

GUROBI
OPTIMIZATION



How supply chain companies can achieve decision-centric optimization

About ICRON



integrated and **intelligent** platform for **strategic, tactical** and **operational** decision processes



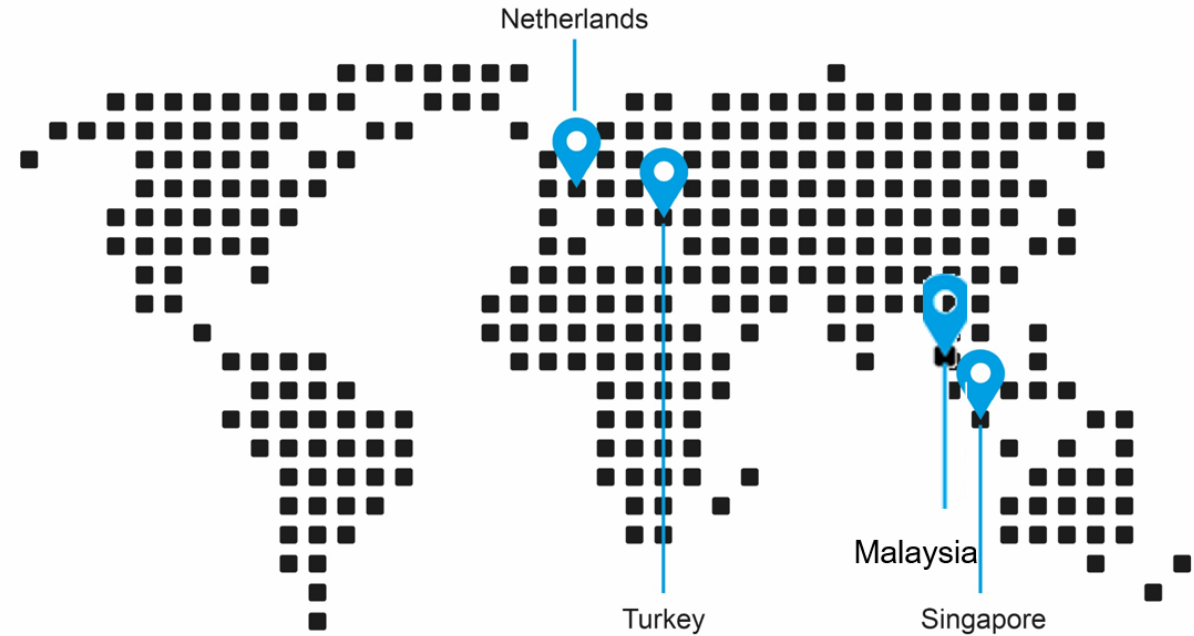
25+ years of experience



100+ customers

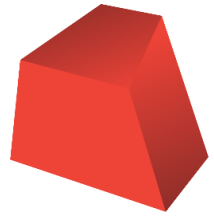


500+ implementations



Selected Customers





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Supply Chain Optimization



Elements of Business Pain in the Supply Chain



High



Middle



Low



*Top pain elements

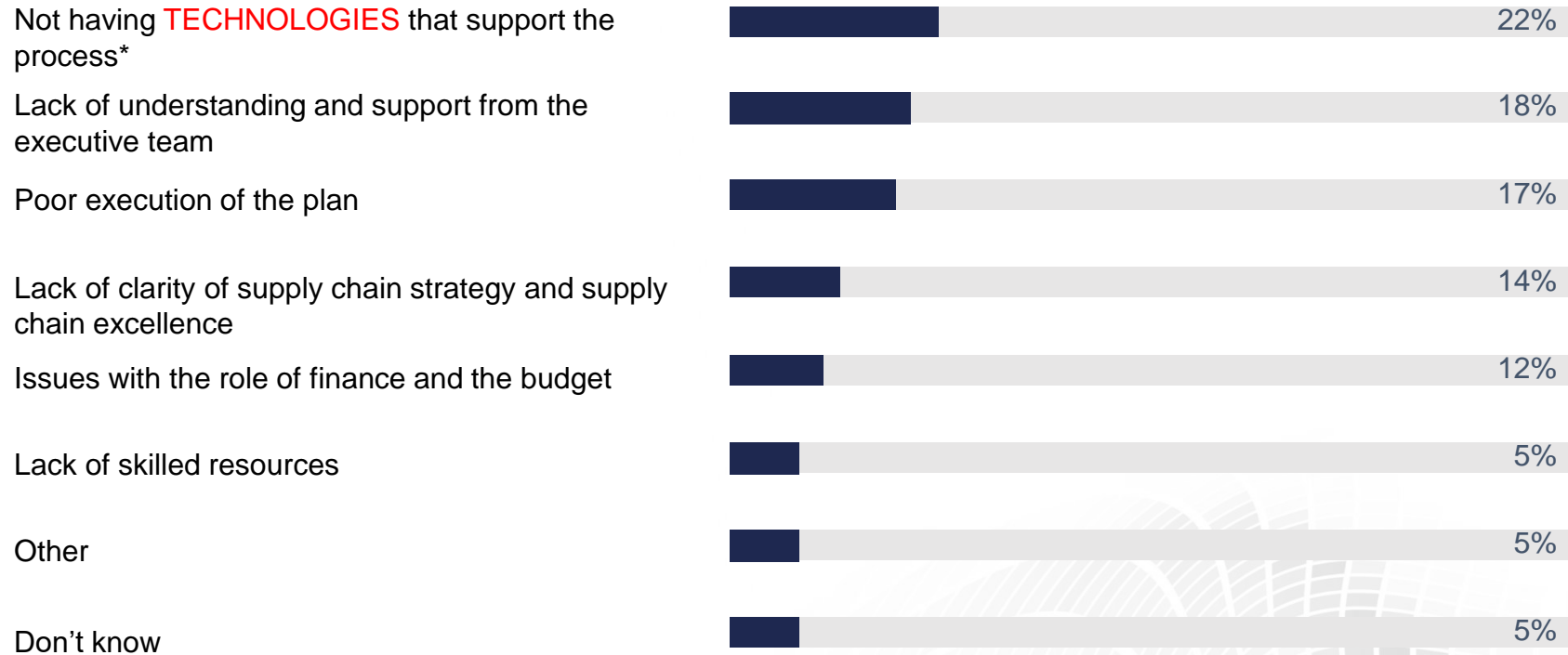
Source: Supply Chain Insights LLC

Improvement Achieved with Advanced Analytics



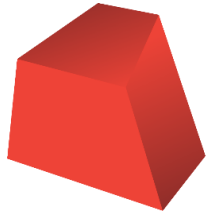
Source: Gartner Report ID G00347825

Challenges in Building Effective Supply Chain Planning Processes



*Top challenge

Source: Supply Chain Insights LLC



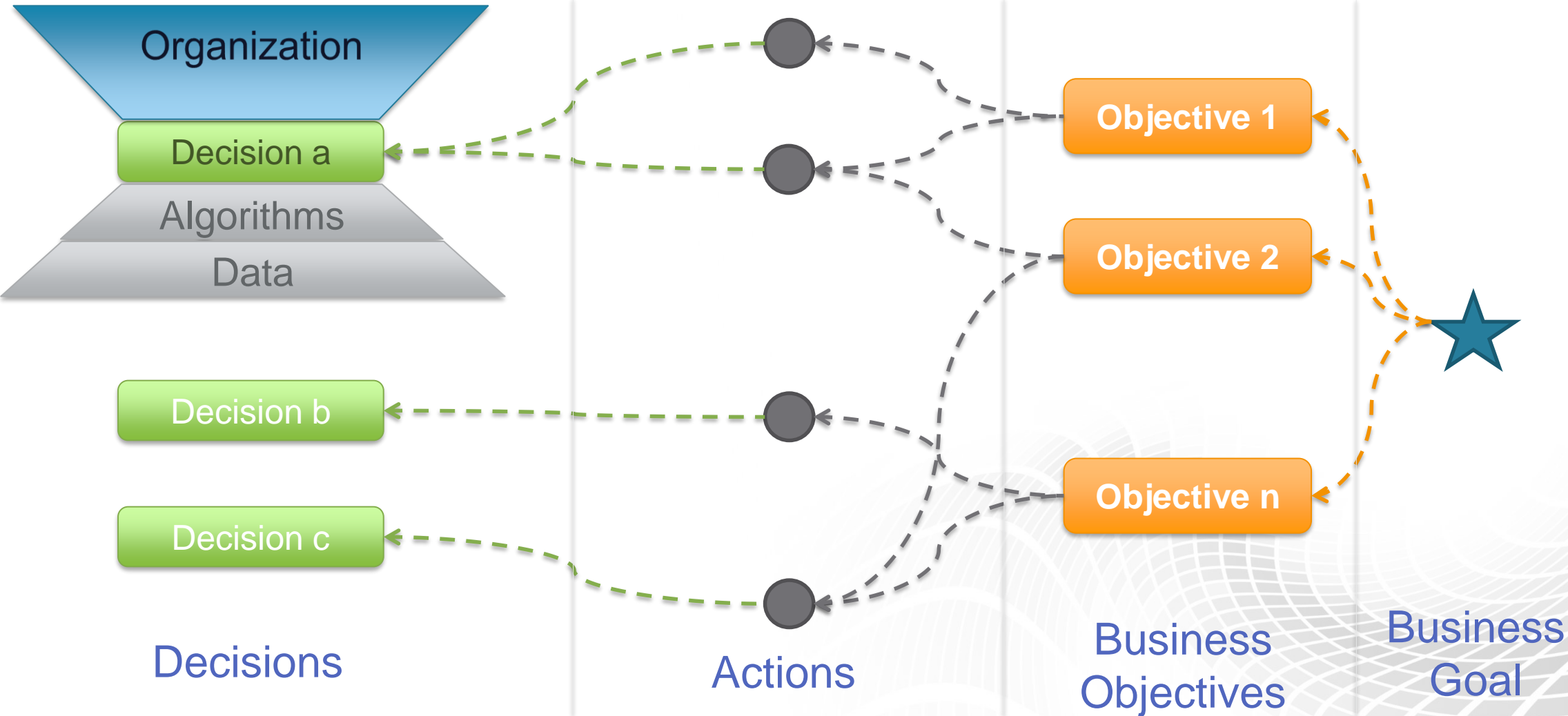
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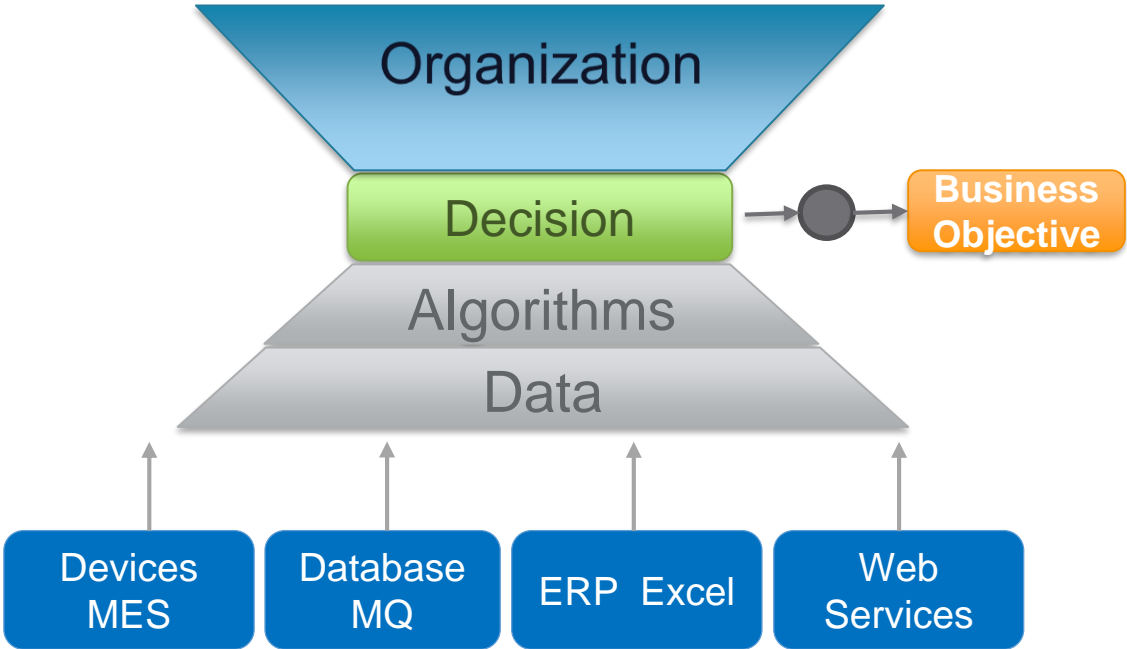
Decision-Centric Optimization



