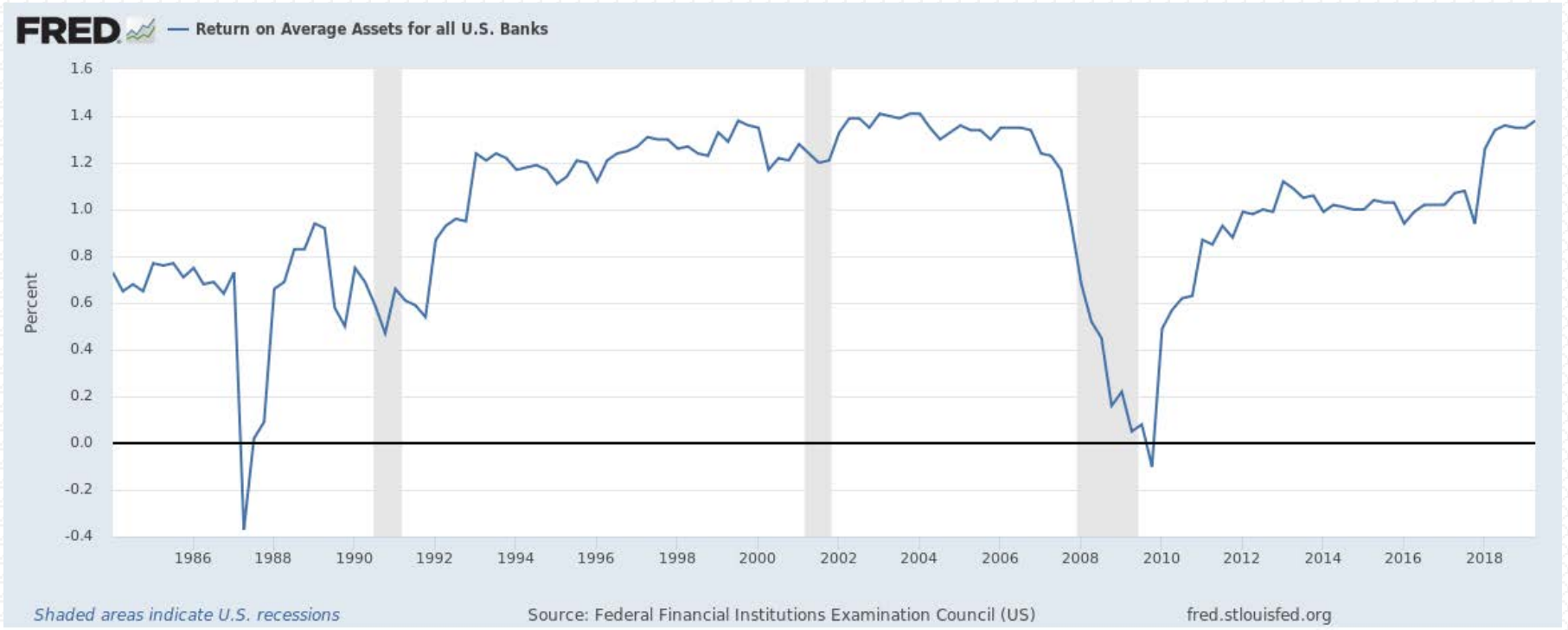
# Quantum Applications for Financial Institutions

CogniFrame®

The Hybrid Machine Learning Company

# Why is Quantum relevant for FI's?




Small improvement in Return on Assets (ROA) can make a massive $$$ impact

**Quantum could help solve intractable problems and deliver performance improvements**

# The Framework

## STAKEHOLDERS

Financial Institution
Quantum Hardware Co.
Quantum Application Co.

