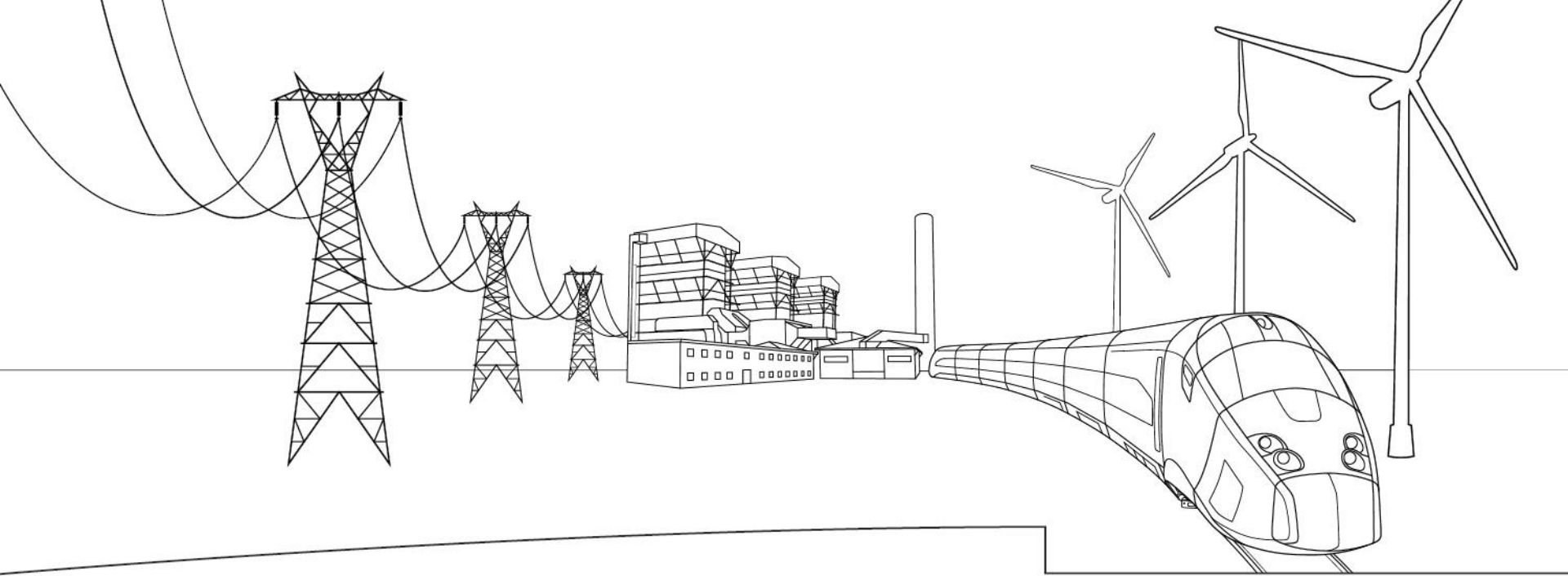
Anticipate, Identify, Remedy Gaps

Business Use Case: *Day-Ahead Market Clearing*



R&D Directions

- Extended Problem Complexity:
 - Risk-based decisions
 - Multi-level & distributed decision: coordination, aggregation
 - Extended domain: gas-electric coordination,
- Improved optimization technology:
 - MIP: hot-start, heuristics
 - Stochastic/robust optimization
 - Post-solution assessment & suggestions
- IT/OT Integration
 - Visual analytics
 - High performance computing



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