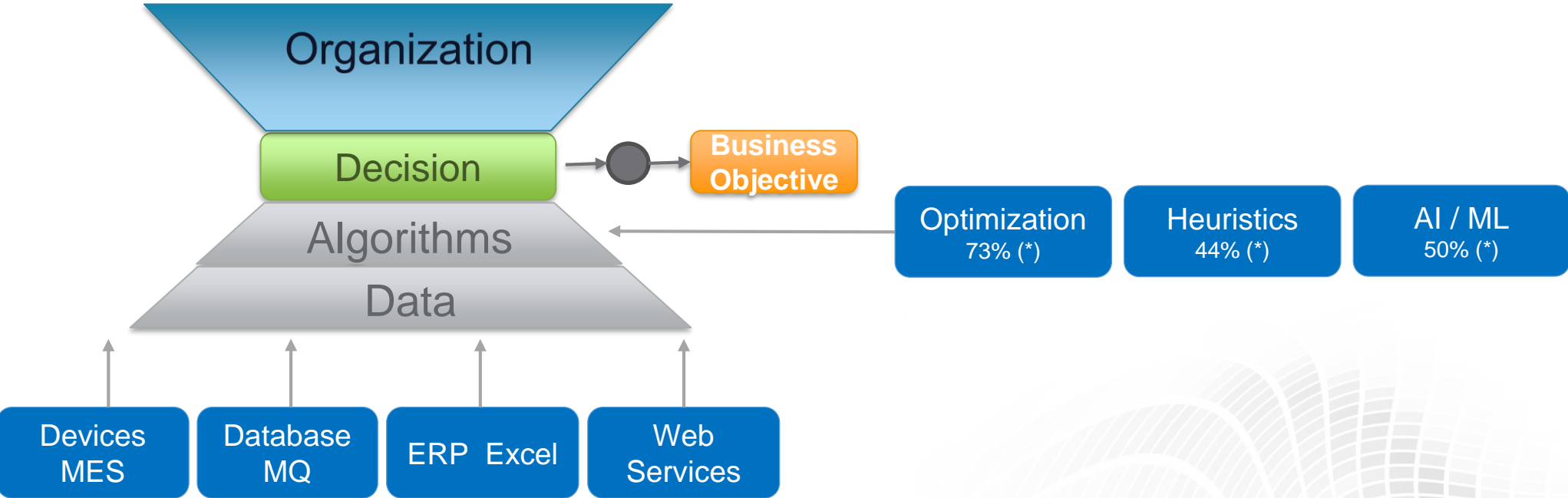
Decision Flow



Decision-Centric Optimization

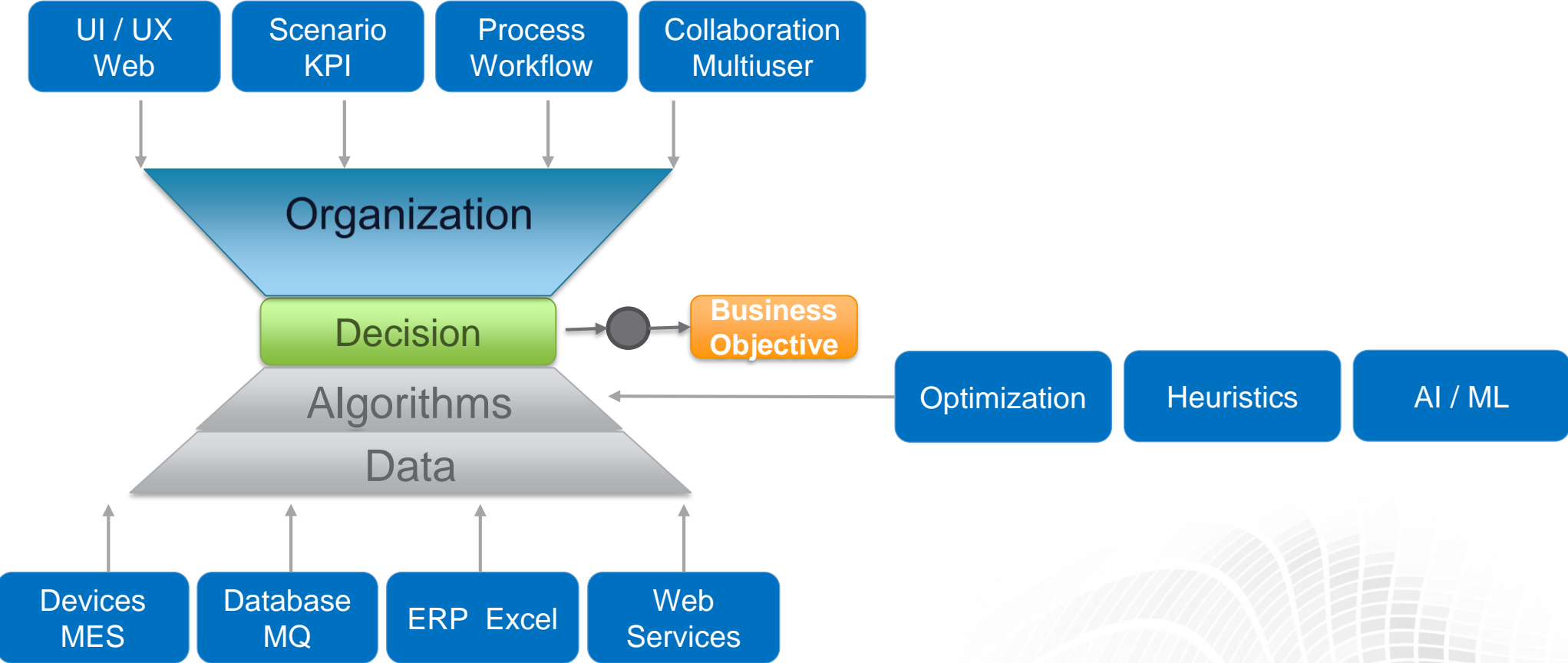


Decision-Centric Optimization

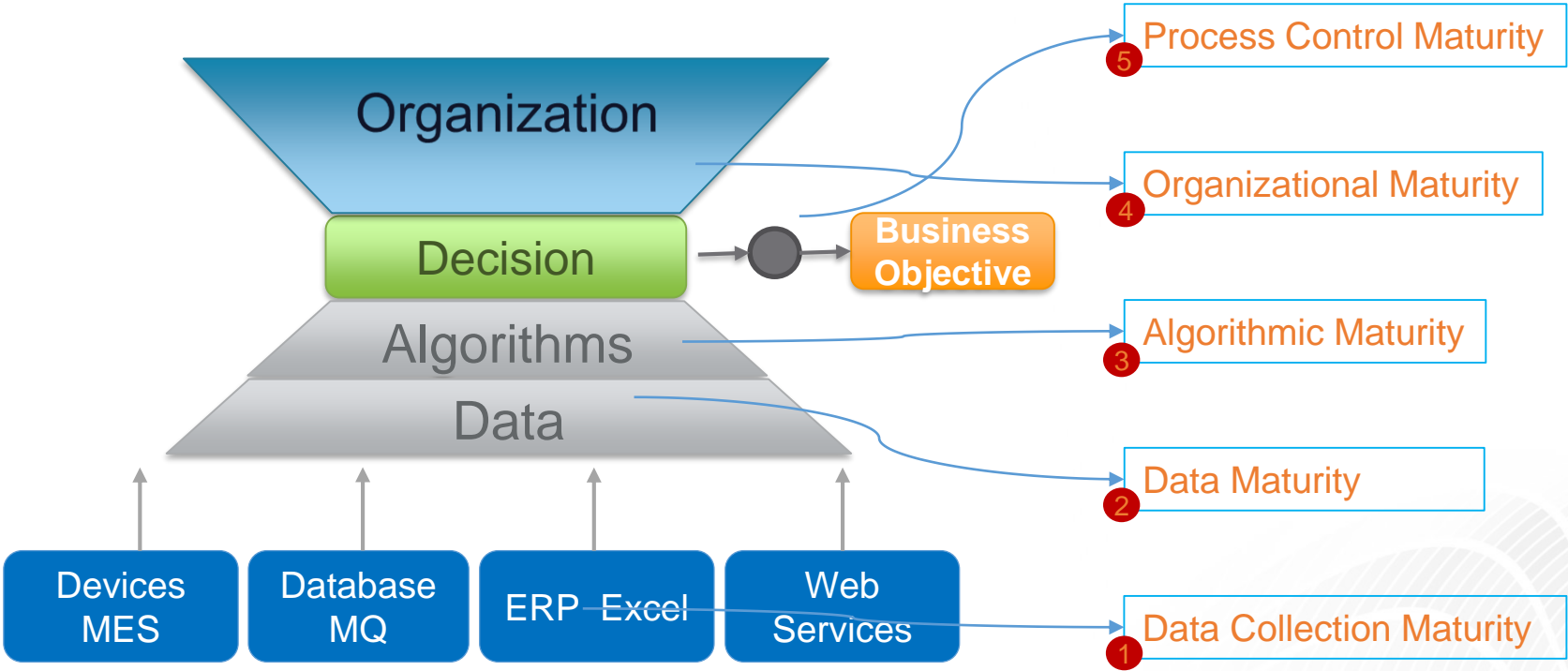


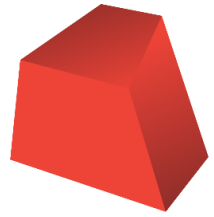
