SMLC
SMART MANUFACTURING
LEADERSHIP COALITION

The infusion of intelligence that transforms the way industries conceptualize, design and operate the manufacturing enterprise.

Smart Manufacturing and Sustainability

Jim Davis UCLA & Tom Edgar UT Austin
SMLC Board

https://smartmanufacturingcoalition.org
http://smartmanufacturing.com

Smart Manufacturing

All information about the manufacturing process available when it is needed, where it is needed, and in the form that it is needed.

Industrial Gas Manufacturing

Energy Supply

Production and Delivery

Steel

Energy

Bio/Pharma

Electronics

Healthcare

Customers
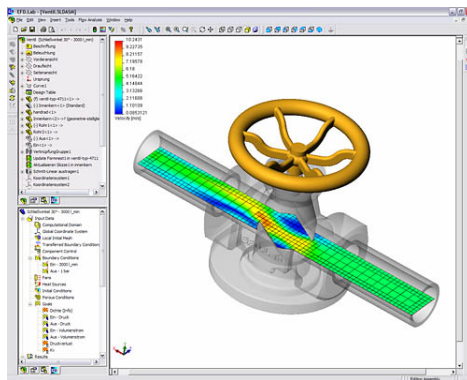
Our customers demand capital discipline and high reliability

Our goal is to meet their demands *and* maintain high energy efficiency
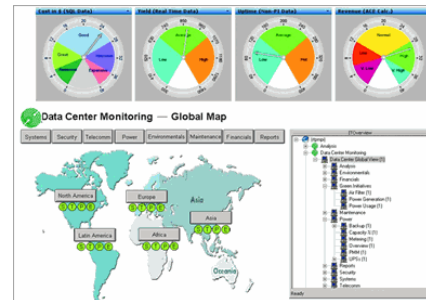
- **Low cost sensors and wireless enable real time decisions**

- **Hosted computing improves results at a lower cost**

Design

Operations

- **Common infrastructure facilitates supply chain collaboration**

manufacturer (oem)

distributor/ reseller

retailer

customer

supplier

logistics

General Dynamics

Machine Function Benchmarking & Integrated Line and Energy Management

Managing Power from the Grid

![SMLC — Smart Manufacturing Leadership Coalition]

General Mills

- *Customers "pushing" demands*
- *Tracking & Traceability*

Farming

Supply Chain

DEMAND DRIVEN

DRIVE OUT VARIABILITY

Manufacturing Plant

Distributor

Customer

General Mills
Networked-Based Manufacturing
Intelligence & Collaborative Manufacturing

EDI transaction & quality certifications

Business Systems, ERP

Recipe Management
Mapping formula into operating recipes

Mapping SAP information Into operation

Customer

Supply Chain

Distribution Center

Smart Factory

Smart Grid

FDA Tracking & traceability

Green Light
Analyze - to put into production
Make – right ingredients – confirmation on recipe
Release – meet requirements to release
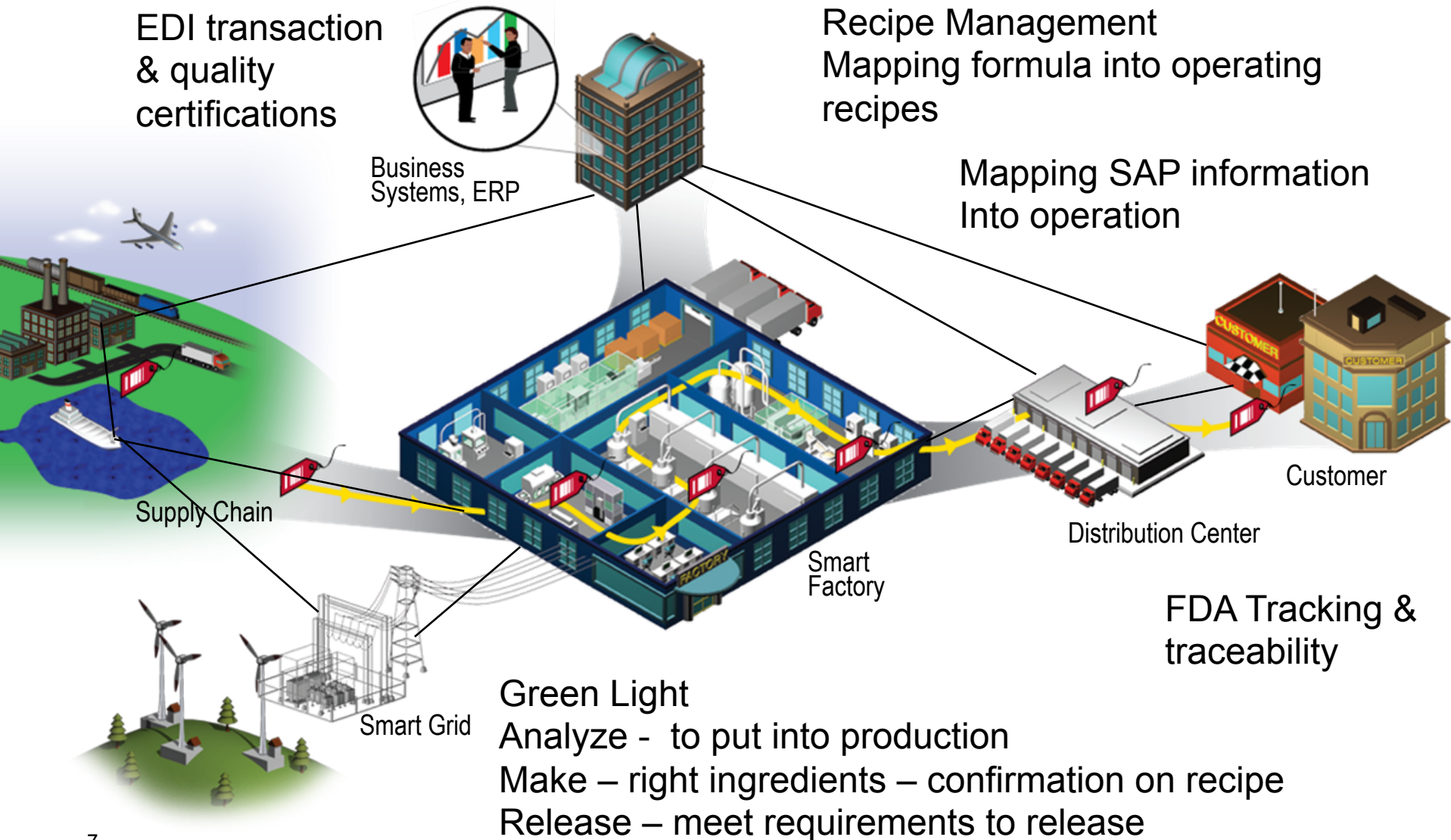
Smart Machine Operations

