Solve Your Optimization Problems Like the Pros

FICO Xpress Optimization Suite 9

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Agenda

» Case Studies

» Introduction to Xpress

» Modeling complex problems

» How to rapidly build applications

Business Challenge

» Optimize the operations at American Airlines

Tasks are

» Plan network, fleet and facilities

» (Re)Schedule flights and crew

» Manage revenue

Solution

» AA internal solutions based on Xpress

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Business Challenge

» Create the NFL schedule

Take into account

» stadium availability

» competitive impact

» television schedules

Solution

» Custom solution built by Optimal Planning Solutions based on Xpress

Xpress Optimization Suite

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Model
Language
Mosel

FEATURES
- Flexible, modular, easy-to-learn and use
- Development IDE
- Data connectors (spreadsheets, xml, databases, hdfs, web services…)
- Distributed modeling and solving
- Precompiled for efficiency and IP protection
- Fully featured APIs

Optimize
Engines
Optimizer
NonLinear
Kalis

FEATURES
- High-performance, scalable and robust LP (Simplex|Barrier), MIP, QP, MIQP, QCQP, MIQCQP, SOCP, MISOCP, NLP, MINLP, and CP engines
- Great out of the box performance, advanced users have full control over the solution process
- Utilizes multi-core/CPU machines, automatic tuning
- N-best solutions capabilities and advanced infeasibility handling
- Fully featured APIs

Gain Insight
RAx framework
Insight

BENEFITS
- Adapt data and parameters to create and compare scenarios
- Understand trade-offs and sensitivities
- Visualize data and results for analysis
- Collaborate in a multi-user environment
- Works in a web browser and rich client – on premise and in the cloud
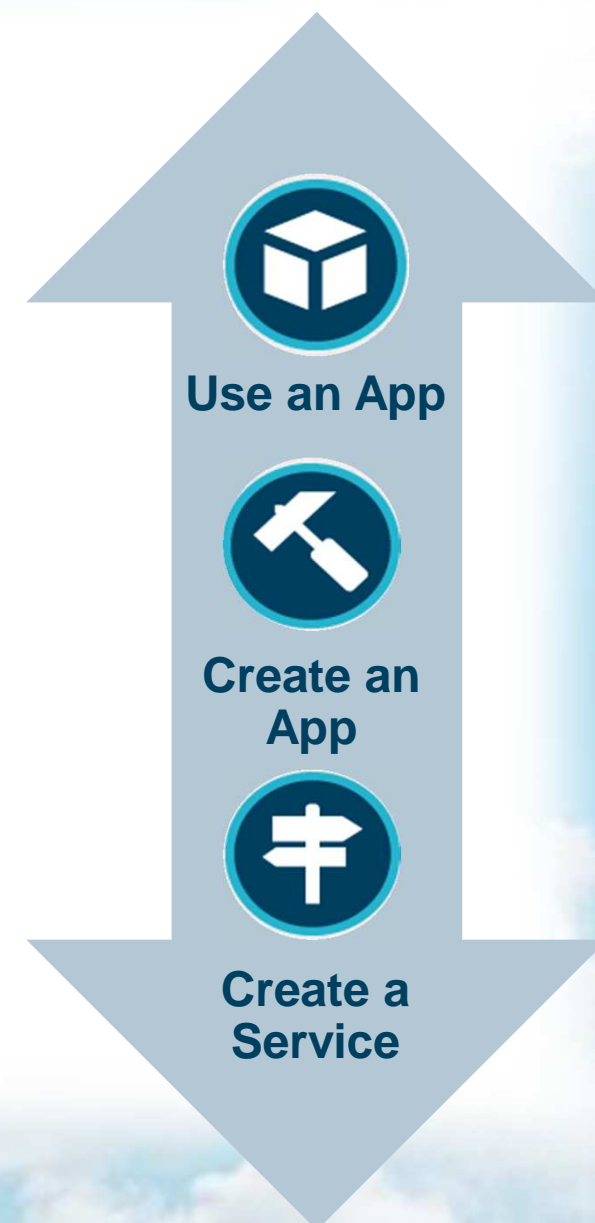- Fully featured APIs including web

FICO Applications

Analytic Marketplace

Decision Management Platform

Open Source & Standards

Infrastructure & Capacity

Use an App

Create an App

Create a Service

The Decision Management Platform

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FICO Application Studio: Rapid App Dev tools

FICO Decision Studio: Decision Management Tools

| Decision Modeler | Analytic Modeler | Optimization Modeler | Templates & Frameworks |