(*) Source: Gartner Report ID G00347825

Decision-Centric Optimization



Decision-Centric Process Maturity





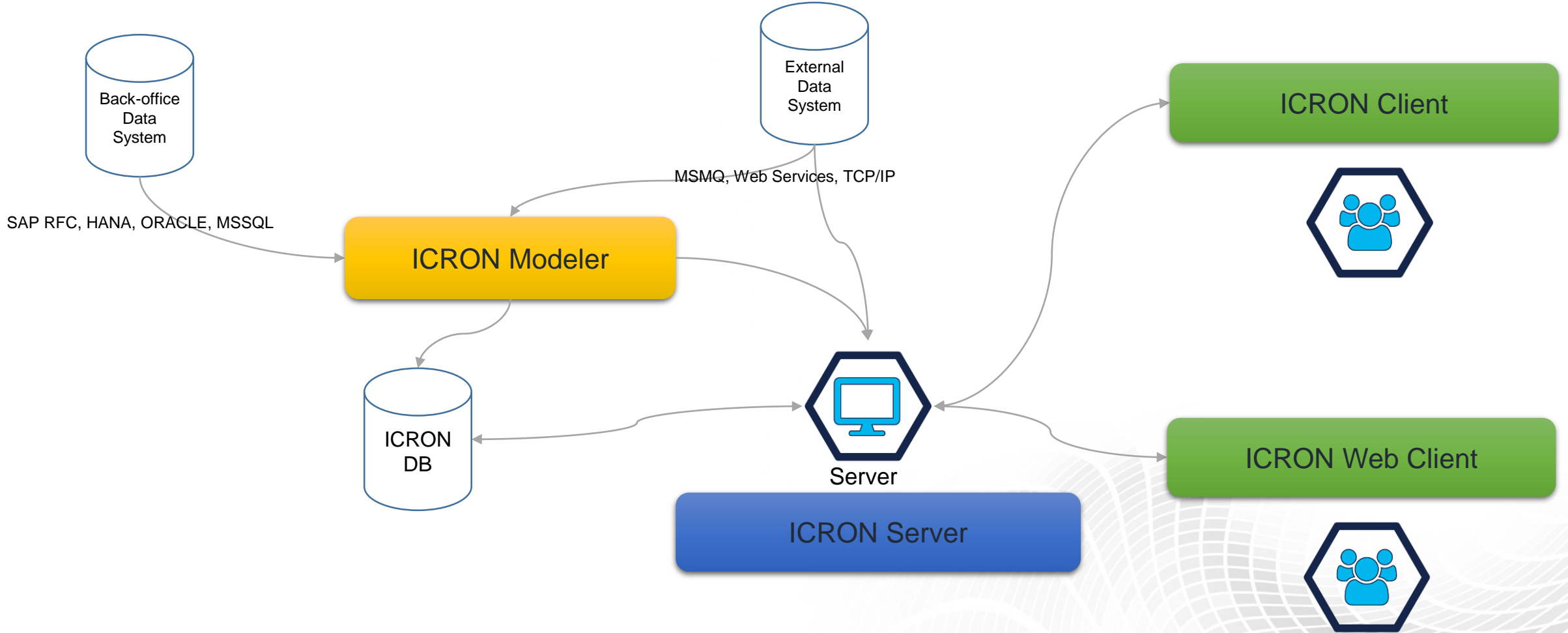
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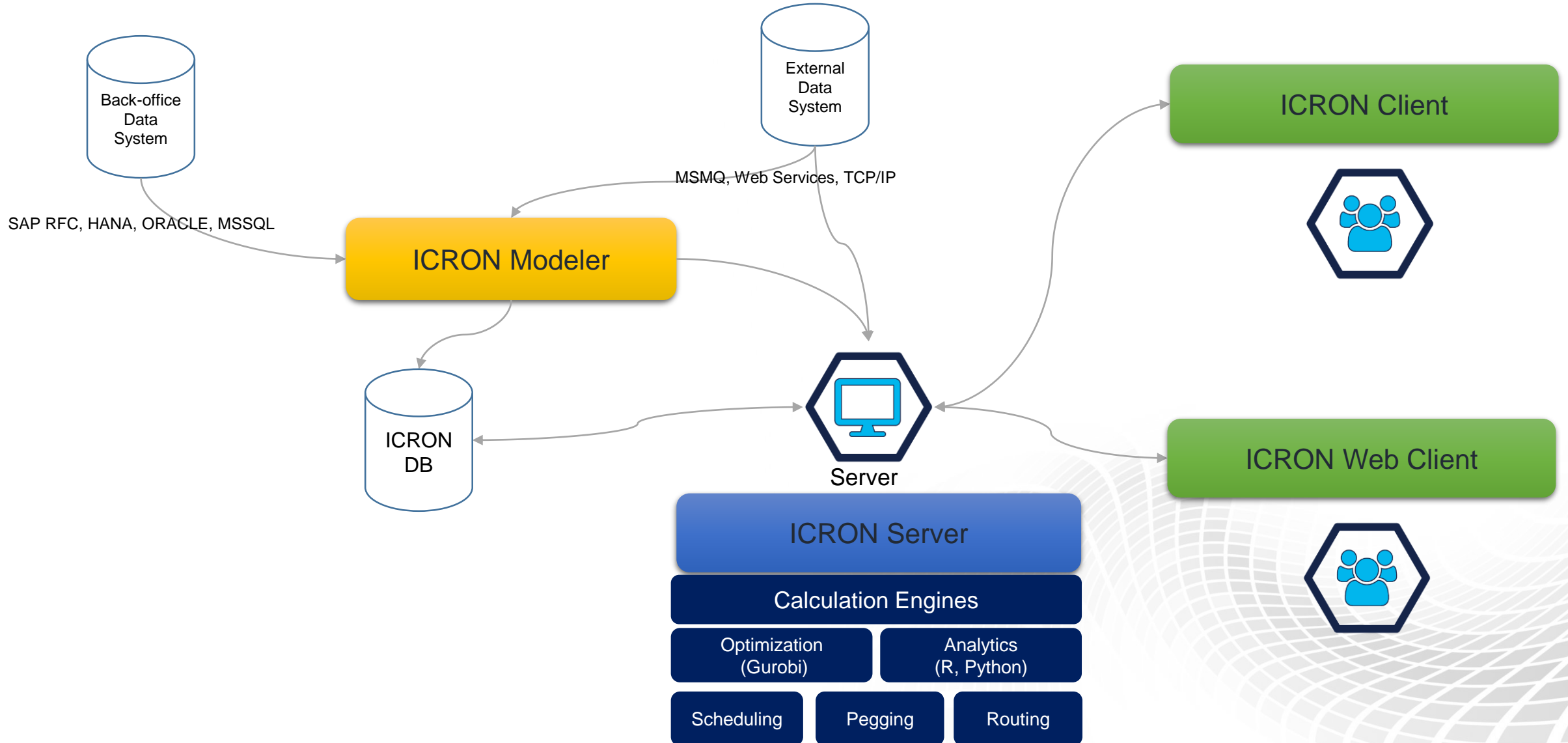
ICRON and Gurobi