- In production machine-product management
- Benchmarking machine-product interactions
- Integrated dynamic management of machine-electrical power interactions
- Adaptable machine configurations

In Production Use of High Fidelity Modeling and Simulation

- High fidelity modeling for better management
- Rapid qualification of components and products

In Production Decision Making with Global Integrated Metrics

- Dynamic Business and Operational Tradeoff Decision-Making
- Dynamic performance management of global integrated metrics
- Untapped cross factory degrees of freedom for optimizing efficiency and performance and compressing time
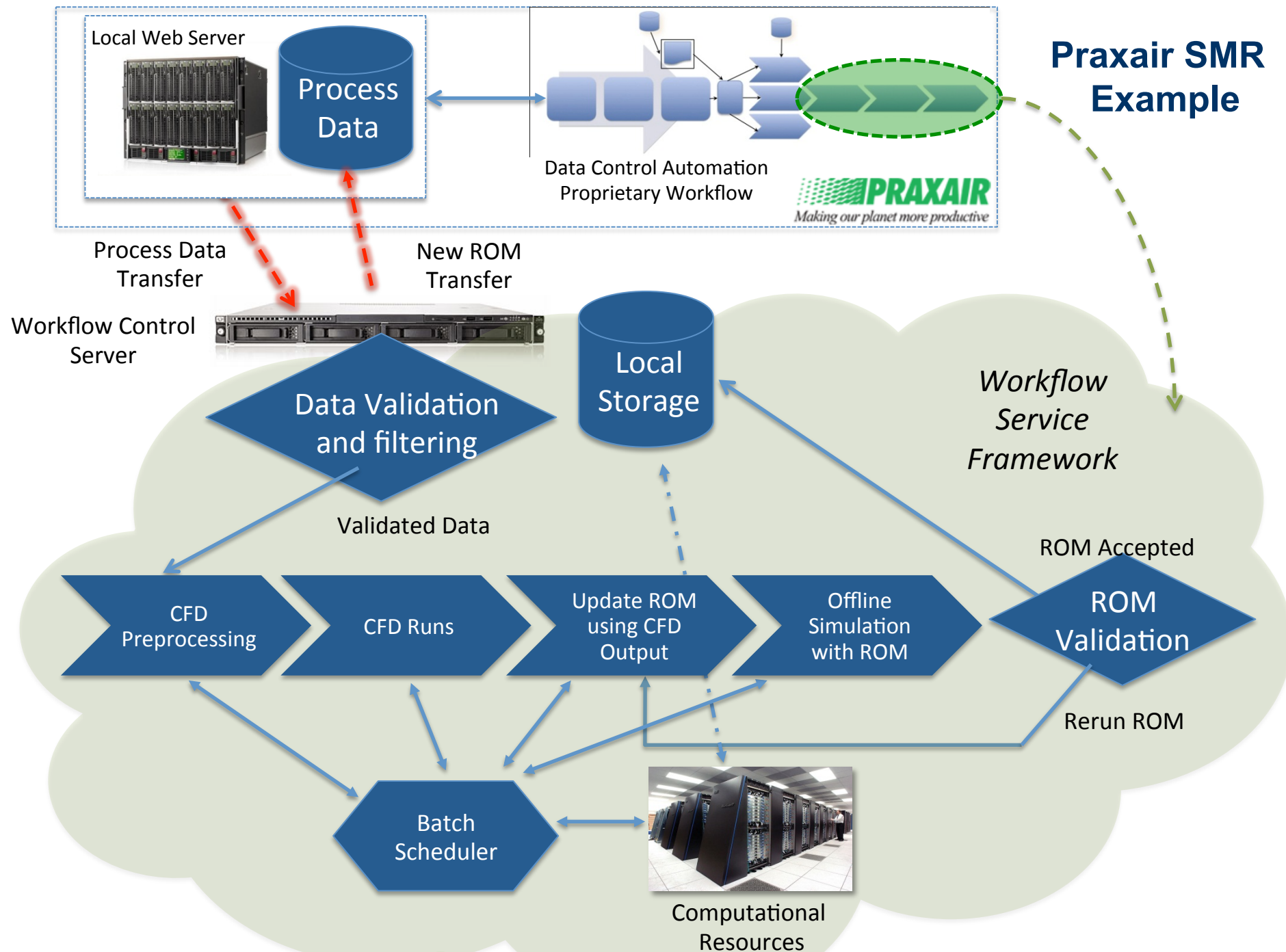
Supply Chain Management

- Supply chain variability reduction and management of risk
- Tracking and traceability