## OWNERSHIP

Intellectual Property
Process Improvement

## DEPENDENCIES

Data
Business Process/Rules
Resources
Proof of Concept
Testing

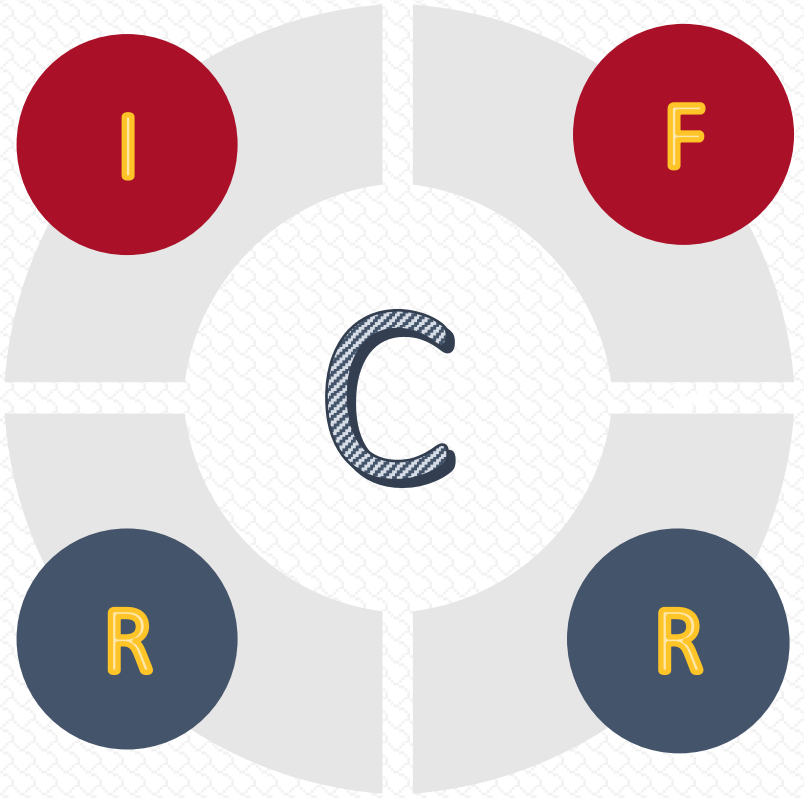
## OUTCOME

Demonstrate Improved Return on Assets (ROA)