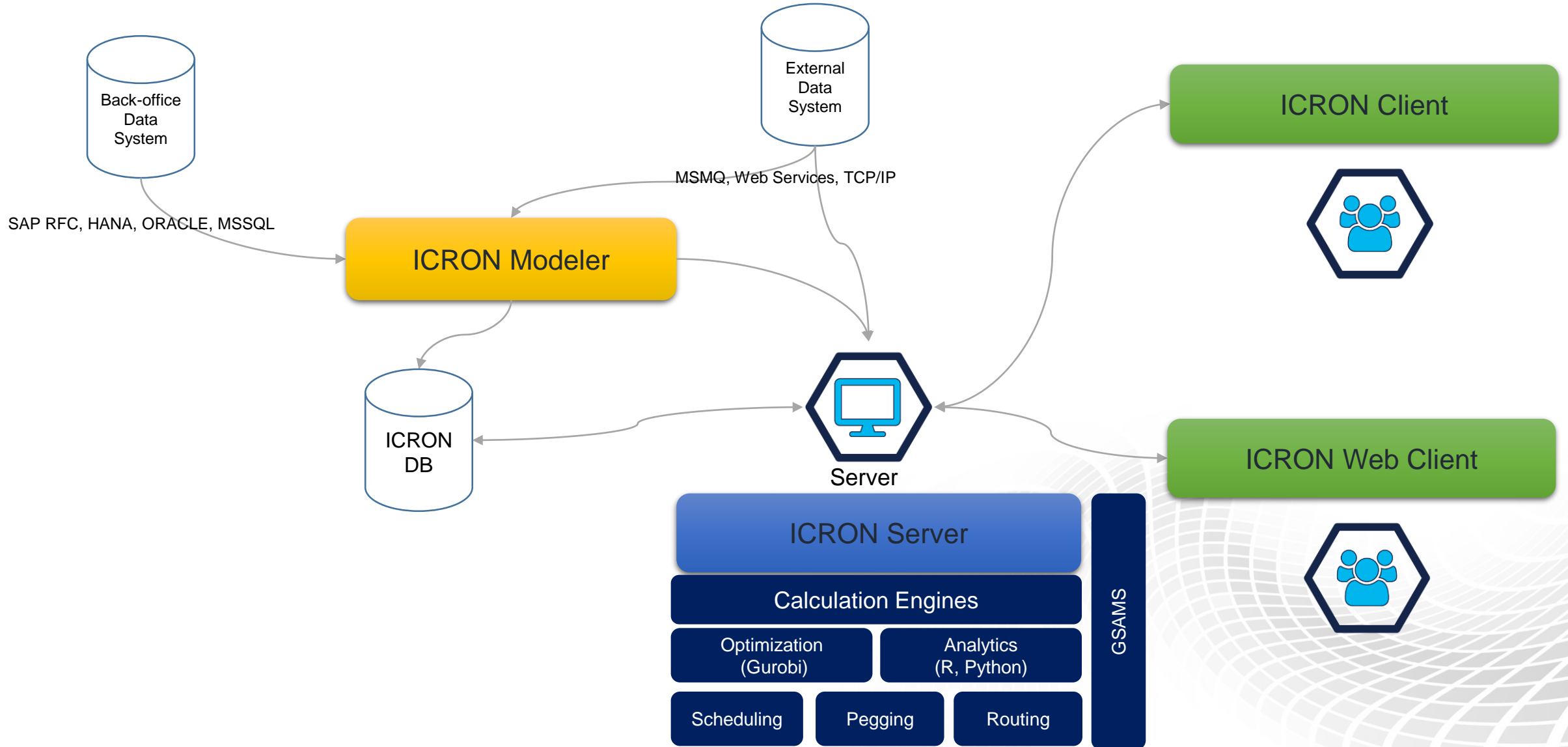
Technical Architecture



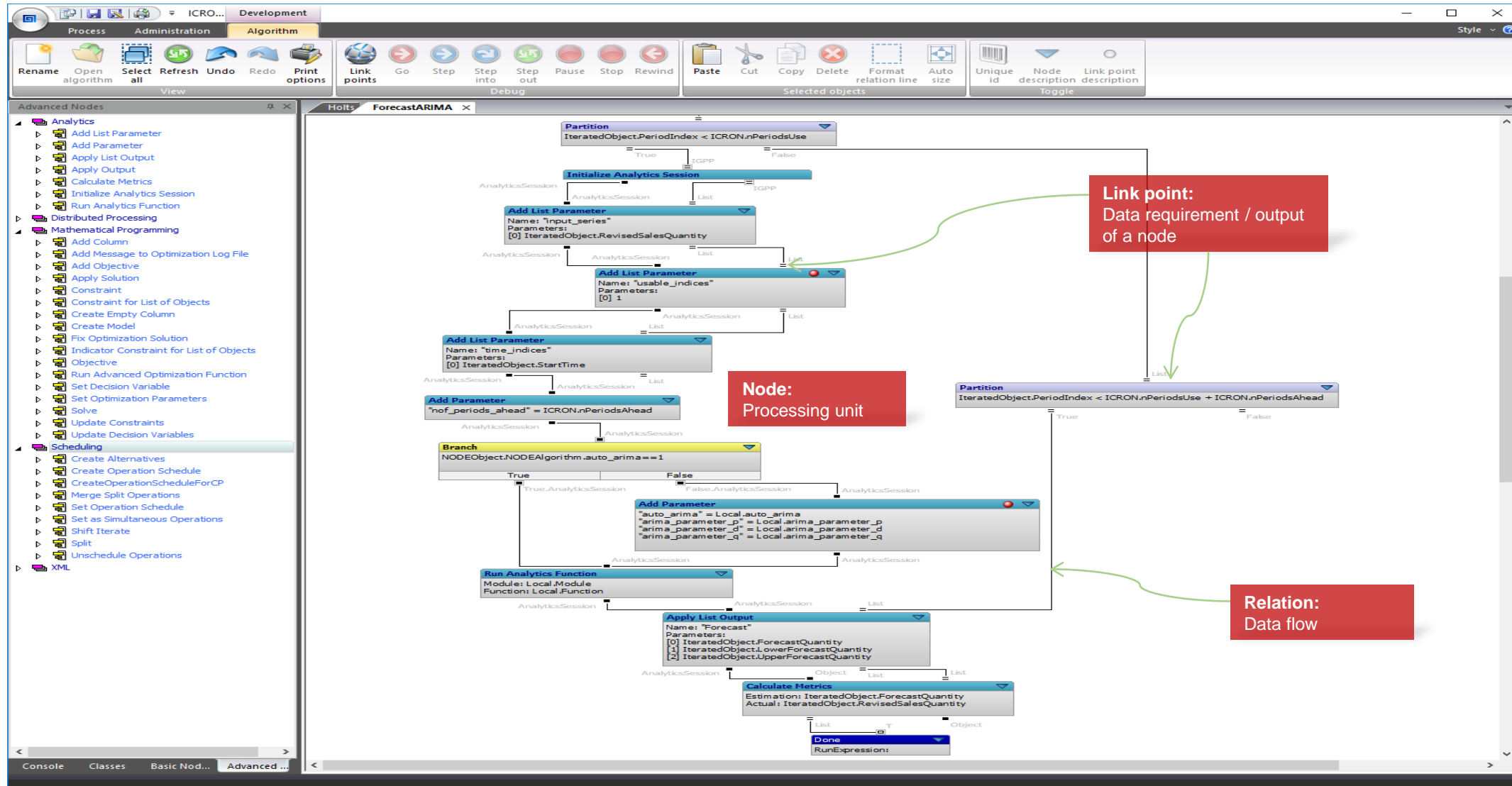
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