Design and Engineering

- Integrated product and manufacturability design
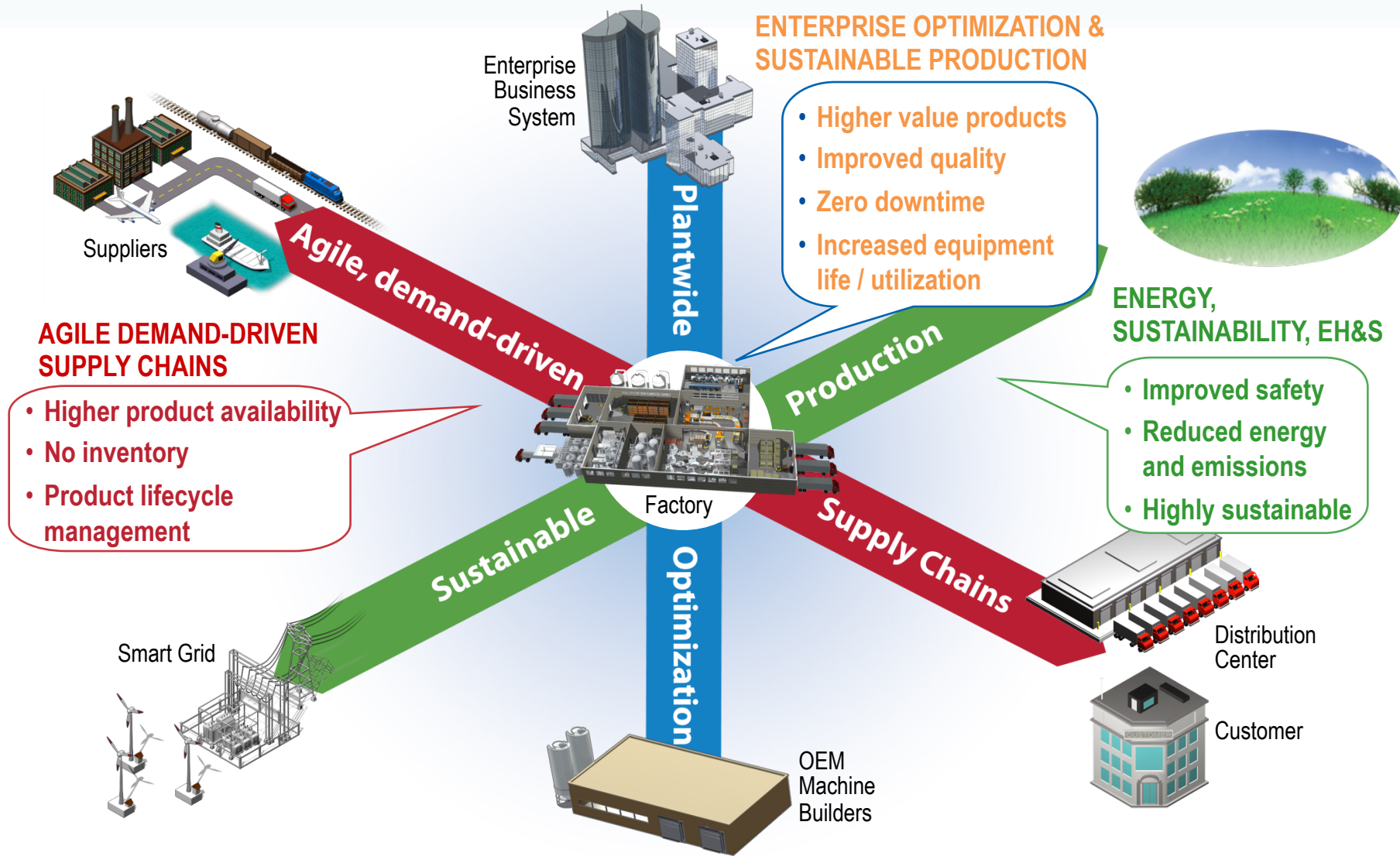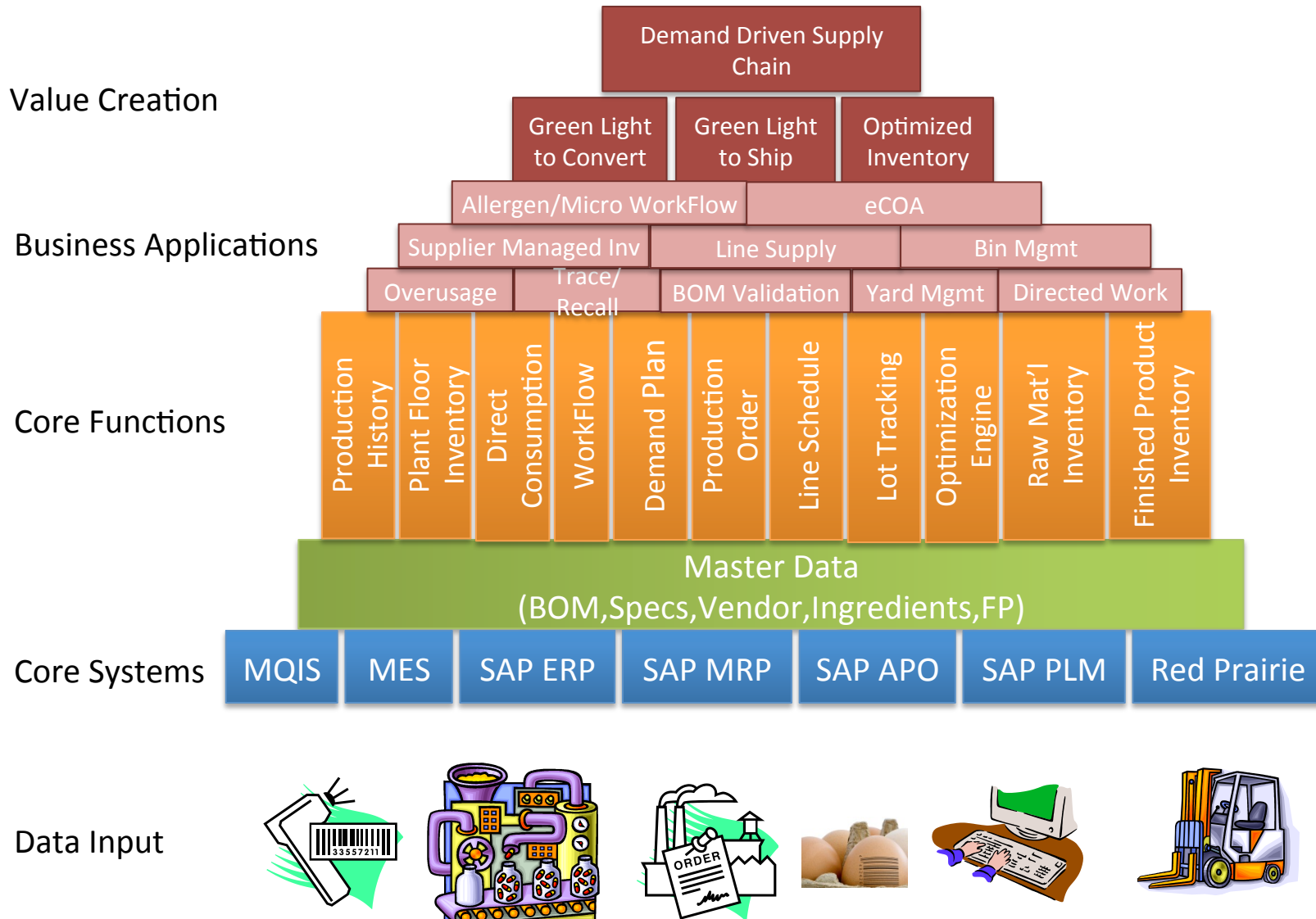- New product and product transition planning

Local Web Server

Process Data

Data Control Automation
Proprietary Workflow

PRAXAIR
Making our planet more productive

Praxair SMR Example

Process Data Transfer

New ROM Transfer

Workflow Control Server

Data Validation and filtering

Local Storage

Workflow Service Framework

Validated Data

ROM Accepted

CFD Preprocessing

CFD Runs

Update ROM using CFD Output

Offline Simulation with ROM

ROM Validation

Rerun ROM

Batch Scheduler

Computational Resources

SMLC Commitment to a Comprehensive Approach

ENTERPRISE OPTIMIZATION & SUSTAINABLE PRODUCTION

Enterprise Business System

- Higher value products
- Improved quality
- Zero downtime
- Increased equipment life / utilization