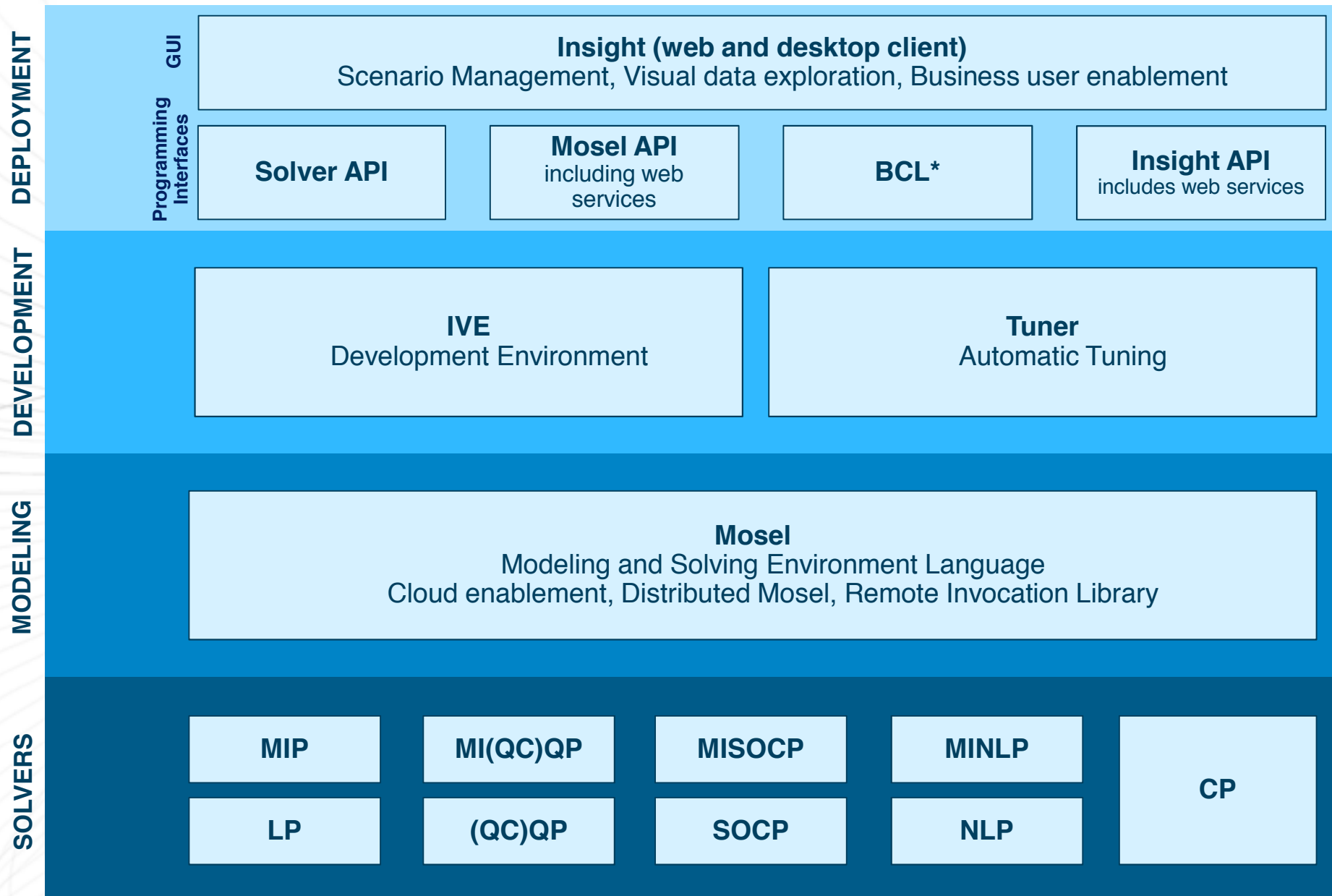**FICO Visual Insights Studio: Data Visualization & Reporting**

Data and Analytics

| Analytic Services | Data Connectors | Analytic Data Store |

Xpress 9 Product Overview

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DEPLOYMENT

GUI

Insight (web and desktop client)
Scenario Management, Visual data exploration, Business user enablement

Programming Interfaces

| Solver API | Mosel API including web services | BCL* | Insight API includes web services |

DEVELOPMENT

| IVE Development Environment | Tuner Automatic Tuning |

MODELING

Mosel
Modeling and Solving Environment Language
Cloud enablement, Distributed Mosel, Remote Invocation Library