# Collaboration Requirements

**IDENTIFY**

Intractable Problem




**FORMALIZE**

Structure
Process
Benchmark

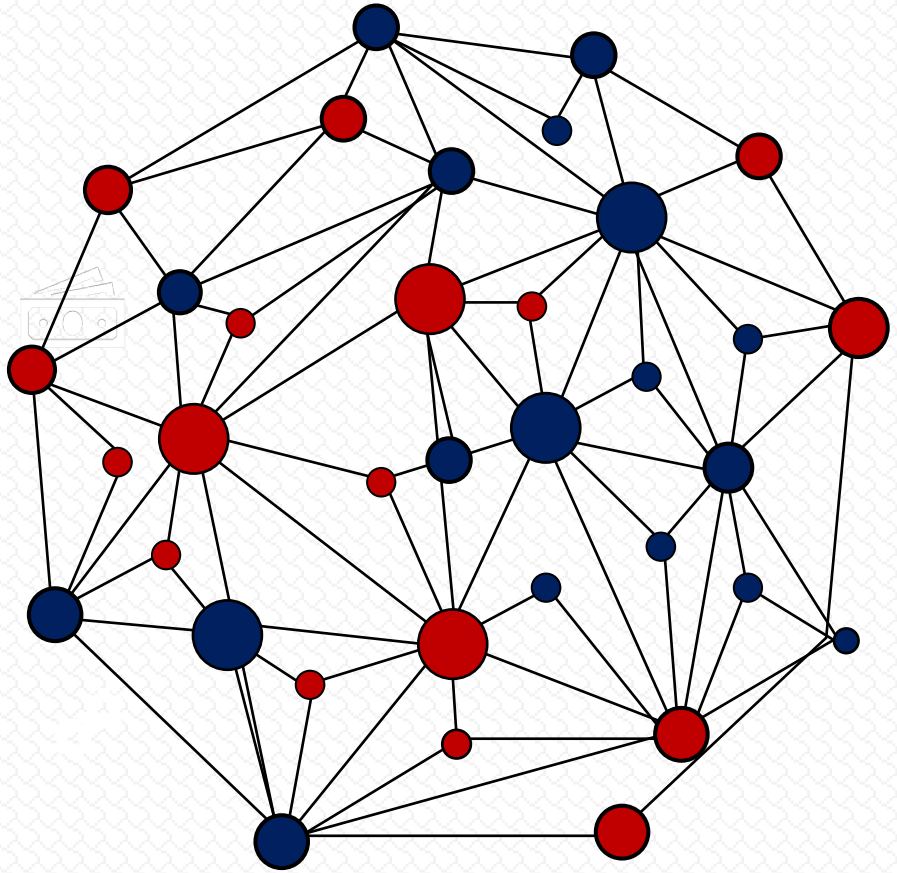
**RESOURCE**

People
Partnerships

**R&D**

Formulate
Test

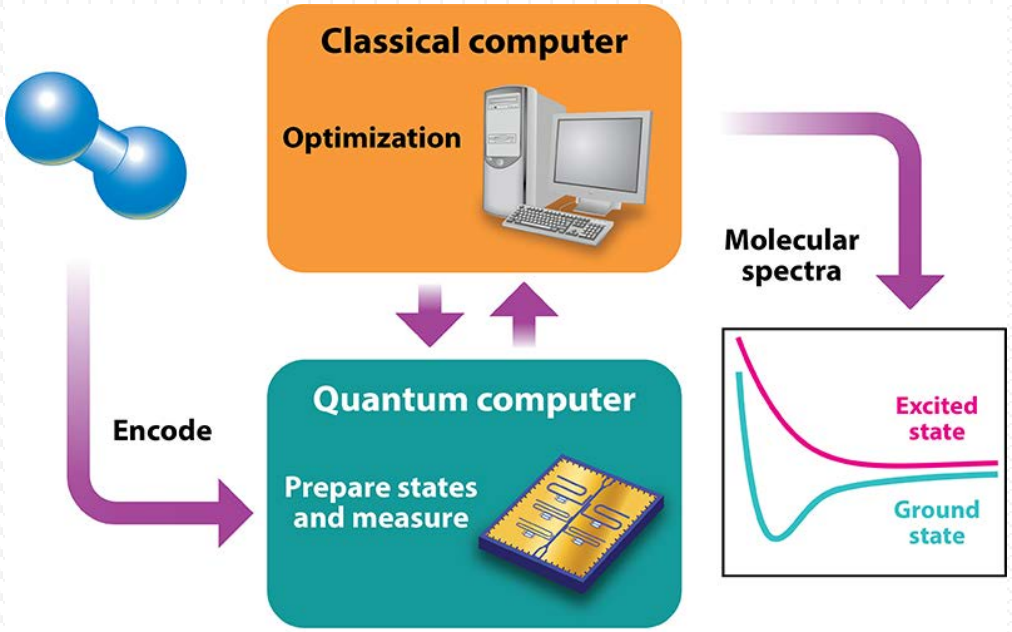
# What to Quantum-ize?