ENERGY, SUSTAINABILITY, EH&S

- Improved safety
- Reduced energy and emissions
- Highly sustainable

AGILE DEMAND-DRIVEN SUPPLY CHAINS

- Higher product availability
- No inventory
- Product lifecycle management

Suppliers

Smart Grid

Factory

OEM Machine Builders

Distribution Center

Customer

Agile, demand-driven

Plantwide

Production

Sustainable

Optimization

Supply Chains

GM's ECO System of " STUFF"

Value Creation

Demand Driven Supply Chain

Green Light to Convert	Green Light to Ship	Optimized Inventory

Business Applications

Allergen/Micro WorkFlow	eCOA

Supplier Managed Inv	Line Supply	Bin Mgmt

Overusage	Trace/ Recall	BOM Validation	Yard Mgmt	Directed Work

Core Functions

- Production History
- Plant Floor Inventory
- Direct Consumption
- WorkFlow
- Demand Plan
- Production Order
- Line Schedule
- Lot Tracking
- Optimization Engine
- Raw Mat'l Inventory
- Finished Product Inventory

Master Data (BOM,Specs,Vendor,Ingredients,FP)

Core Systems

MQIS	MES	SAP ERP	SAP MRP	SAP APO	SAP PLM	Red Prairie

Data Input

International Center for Industrial Ecology

- Whereas <u>productivity</u> measures are used to improve a "linear" process

- <u>Efficiency</u> measures are used to improve a "closed loop" process

- Advanced modeling and software simulation are critical to improve the efficiency of very complex closed loop processes
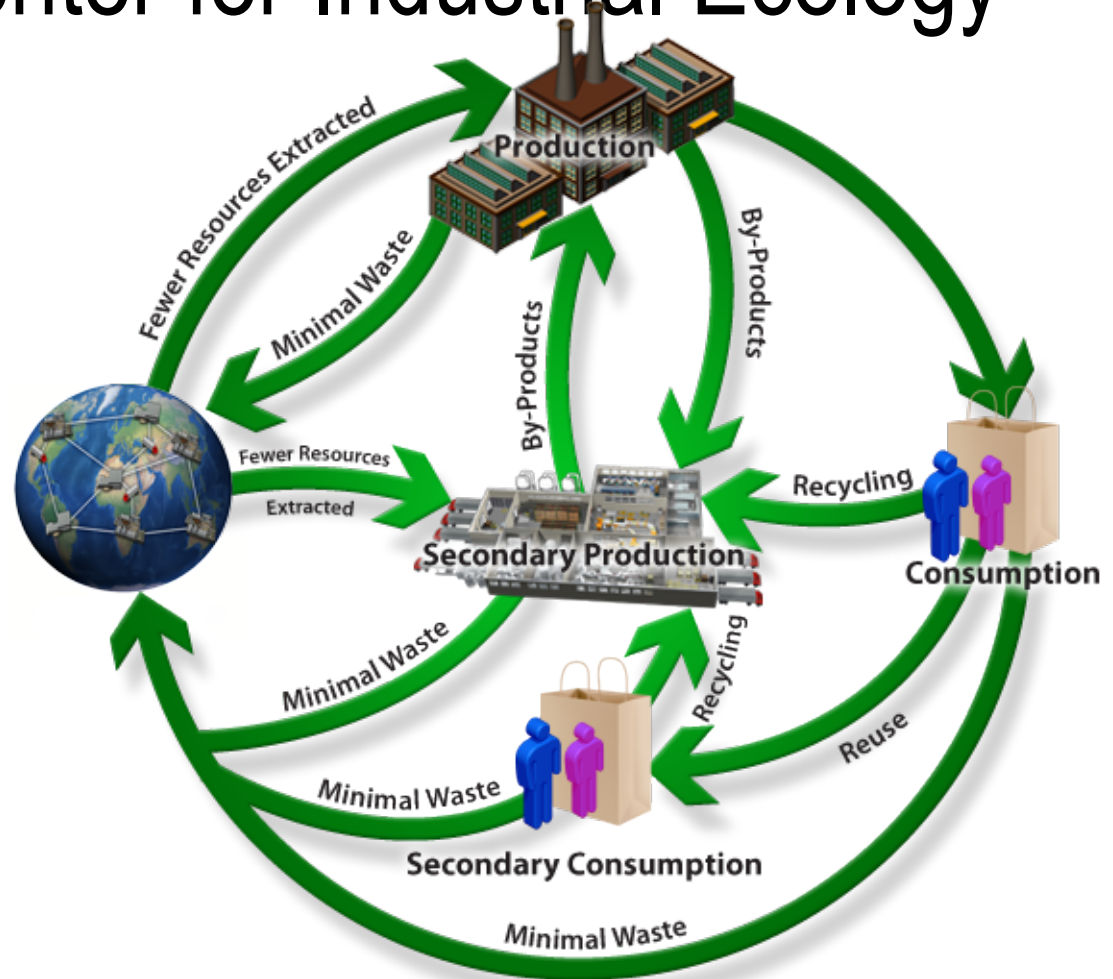
Source: Yale University's School of Forestry & Environmental Studies' Center for Industrial Ecology
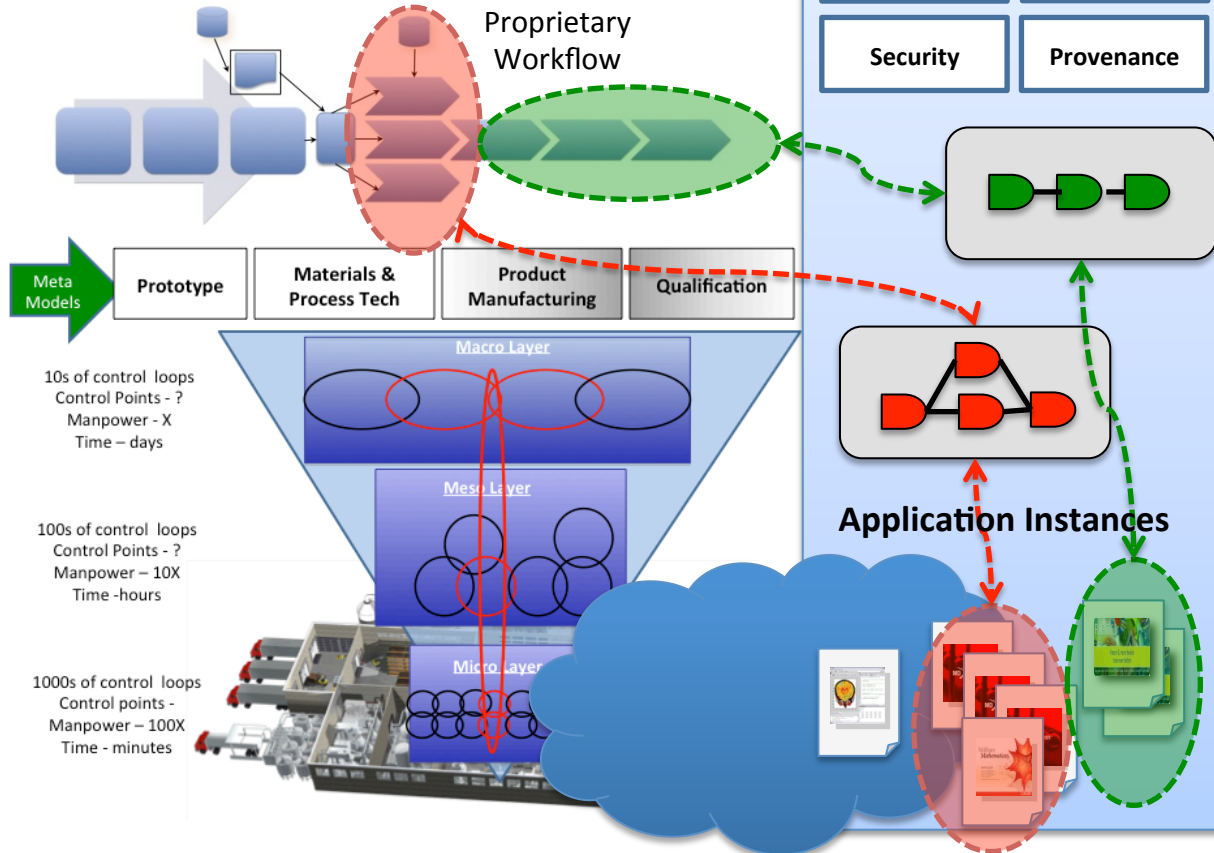
The transformation of IT-connected manufacturing to optimized plants & supply networks may be essential to efficiently manage this vision
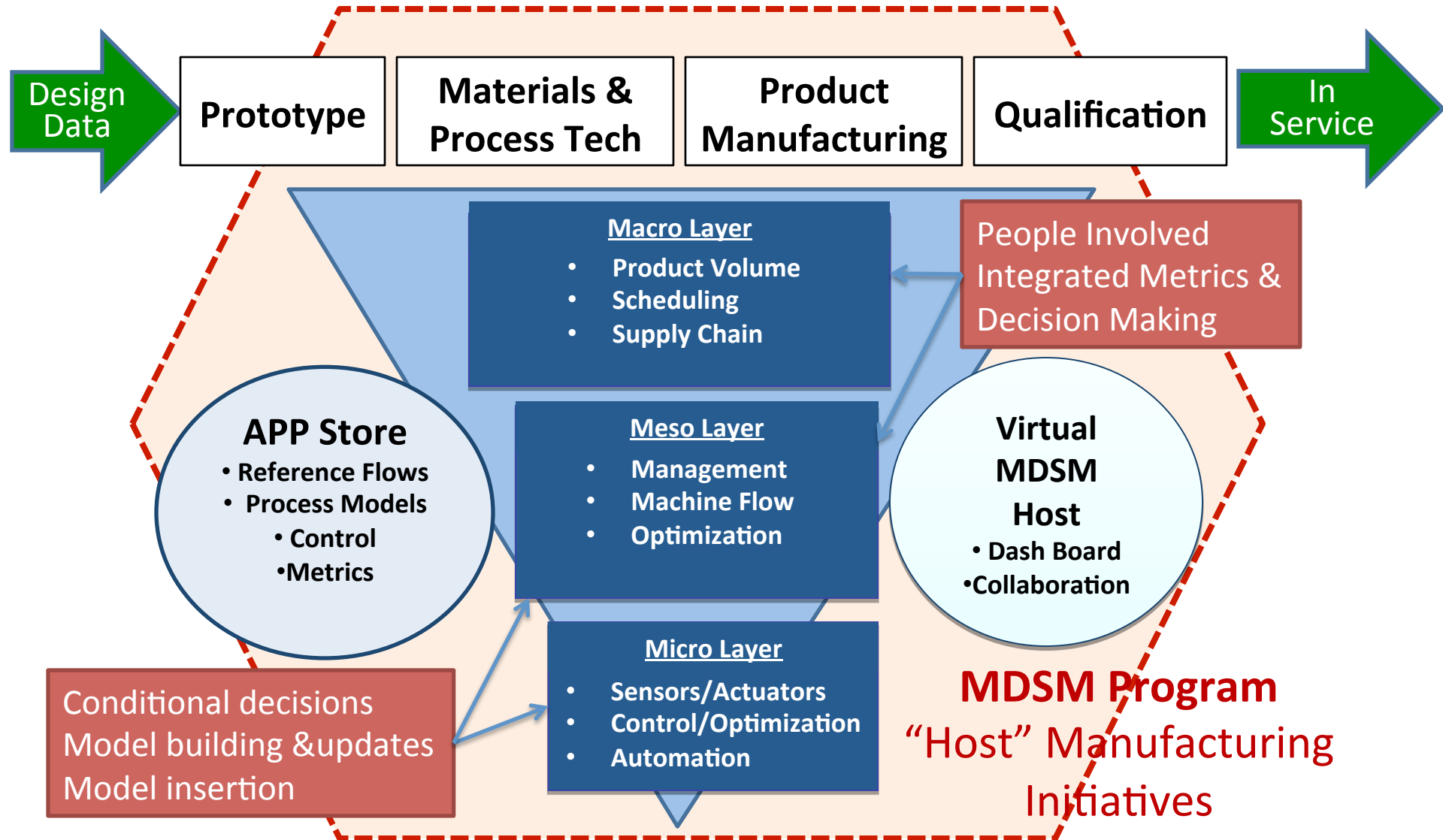
Multi-Layer Smart Manufacturing (MLSM)
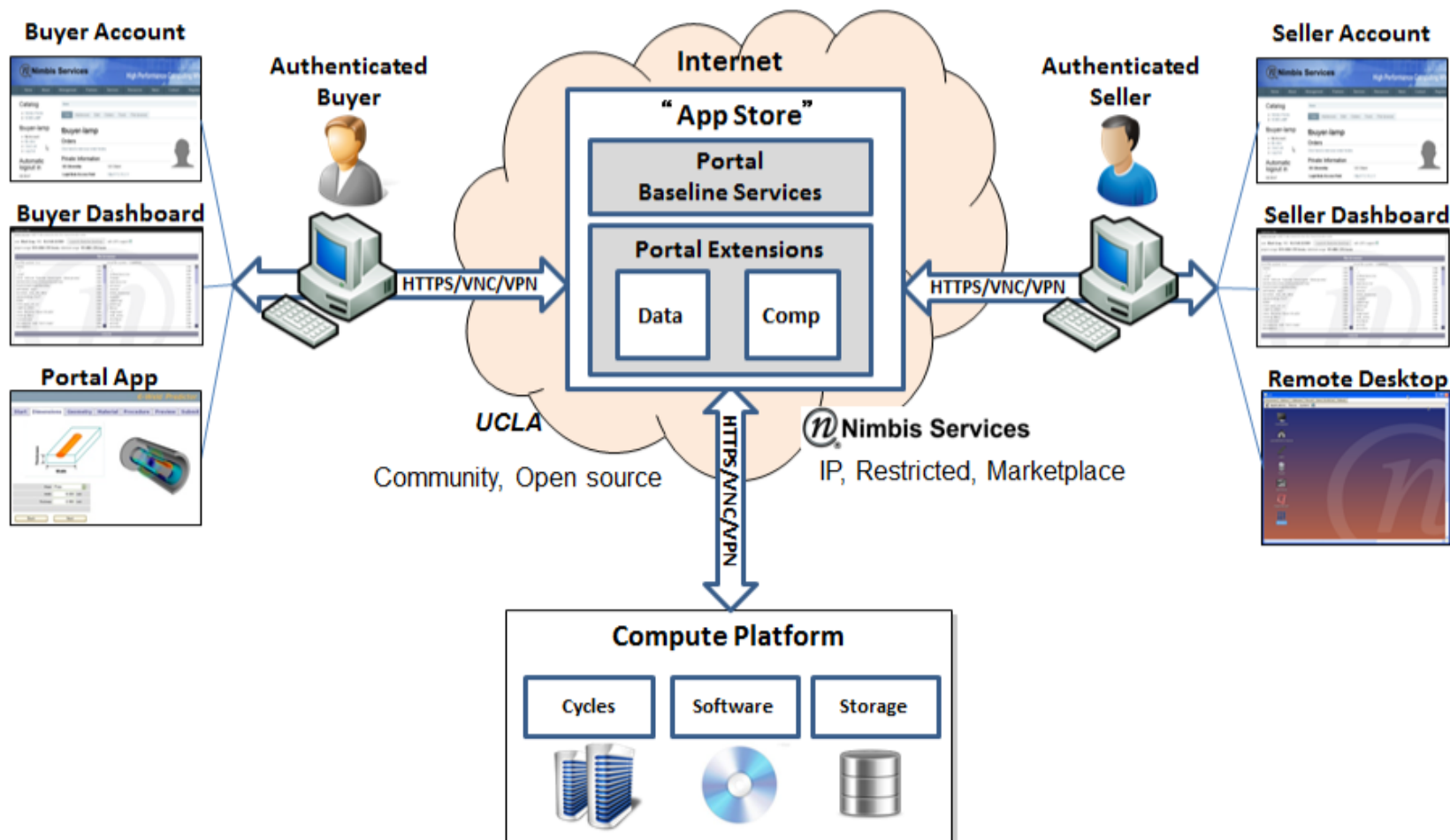## *Workflow Foundation*