SOLVERS

| MIP | MI(QC)QP | MISOCP | MINLP | CP |
| LP | (QC)QP | SOCP | NLP | |

* Builder Component Library for modelling in a programming language

linear

non-linear

Xpress-NonLinear: Optimizing the *real* world

The World is non-linear

Example non-linear problems solved with our technology

» Pricing Optimization

» Portfolio Optimization

» Risk Management

» Credit Risk

» Strategic Bidding and Auctions

» Demand Optimization

» Nonlinear Least Squares (data fitting)

» Blending & Processing

Because

» The world **is** non-linear

» The market demand for non-linear optimization is increasing

» In recent years, non-linear solvers have improved significantly in terms of scalability and robustness

» We have all the ingredients

   » Flexible, modular, easy-to-learn and use modeling environment Xpress-Mosel

   » In-house best-in-class first order non-linear solver Xpress-SLP

   » Partnership with the best-in-class second order non-linear solver Knitro

   » Smart developers who can create a unified non-linear solver experience

» Xpress-NonLinear defines the benchmark for non-linear solvers.

» Auto-selection of most applicable solver algorithm (unique)

» New derivatives engines (competitive with AMPL)

  » Analytic

  » Symbolic and automatic

  » Sub-derivatives

» Extended user functions (for simulations)

» All of the above being available through solver APIs (unique)

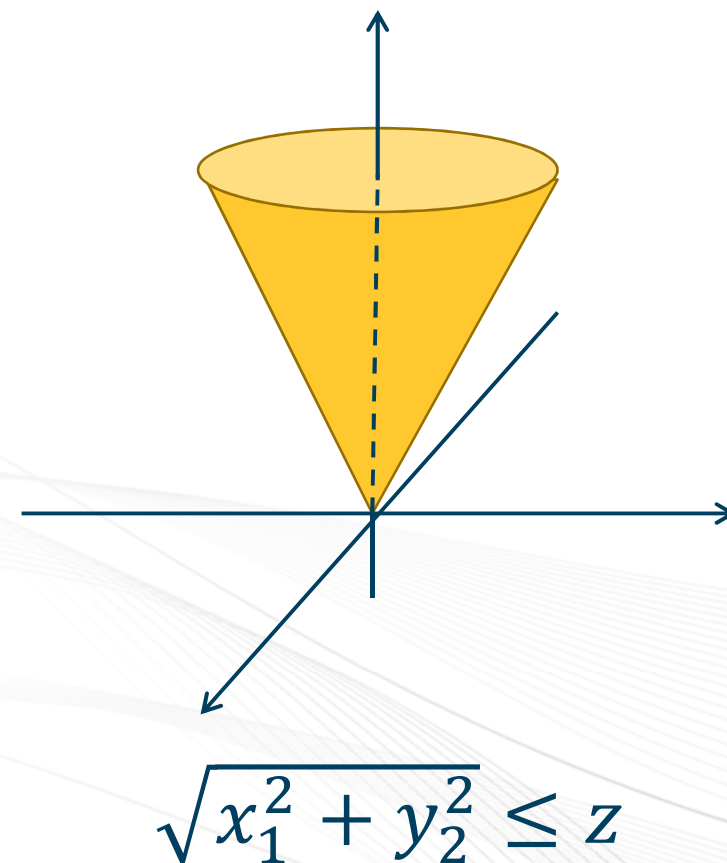» New Mosel non-linear interface (easy-to use!)

Standard cone constraint:

$$|Ax - b|_2 \leq cx + d$$

Applications:

» **Portfolio Optimization**: (modeling variable risk)

» **Optimization under uncertainty**:

$$P(ax \leq b) \geq \eta$$

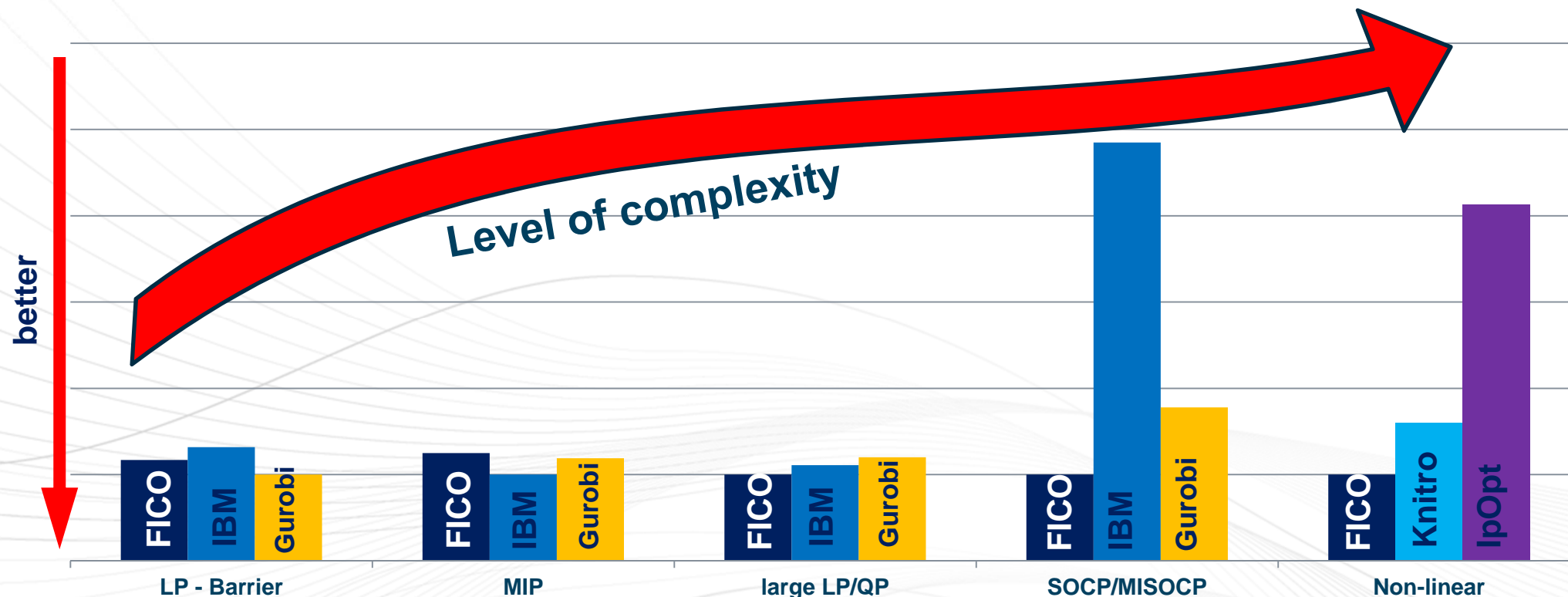(assuming a normal distribution) Similar to *Robust Optimization*.

» …

Reduces to *convex quadratic* constraint when *c = 0*.

$$\sqrt{x_1^2 + y_2^2} \leq z$$

better

Level of complexity

LP - Barrier	MIP	large LP/QP	SOCP/MISOCP	Non-linear
FICO IBM Gurobi	FICO IBM Gurobi	FICO IBM Gurobi	FICO IBM Gurobi	FICO Knitro IpOpt

» FICO has the most complete optimization offering and all solvers are more than competitive

» New SOCP/MISOCP solver dominates the competition

» FICO has the leading non-linear offering with applications in particular in finance, insurance, and power/gas/oil industries

Geometric means of time to optimality, MIP on 12 cores, SOCP|MISOCP combined geometric mean