- Types of Problems
- Scalability
- Hardware Capabilities
- Impact Value

# Approaches

- Classical vs Quantum vs Hybrid
- Simulated vs Quantum
- Evaluation of Results



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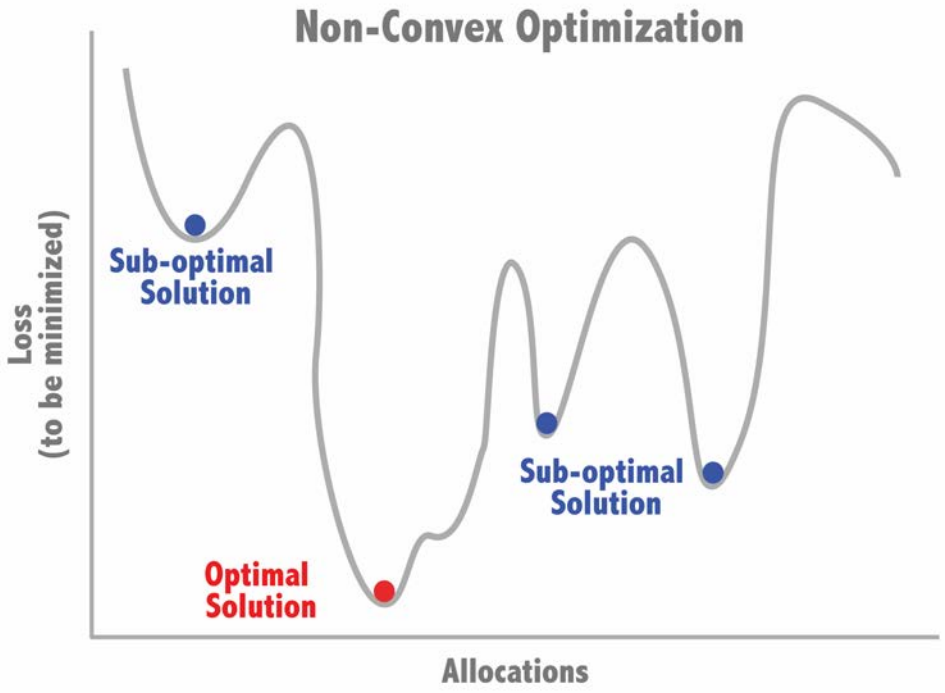
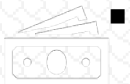
# The Use Case: Non-Convex Optimization




- Our quantum computing software allows financial institutions to find better Optimal Solution(s).
- This leads to increased returns, reduced risk, and greatly outperforms the optimal solution found using convex optimization.
- CogniFrame's solution can be customized for a financial institution's objectives such as risk, returns or other constraints.

# Sources of Non-Convex Problems

- **Nature of Problem**
  Problems that contain a number of local optimality across the energy space (e.g. combinatory optimization, discrete optimization).



- **Choice of Models**
  The choice of utility function, risk metrics, objectives functions (e.g. VaR, trading trajectory).

- **Market Friction and Irrationality**
  The market cost and irrationality embedded in data resulting in negative eigenvalues, usually noticeable when the scale of the problem grows.

- **Optimization Constraints**
  Non-linear/inequality constraints in the optimization problem.

Non-convexity usually emerges with relaxing of certain “handcuffs” in the optimization problem.

# Non-Convex Problems

## Multiple Use Cases

- ALM - Active Portfolio Optimization and cash flow matching for banking book.
- Pension Funds - Optimize allocations of member contributions and benefit payouts.
- Collateral Optimization
- Insurance - Solvency II, Portfolio Optimization.
- Asset Managers - Portfolio Optimization.
- Fixed Income - Portfolio Optimization.