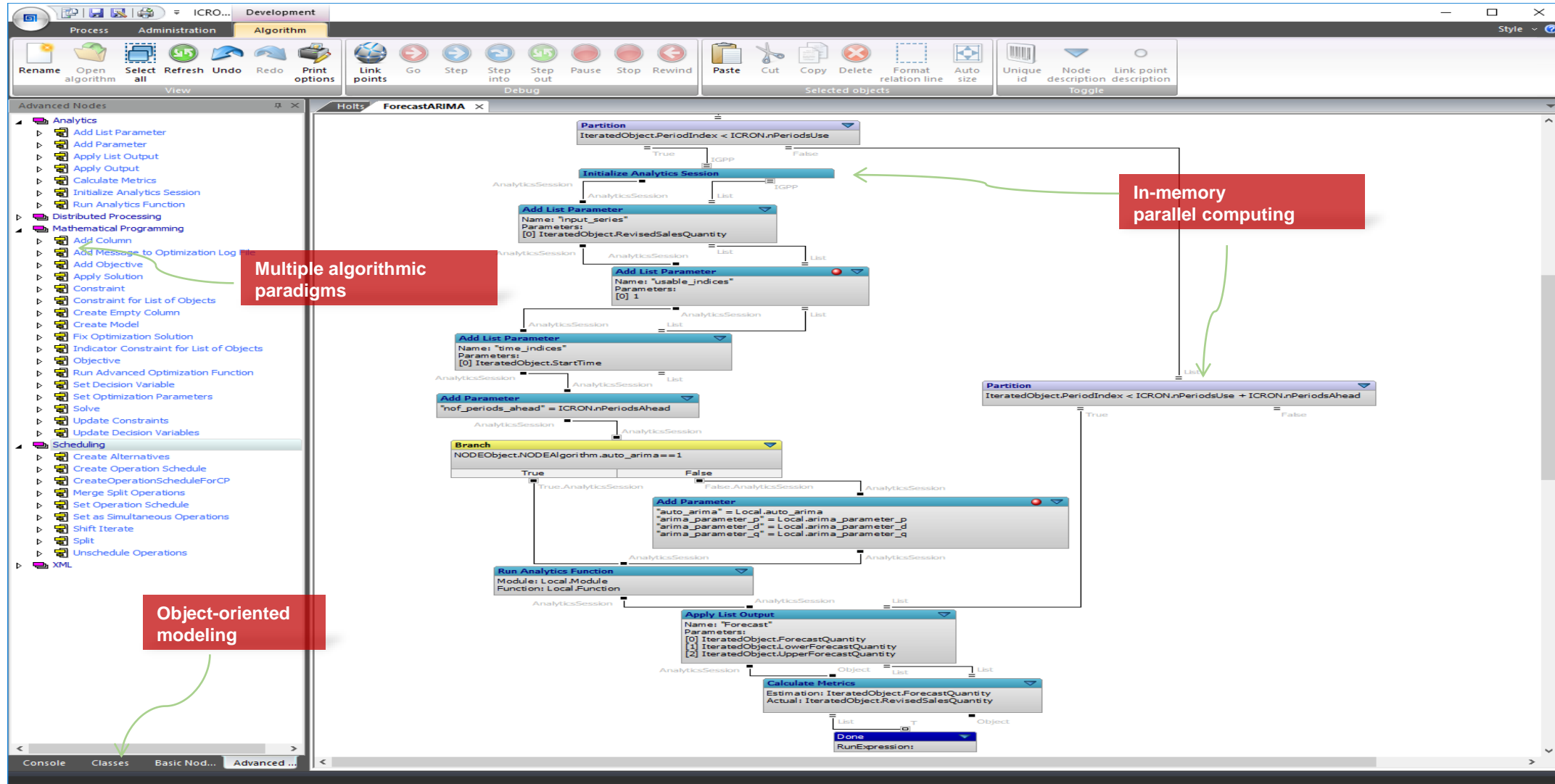
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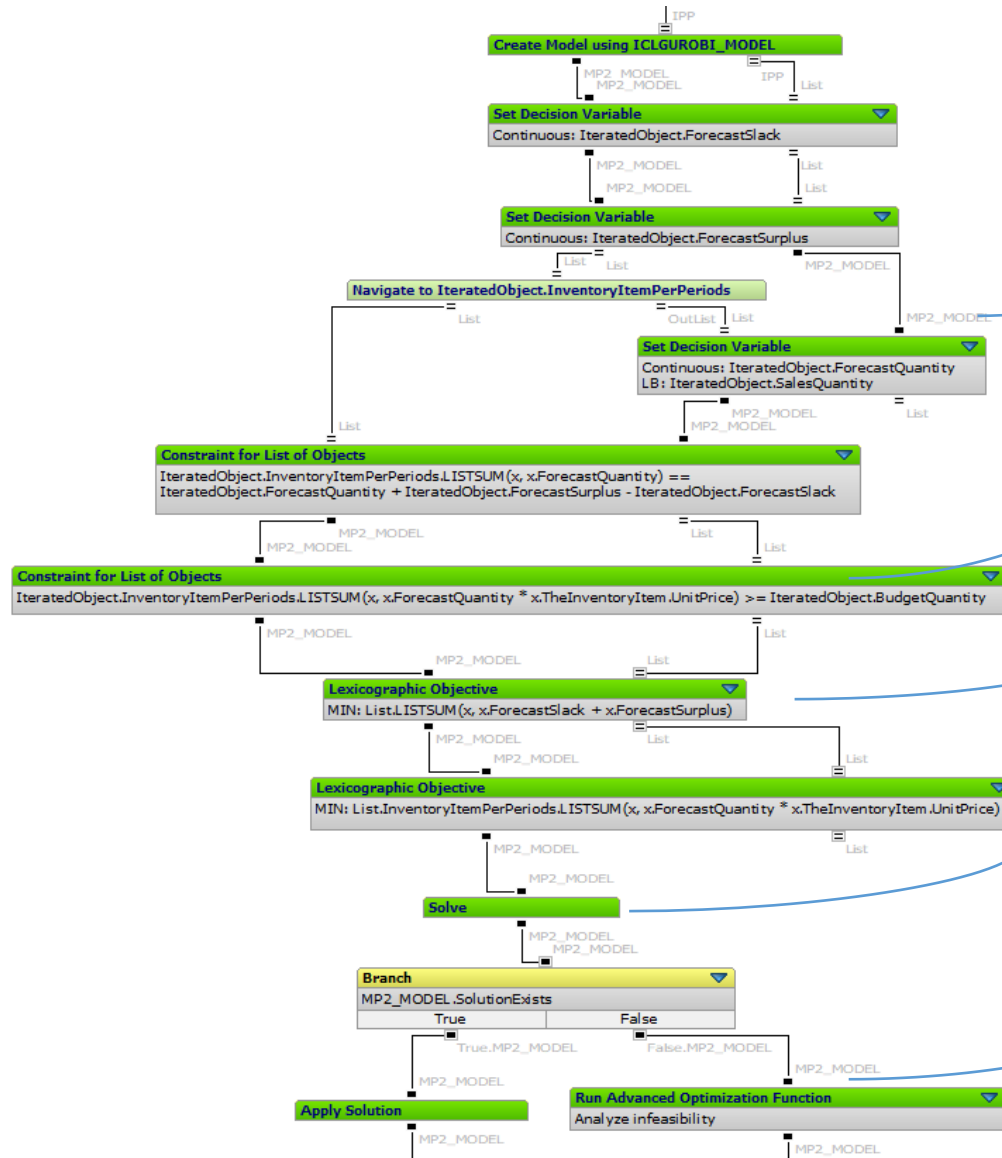
GSAMS: Visual Algorithm Modeling