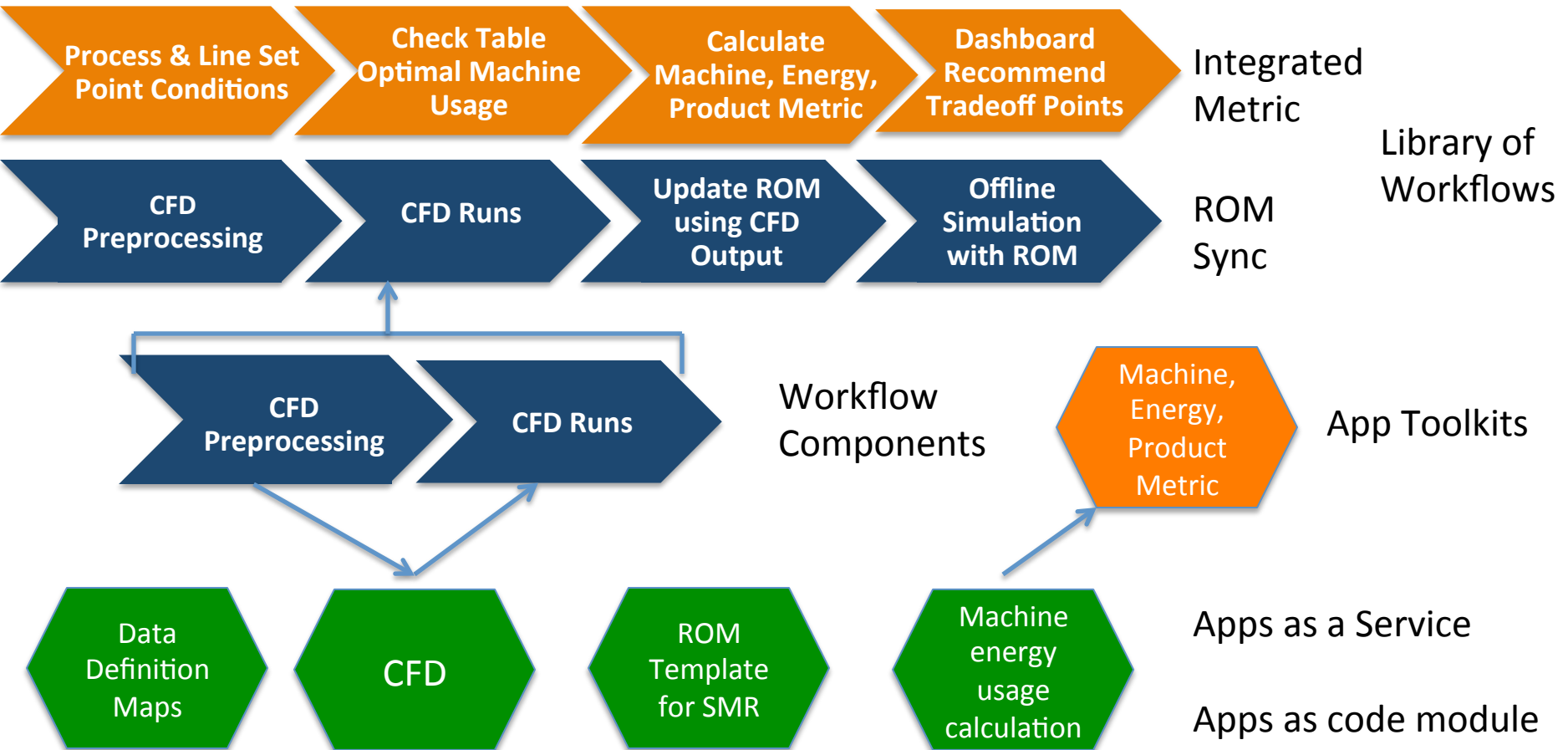# WfaaS Integrated with SaaS, PaaS, IaaS
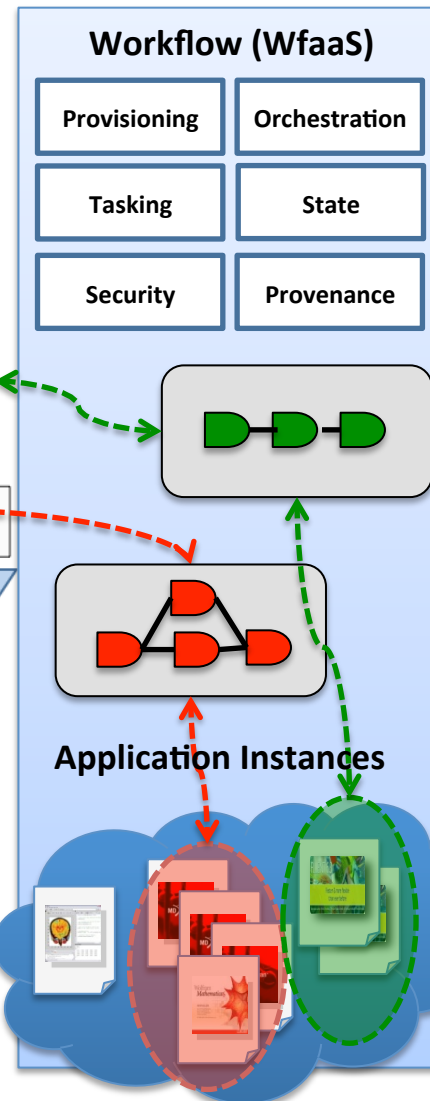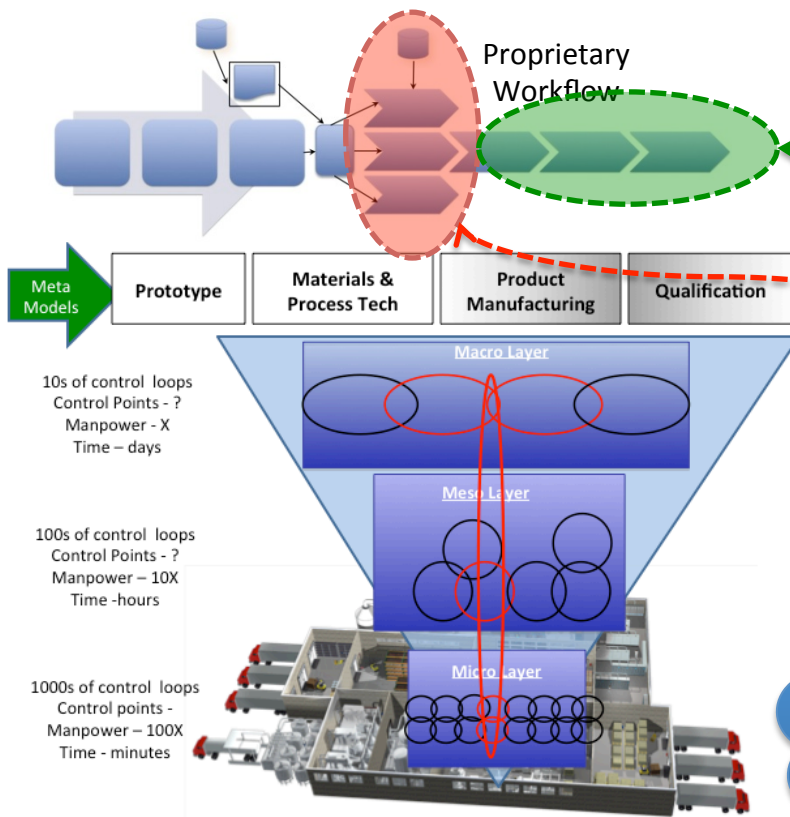