



## MODULE 2: GLOBAL SUPPLY CHAIN NETWORKS

### SECTION A: SUPPLY CHAIN DESIGN AND OPTIMIZATION

## Section A Introduction

### Section A Key Processes:

- Define and manage the supply chain network.
  - Design the supply chain network.
    - Determine business requirements, IT strategy, and cyber security.

### Section A Topics:

- Topic 1: Supply Chain Design and Management
- Topic 2: Business and IT Requirements
- Topic 3: Technology Analysis and Optimization

# Topic 1: Supply Chain Design and Management

## Supply Chain Design: Technology Decisions

- Visibility and velocity enabler
- Theory of constraints also true for IT
- How often data is transferred and analyzed
- Support needs of the infrastructure, internet, and e-commerce
- Competitive strategy with IT and decision support systems

# Topic 1: Supply Chain Design and Management

## Network Configuration

- Number, location, and capacity of warehouses
- Location of plants and production levels per product
- Transportation (plant to warehouse, warehouse to retailer)
- Country-specific infrastructure assessment
- Inventory location and levels
  - Optimal levels of right kinds of inventory
  - Lowest inventory that meets customer service goals

# Topic 2: Business and IT Requirements

## Efficiency with Responsiveness, plus Resilience

### Efficient Supply Chain

- Least-cost manufacturing/supply chain
- Relatively stable demand
- Reasonably accurate forecasts
- Make-to-stock strategy

### Resilient Supply Chain

- Enhance fit of supply chain to product
- Agile, adaptable, and aligned to other supply chain participants
- Ability “to anticipate, create plans to avoid or mitigate, and/or to recover from disruptions...”

### Responsive Supply Chain

- Flexible in response to changing demand
- More volatile demand
- Uncertain forecasts
- Make-to-order or assemble-to-order strategy

# Topic 2: Business and IT Requirements

## Fit Supply Chain Type to Product

	Efficient Supply Chain	Responsive Supply Chain
High Volume	Make-to-stock products	Assemble-to-order products
Low Volume	Make-to-stock products	Make-to-order products

Low Demand Uncertainty High

# Topic 2: Business and IT Requirements

## Supply Chain IT Requirements and Benefits

Efficient transfer of secure information

Massive data flow over internet

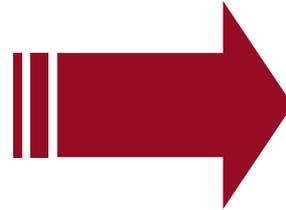
Gather, integrate, report data

Replace push with pull

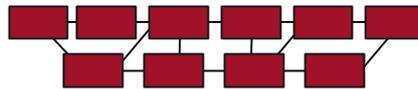
Strategic/tactical capabilities

Data entered only once

Remove “friction”



Throughout the extended supply chain



SC velocity, agility, scalability

Cost-effective global visibility

Avoid the bullwhip effect

Lean, cost-effective SCs

Share knowledge with SC

Data accuracy and straight-through processing

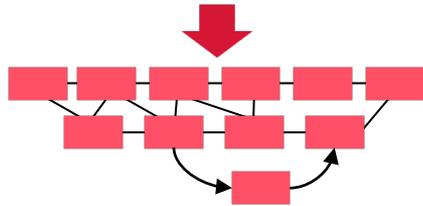
New relationships

# Topic 2: Business and IT Requirements

## Sharing Information Helps Build Trust

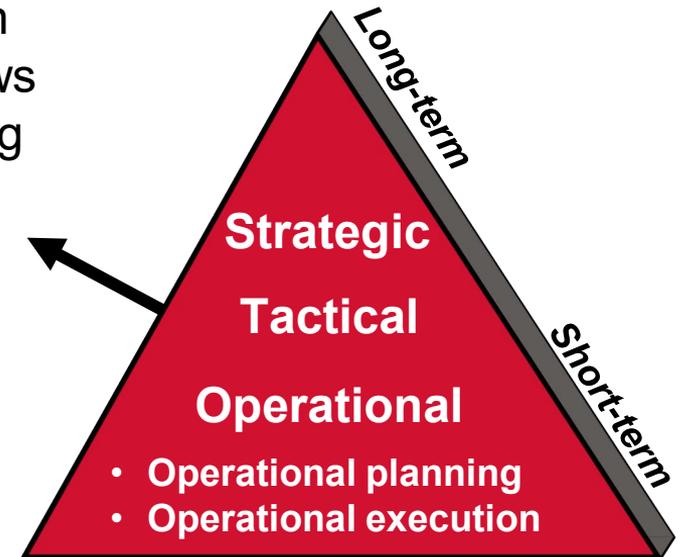


- Real-time information



- Ad hoc links in the extended supply chain increase adaptability.

Sharing information builds trust and allows coordinated planning between partners.



## Supply Chain IT Cost-Benefit Analysis

- Not a computer project; a business decision.
- Recipient, not IT, develops business case.
- Strategic IT investments should
  - Pay back in cost savings
  - Increase market share
  - Innovate product/service
  - Make company more adaptive to change
  - Match company's goals.
- Technology audits for justifications and pre- and post-implementation reviews.
  - Audience is upper management.