GSAMS: Visual Algorithm Modeling



GSAMS: Gurobi Integration



Object-oriented, algorithmic modeling

Debugging

Multi-objective optimization

Warm-start

Infeasibility analysis

Supply Chain Optimization and Gurobi



| Supply Chain Requirements | Gurobi Features |
|----------------------------------|----------------------------------|
| Dynamic, large-scale operations | High performance |
| Multiple business objectives | Multiple optimization objectives |
| Rapid what-if analysis | Warm-start |
| Changes in business requirements | Flexible modeling |
| Conflicting constraints | Infeasibility analysis |
| Data errors | Infeasibility relaxation |
| Quick and good solutions | Heuristics |
| High financial impact | Optimization |

User Interface



ICRON FRC-RL - MONTH - 01/01/2017 00:00 Session ID: 484097

Manager

FRC-RL (2)

Baseline Forecasts

| Item Code | Main Group | Sales Office | Seas... | Brand | BSJ Group | Size Co... | Size Descripti... | Default Forecast Method | Is Forecasted |
|--------------------------------|------------|--------------|---------|-------|------------|------------|-------------------|-------------------------|---------------|
| 1000_BS_BNK_PSR 15_Yaz_B46 | BNK | 1000 | Yaz | BS | PSR 15 | B46 | 195/65R15 | ARIMA | 0 |
| 1000_BS_BNK_PSR 15_Yaz_B48 | BNK | 1000 | Yaz | BS | PSR 15 | B48 | 195/65R15 | ARIMA | 0 |
| 1000_BS_BNK_PSR IPPAN_Yaz_B19 | BNK | 1000 | Yaz | BS | PSR IPPAN | B19 | 165/80R13 | ARIMA | 0 |
| 1000_BS_BNK_PSR IPPAN_Yaz_B25 | BNK | 1000 | Yaz | BS | PSR IPPAN | B25 | 175/65R14 | ARIMA | 0 |
| 1000_BS_BNK_PSR IPPAN_Yaz_B26 | BNK | 1000 | Yaz | BS | PSR IPPAN | B26 | 175/70R13 | ARIMA | 1 |
| 1000_BS_BNK_PSR IPPAN_Yaz_B35 | BNK | 1000 | Yaz | BS | PSR IPPAN | B35 | 185/65R14 | ARIMA | 0 |
| 1000_BS_BNK_PSR OOGATA_Yaz_B59 | BNK | 1000 | Yaz | BS | PSR OOGATA | B59 | 205/55R16 | ARIMA | 0 |
| 1000_BS_BNK_PSR OOGATA_Yaz_B73 | BNK | 1000 | Yaz | BS | PSR OOGATA | B73 | 215/55R16 | ARIMA | 0 |
| 1000_LS_BNK_PSR 15_Kis_B36 | BNK | 1000 | Kis | LS | PSR 15 | B36 | 185/65R15 | ARIMA | 0 |
| 1000_LS_BNK_PSR 15_Kis_B48 | BNK | 1000 | Kis | LS | PSR 15 | B48 | 195/65R15 | ARIMA | 0 |
| 1000_LS_BNK_PSR 15_Yaz_B36 | BNK | 1000 | Yaz | LS | PSR 15 | B36 | 185/65R15 | ARIMA | 0 |
| 1000_LS_BNK_PSR 15_Yaz_B41 | BNK | 1000 | Yaz | LS | PSR 15 | B41 | 195/50R15 | ARIMA | 0 |
| 1000_LS_BNK_PSR 15_Yaz_B46 | BNK | 1000 | Yaz | LS | PSR 15 | B46 | 195/60R15 | ARIMA | 0 |

[To Be Forecasted] = '1'

Baseline Forecasts Chart

2848001

Sales Forecasts Revised Frc. Lower Frc. Upper Frc.

Forecast Methods Comparison Chart

2848001.ARIMA [2] 2848001.Prophet [1] Sales

KPI Monitor

KPI monitoring

Legend: Budget (Green), Forecast Financial (Grey)

Sales Offices (Select All):

- 1000
- 1200
- 1400
- 1600
- 1800
- 2000
- 2200
- 2400
- 2600

User Interface



ICRON FRC-RL - MONTH - 01/01/2017 00:00 Session ID: 484097

Manager

Multiple users / user roles

TOP

Baseline Forecasts

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[To Be Forecasted] = '1'

Scenarios

KPI Monitor

Messaging / collaboration

Forecast Financial

Sales Offices

- (Select All)
- 1000
- 1200
- 1400
- 1600
- 1800
- 2000
- 2200
- 2400
- 2600

2848001

Baseline Forecasts Chart

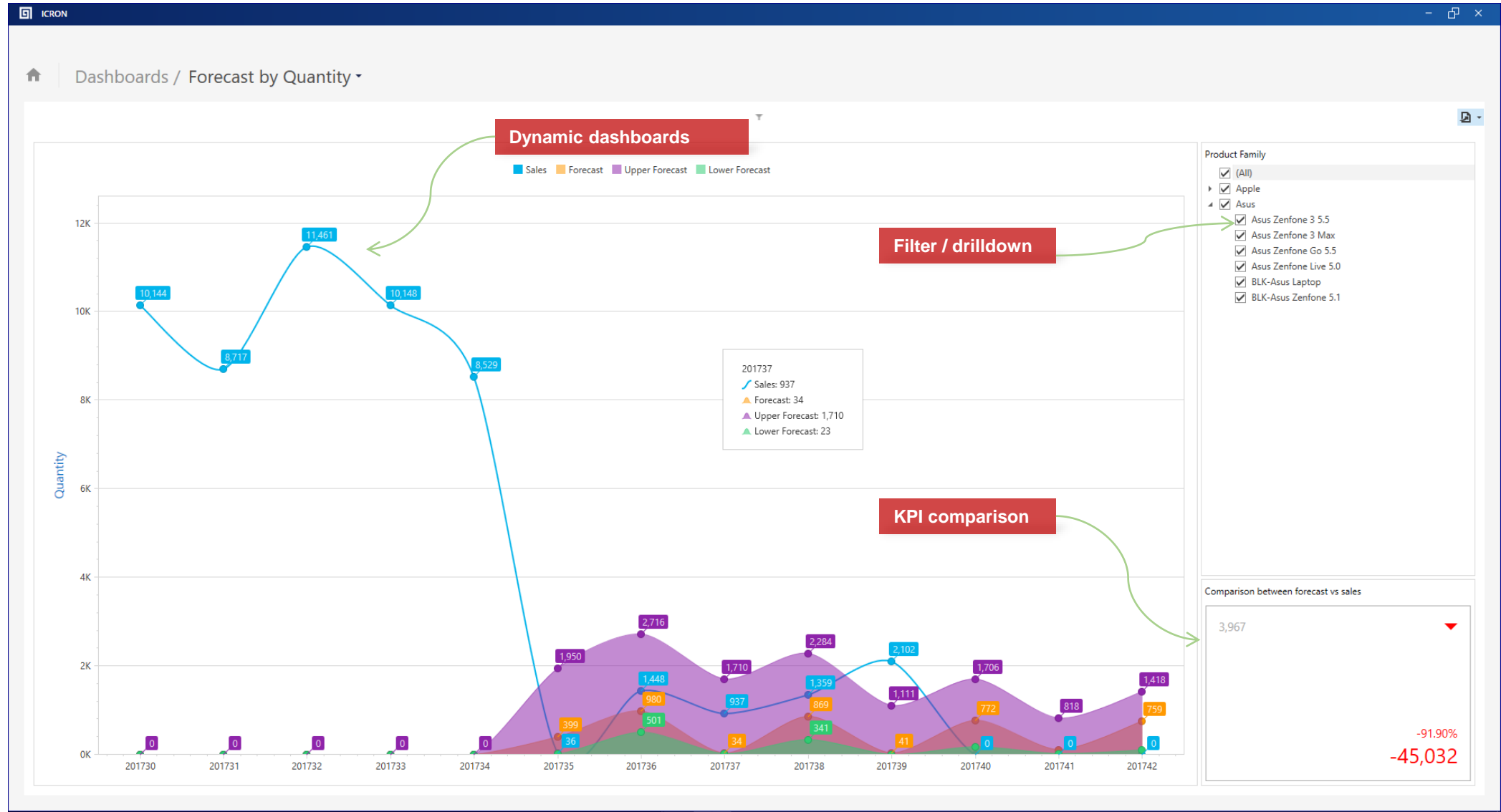
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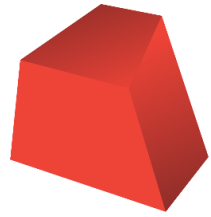
Sales Forecasts Revised Frc. Lower Frc. Upper Frc.