# Workflow

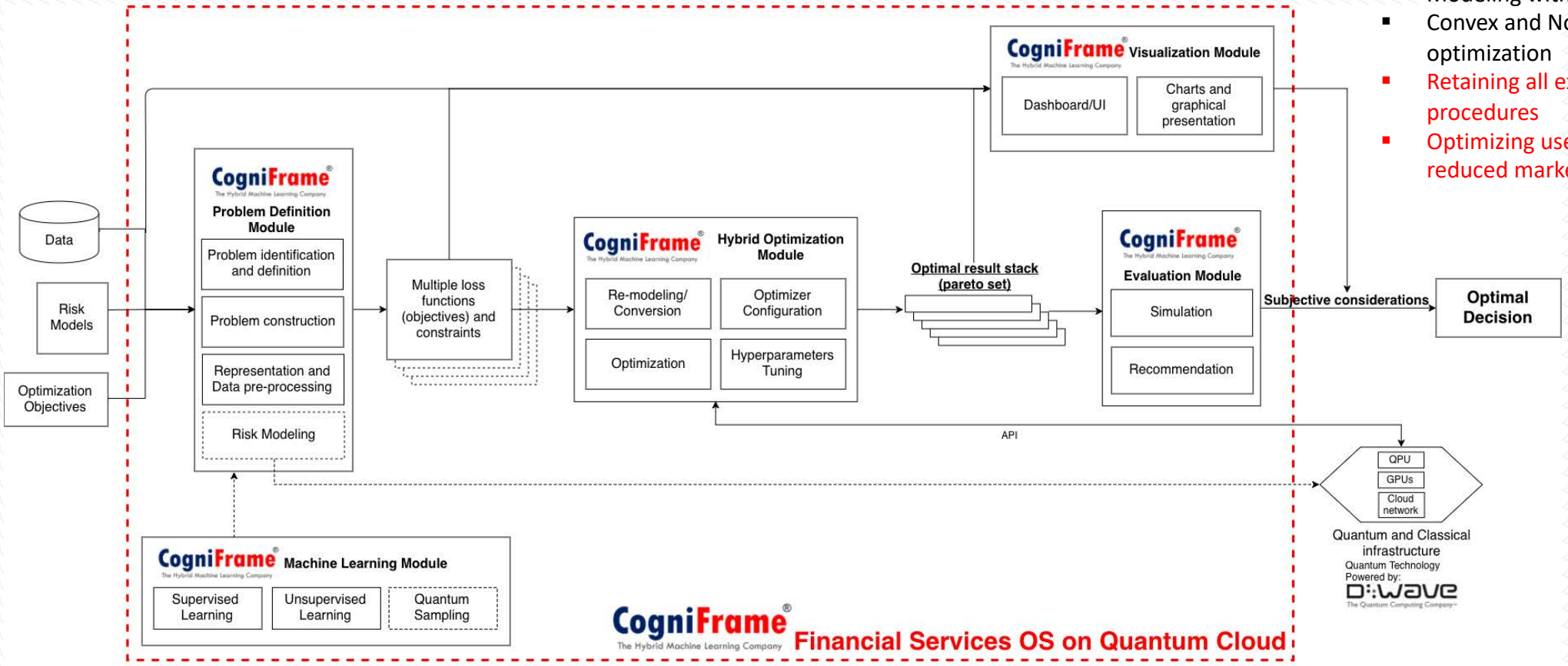
## How does our model work?

**Current FI approach**

- Linear Risk Modeling
- Convex Optimization

**The CogniFrame approach**

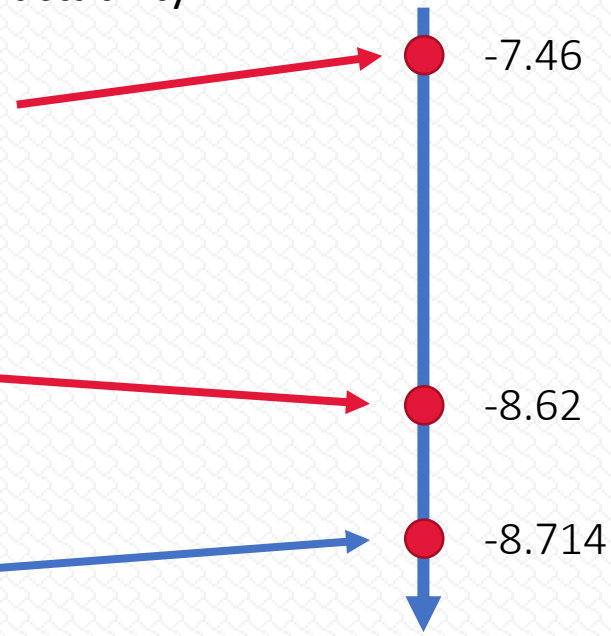
- Linear and Non-Linear Risk Modeling with ML
- Convex and Non-Convex optimization
- Retaining all existing models and procedures
- Optimizing use of funds with reduced market and liquidity risks