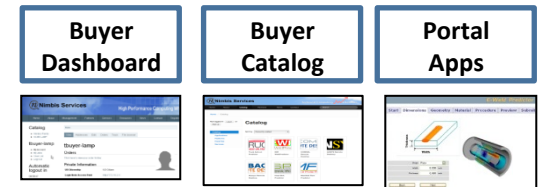
SM Platform Apps Store,
Shared Market Place & Distribution Hub
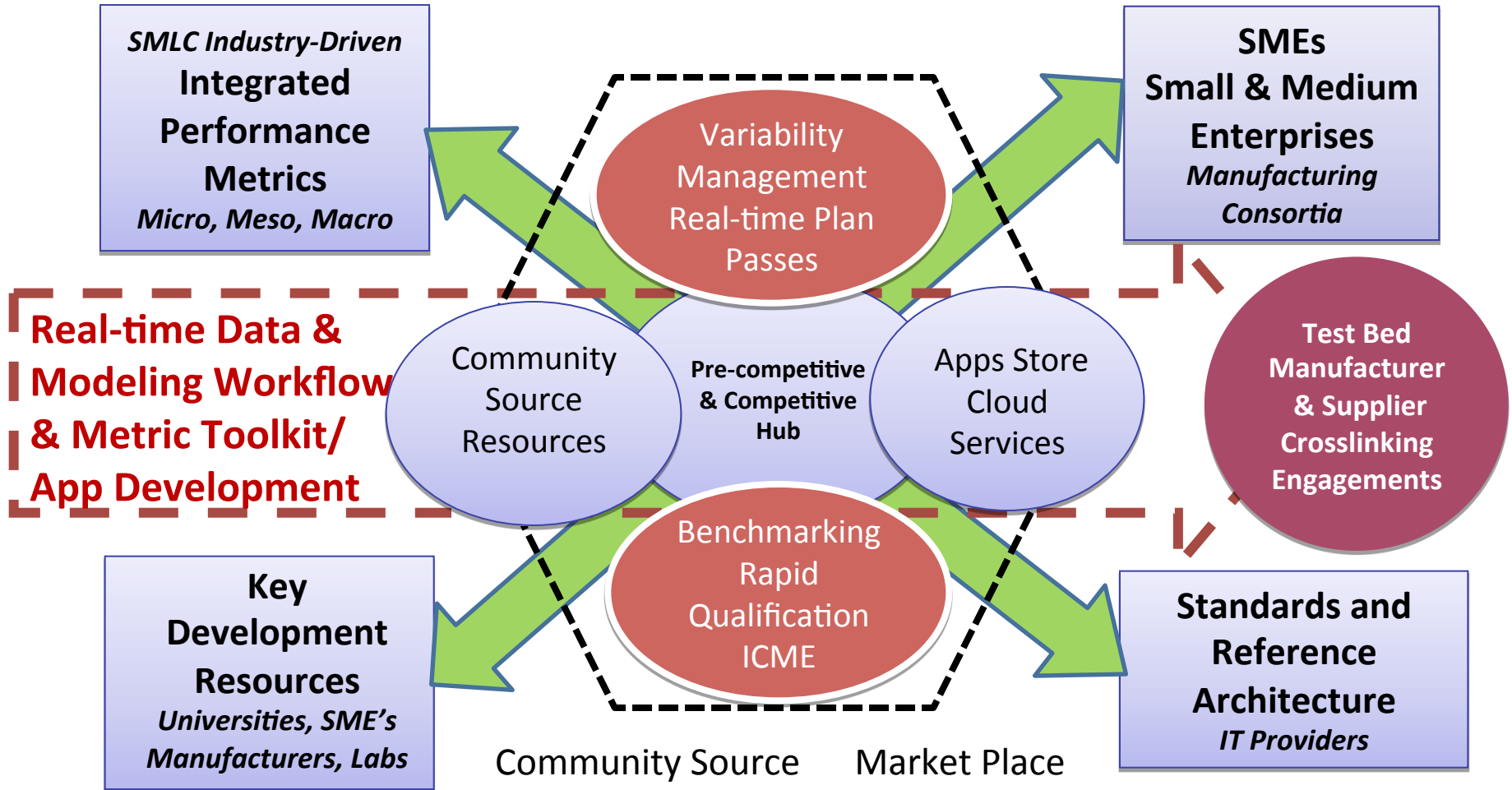# *Multiple Service Environments*