FICO Xpress-Insight
Optimization Application Framework

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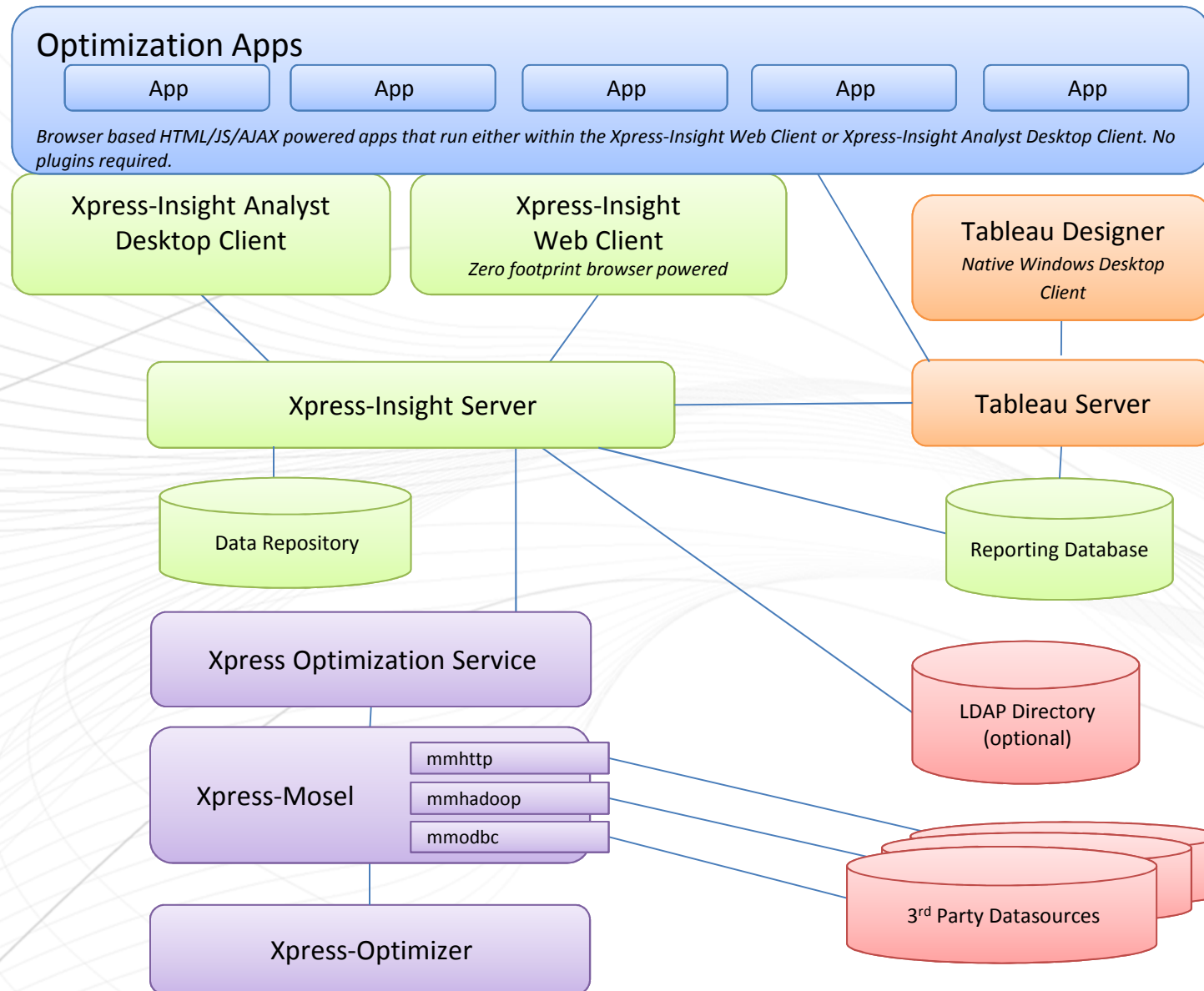| Speed to Solution	Agility	Flexibility
• Insight **provides** most of the needed optimization application **functionality out-of-the-box.** • A Mosel model **works** in Insight **within minutes.** • **Powered** by fast, robust and scalable algorithms • **Integrates seamlessly** 3rd party components for the best experience.	• Allows **Business users** to **interact** with optimization from anywhere with everyone • Optimization model **changes** are **reflected** in Insight **instantly.** • Changes to the model do **not** require **expensive reimplementation** of the application	• Enables **analysts** to **modify** Insight **easily** • Insight applications can be **easily extended** and **connected** • Is a great solution for **small** and **large** optimization **projects**.

Xpress-Insight Architecture

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Optimization Apps

App	App	App	App	App

Browser based HTML/JS/AJAX powered apps that run either within the Xpress-Insight Web Client or Xpress-Insight Analyst Desktop Client. No plugins required.

Xpress-Insight Analyst Desktop Client

Xpress-Insight Web Client
Zero footprint browser powered

Tableau Designer
Native Windows Desktop Client

Xpress-Insight Server

Tableau Server

Data Repository

Reporting Database

Xpress Optimization Service

LDAP Directory (optional)

Xpress-Mosel

- mmhttp
- mmhadoop
- mmodbc

3rd Party Datasources

Xpress-Optimizer

1. A simple linear model
2. A more complex mixed integer programming model
3. Column generation example
4. Decomposition algorithms
5. Going to the moon

Modeling complex problems
Scalability considerations

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1. **General considerations**
2. **Processors versus cores and shared memory considerations**
3. **Parallelism considerations**
4. **Distributed computing at the model level**
5. **Mosel and Amazon EC2 (or another provider)**
6. **Xpress-Insight load balancer**
7. **There's more in store**

How to rapidly build applications
Xpress-Insight

1. **Live typing! building a Mosel model from scratch**
2. **Build an application for your colleagues in 30 seconds**
3. **Share insights with your bosses in minutes**

THANK YOU

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