2848001.ARIMA [2] 2848001.Prophet [1] Sales

Values

January 2016 July 2016





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Decision-Centric Optimization at **VESTEL** Electronics



Vestel Group:

- Operations in consumer electronics, household appliances, defense, marketing
- 4.2 Billion \$ revenue

Vestel Electronics:

- Flagship of Vestel Group
- Biggest TV manufacturer in Europe
- ~20% share in European market
- > 9.5 million units of annual production capacity (30,000 daily)

Heavily customizable products

Rapidly changing technology

- Plasma -> LCD -> LED -> 3D -> Smart -> UHD -> Curved -> OLED ...
- 70-80% of monthly production is for new products
- Entire product portfolio refreshed every 6 months

Product brands

- Vestel owned
- Original Equipment Manufacturer (OEM) agreements with leading European and Japanese brands

Common practice in TV manufacturing:

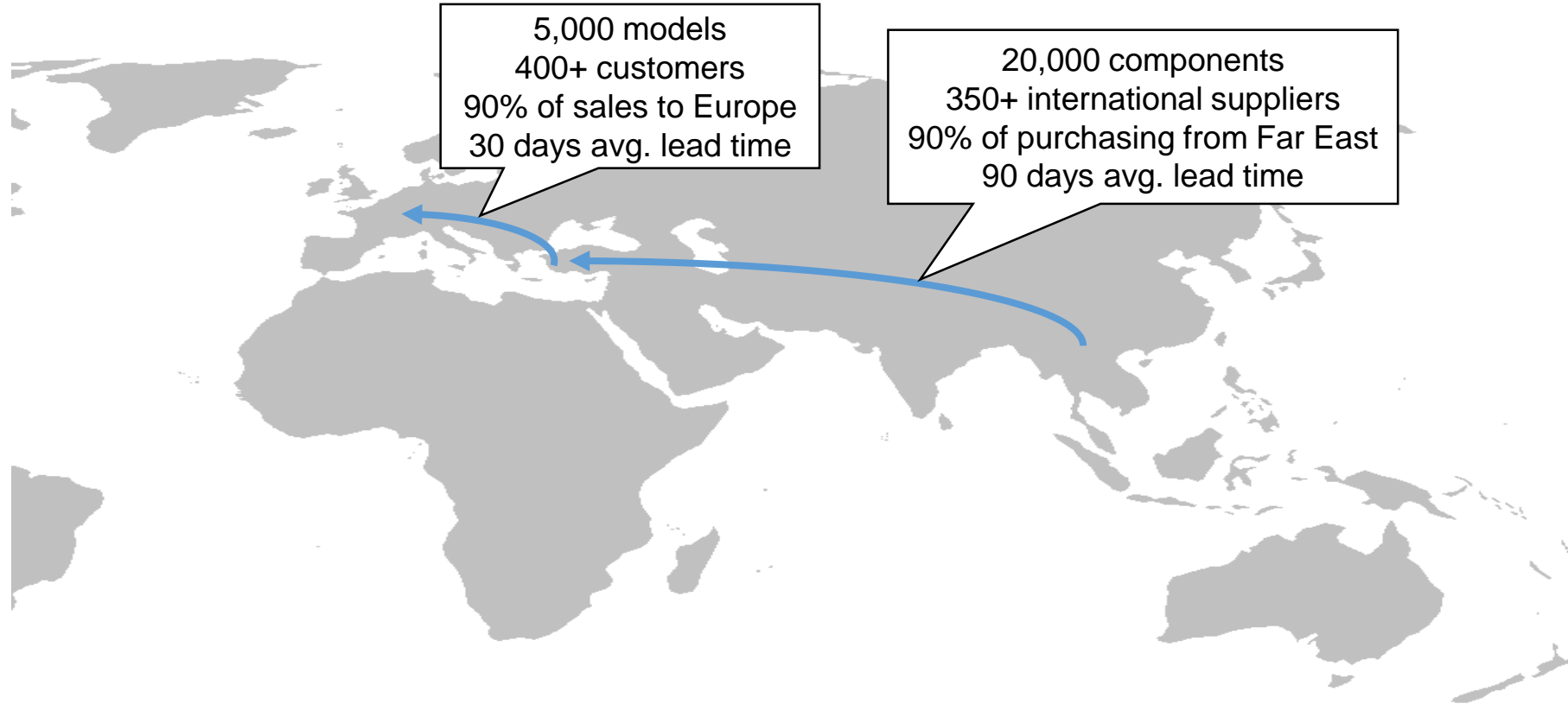
- Creating a stable operational environment
- Limiting product variety
- Long order acceptance and order fulfillment times
- Large order batch sizes