Figure 2: SM Platform Apps Store, Shared Market Place, and Distribution Hub for Manufacturers
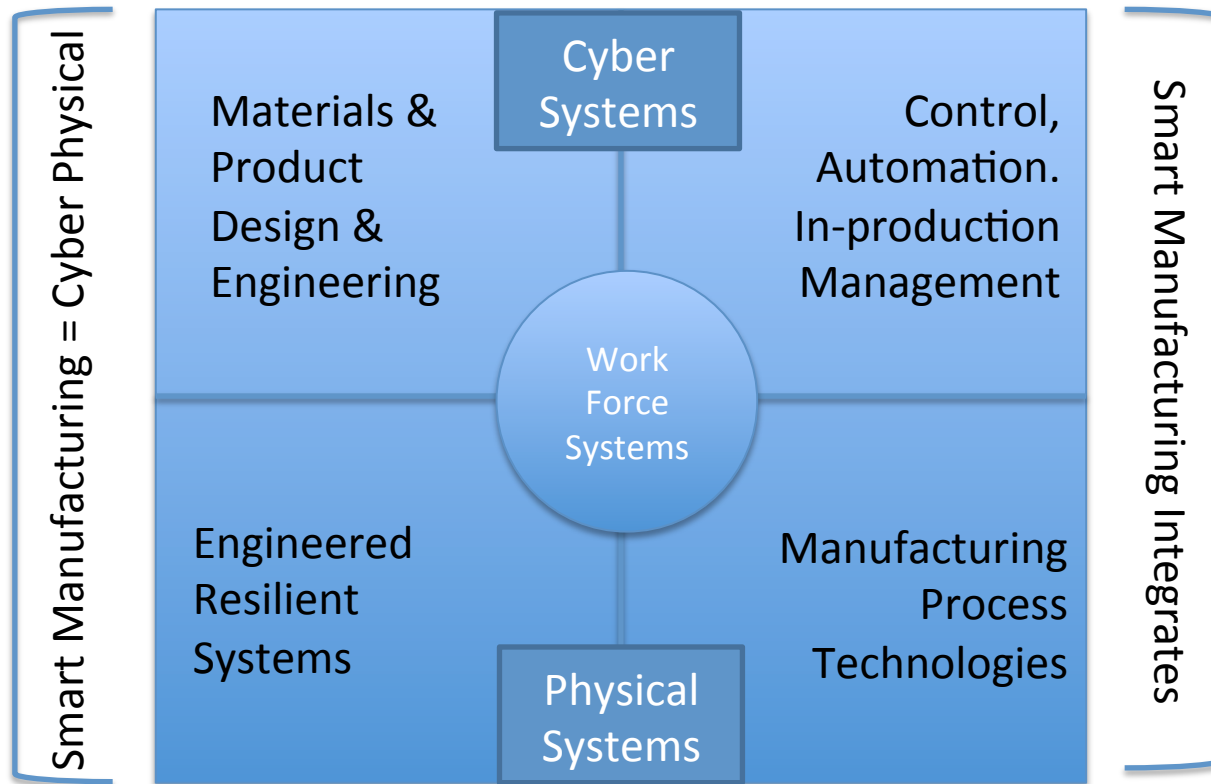
"Apps" Store

First Concept of the Smart Manufacturing Platform
Infrastructure for Real-Time Data Driven Modeling and Simulation

SMLC Industry-Driven
Integrated Performance Metrics
Micro, Meso, Macro

SMEs Small & Medium Enterprises
Manufacturing Consortia

Real-time Data & Modeling Workflow & Metric Toolkit/ App Development

Variability Management Real-time Plan Passes

Community Source Resources

Pre-competitive & Competitive Hub

Apps Store Cloud Services

Test Bed Manufacturer & Supplier Crosslinking Engagements

Benchmarking Rapid Qualification ICME

Key Development Resources
Universities, SME's Manufacturers, Labs

Community Source   Market Place

Standards and Reference Architecture
IT Providers

Real Time Virtual Manufacturing Demonstration Facility (VMDF)

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