# Early Results using Non-Convex Return Matrices

Hybrid Solution = Classical Methods + D Wave Quantum

- Problem: 12 constraints, 20 variables (investments) per constraint
- Objective:  Lower is better; small decimals represent hours of run time or even intractability
- Specialized Classical optimization tools accelerated on Graphics processor (GPU):
  - Brute force use of compute power with a robust optimization method
  - 2.5 hours of runtime
- Industry-standard package (CPLEX 12.8):
  - 2.5 hours of runtime
  - Out-of-memory condition on a 64GB machine
  - Optimal not proven
- Hybrid solution
  - 30 minutes of runtime



# Proof Of Concept - Objectives

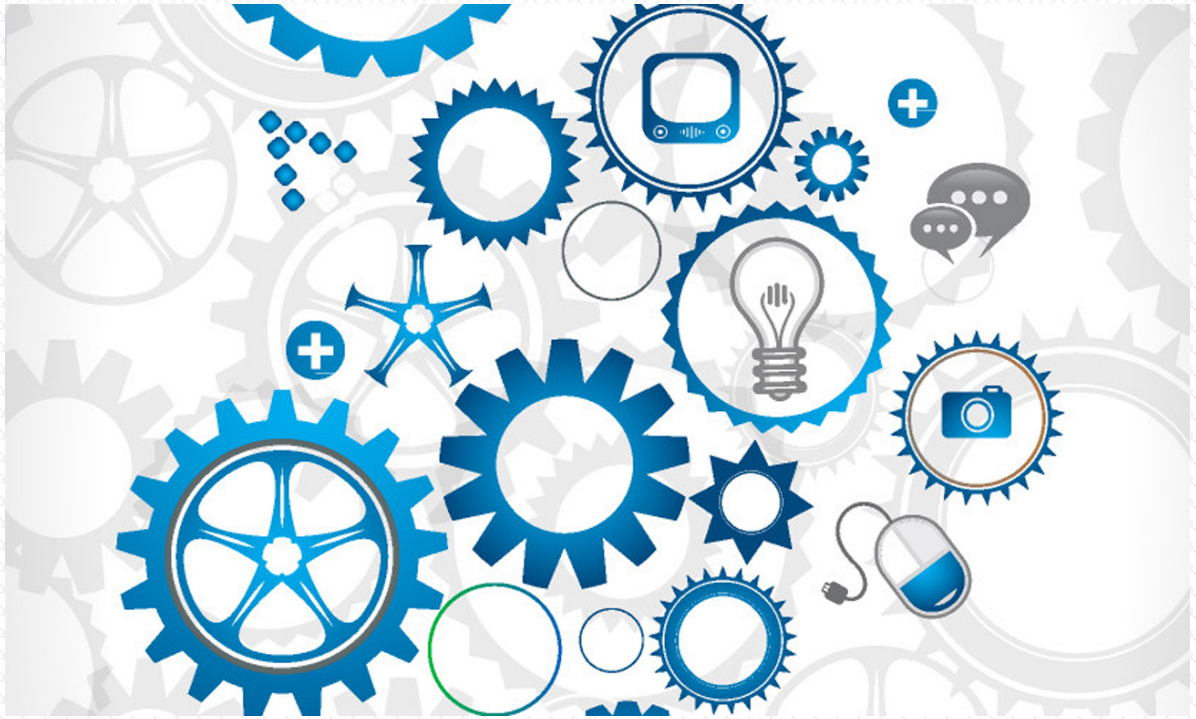
- Demonstrate “performance improvement” vs Classical
- Demonstrate Financial Value
- Demonstrate Commercial Scalability
- Costs vs Benefits Analysis

# Key Challenges

- Choosing the right problem (setting up for success)
- Data aggregation/acquisition – dispersed among many legacy systems
- Commercial Scalability
- Multiple Low Energy Solutions – evaluating ROA

# Commercialization

- Business Models (In-house vs SaaS, Pricing structure, IP)
- Implementation Challenges
- Repeatability



**Going beyond the Technology**


# THANK YOU

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