Vestel's competitive strategy: flexibility, responsiveness

Goal: efficiently managing its dynamic operational environment

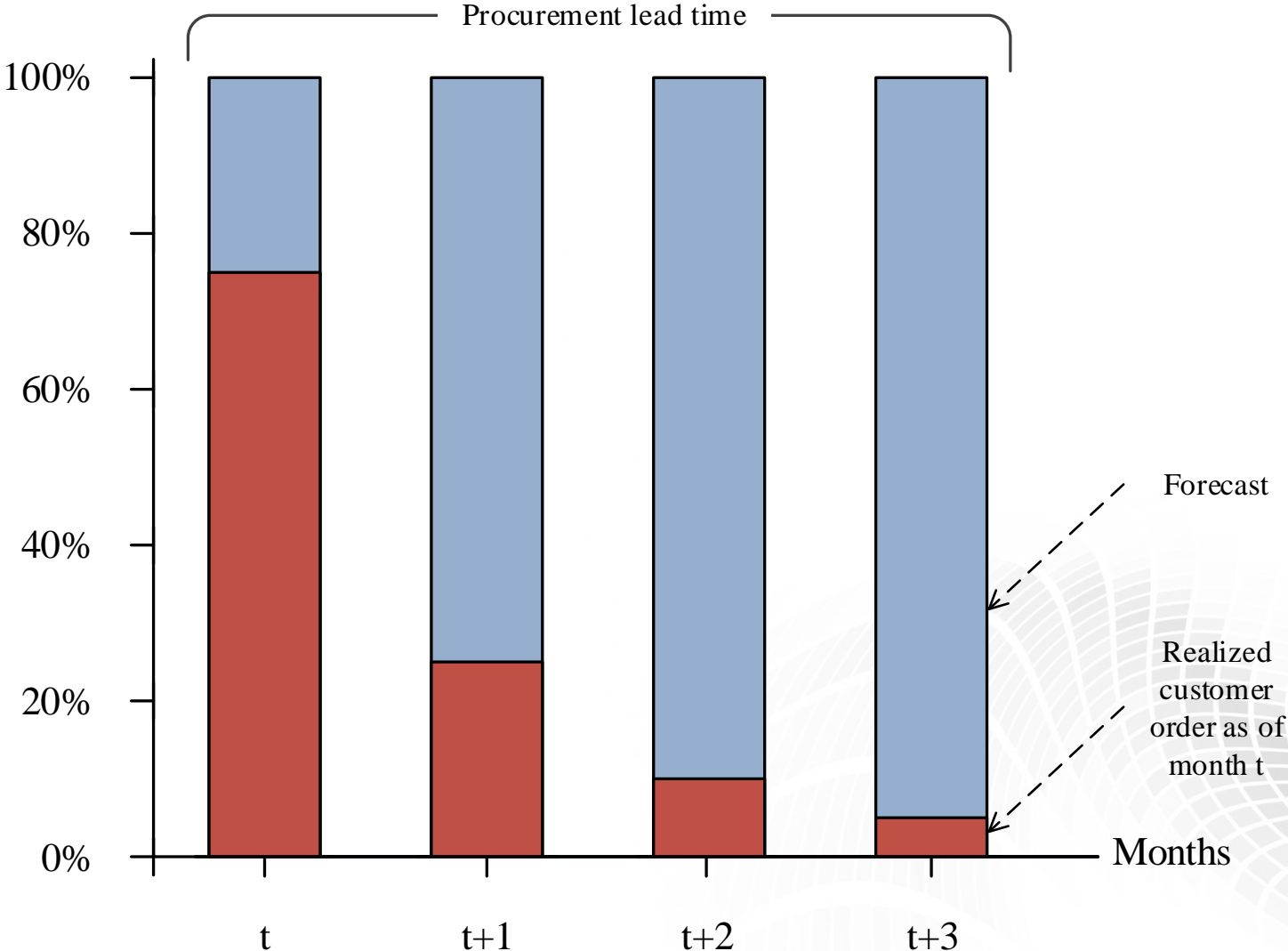
- Mass customization: increasing the number of product configurations
- Short order acceptance and order fulfillment times
- Small order batch sizes: 37% < 200 units, 66% < 500 units

Vestel's Supply Chain

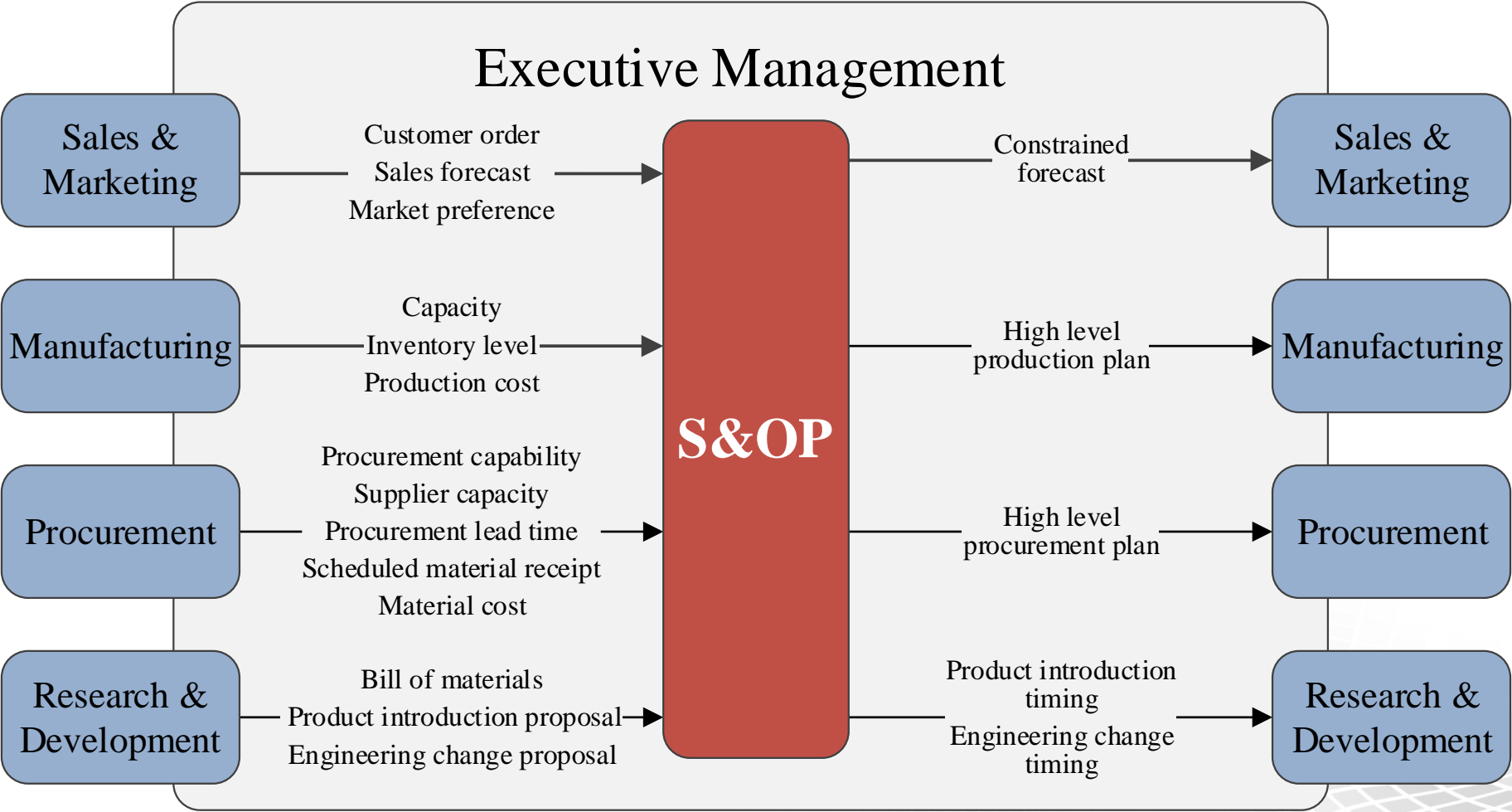


Challenge: how to manage lead time difference between procurement and sales?

Realized Customer Orders / Forecast



Sales & Operations Planning



Objective functions:

- Customer satisfaction
- Operation costs (production, procurement, inventory)
- Business preferences

Decision variables:

- Planned production quantity in each period
- Planned purchase quantity of critical components in each period

Constraints:

- Sales forecasts
- Realized customer orders
- Manufacturing capacity
- Critical component inventory levels and scheduled receipts
- **Manually created** constraints

Implementation



10,000 PMs; 15,000 processes; 6+ months planning horizon

150,000 decision variables; 200,000 constraints

Data integration, validation and transformation: 30 minutes

Model construction and initial solution: 3 minutes

Re-optimization after manual changes: 3 seconds

Infeasibility analysis: 15 seconds

DSS fully deployed in 2011 and has been in continuous use since

Intangible Gains



Reduction in MRP nervousness

Increase in data visibility and correctness

Provided a basis for further studies

- DSS for capable-to-promise (CTP) process
- DSS for detailed scheduling of all main work centers

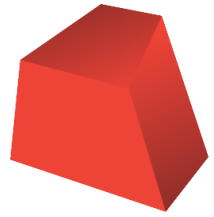
Increased S&OP process effectiveness

Established new way-of-working among various business functions

Tangible Gains



| | Before | After |
|--|--------------------------|-------------------------------|
| Planning technique | Manual, experience-based | Automated, optimization-based |
| Planning time | 2 days (single scenario) | 3 hours (multiple scenarios) |
| Feasibility/consistency check | Manual | Automated |
| S&OP meeting frequency | Monthly | Weekly / as needed |
| Planning accuracy | | 20% improvement |
| Netting of forecasts and customer orders | Bi-weekly | Daily |
| Inventory levels | | 5% decrease |
| Financial benefits | | Over one million \$ annually |



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Conclusion



Takeaway Points



Supply Chain Optimization is critical for

- Ensuring supply and demand balance
- Efficient utilization of resources
- Cross-functional alignment
- Sustainability and profitability of the company

Effective Supply Chain Optimization requires:

- Focus on **decision** processes
- Situational awareness and visibility
- Rapid scenario analysis
- Coordination between business functions

Mathematical programming provides a practical and flexible technique for Supply Chain Optimization

Visual algorithm modeling by GSAMS facilitates usage of optimization within decision processes

ICRON and Gurobi enable **decision-centric optimization** for the Supply Chain