# Topic 3: Technology Analysis and Optimization

## Benefits and Costs

Benefits		Costs
Tangible	Intangible	
<ul style="list-style-type: none"><li>• Lower maintenance costs</li><li>• Faster implementation</li><li>• Increased sales volume</li><li>• Improved scheduling</li><li>• Greater financial returns</li><li>• Lower overhead</li><li>• Reduced cash-to-cash cycle</li></ul>	<ul style="list-style-type: none"><li>• Customer retention</li><li>• Customer service</li><li>• Order status visibility</li><li>• Workforce redeployment</li><li>• Employee satisfaction and efficiency</li></ul>	<ul style="list-style-type: none"><li>• Hardware/software</li><li>• Maintenance fees</li><li>• Capital expenditures</li><li>• Opportunity costs</li><li>• Staff/consultant time</li><li>• Configuration and customization</li></ul>

# Topic 3: Technology Analysis and Optimization

## Benefit-Cost Analysis and ROI

- Benefit-Cost Analysis =  $\frac{\text{Total Benefits}}{\text{Total Costs}}$   
 $= \frac{\text{US\$345,000}}{\text{US\$259,000}} = 1.33$

- Return on Investment =  $\frac{\text{Total Benefits} - \text{Total Costs}}{\text{Total Costs}}$   
 $= \frac{\text{US\$345,000} - \text{US\$259,000}}{\text{US\$259,000}} = 0.33 = 33\%$

# Topic 3: Technology Analysis and Optimization

## Stages of Supply Chain Network Technology Optimization

	1: Multiple Dysfunction	2: Semi-Functional Enterprise	3: Integrated Enterprise	4: Extended Enterprise	5: Orchestrated SC
Internet	Static websites	Online catalogs	Intranets across all functions	E-commerce	Responsive; cybersecurity
Integration	None; no teamwork	Batch	Internal process integration; teams	SC networks; process integration	Closed gaps; automation, visibility
SC planning	Little information exchange	Informal; no initiative coordination	Formal/global; enhanced logistics	Integrated global planning; SC vs. SC. competition	Data driven analytics; cross-functional teams
Production scheduling	Basic MRP	Closed-loop MRP	MRP—ERP	Externally integrated ERP	Automated demand data
Integration with suppliers	Fax/phone	EDI; seek low price	EDI with all large suppliers	VMI, online RFQ	Category strategies drive integration
Customer delivery	Research	Local inventory	ATP	CTP	Automated delivery quotes

# Topic 3: Technology Analysis and Optimization

## Supply Chain Network Optimization Strategy

**1.** Determine goals and desired end state of SC.

**2.** Create cross-functional/cross-business teams.

**3.** Organize SC's operational processes and IT's mission.

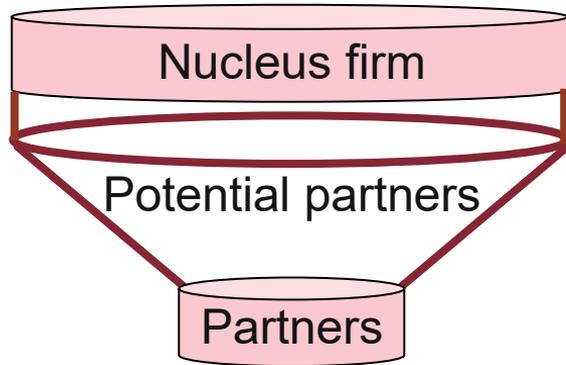
**4.** Design in change management and training with stringent timetables.

**5.** Create conceptual model.

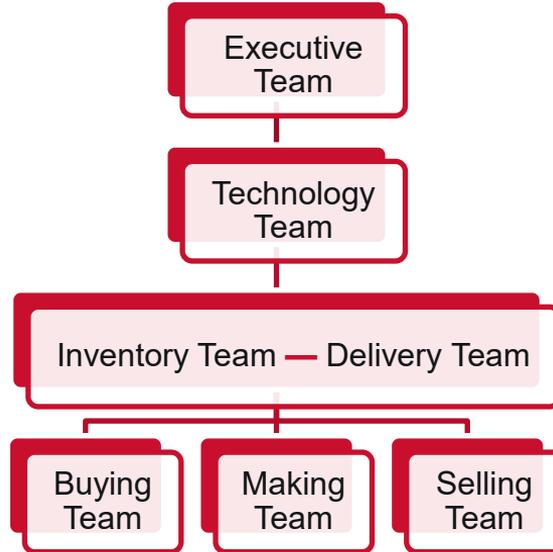
**6.** Establish technical infrastructure.

# Topic 3: Technology Analysis and Optimization

## Role of Nucleus Firm/Cross-Functional Teams



Teams



**CSCP** CERTIFIED SUPPLY CHAIN  
PROFESSIONAL

**SECTION B:  
END-TO-END CONNECTIVITY  
AND VISIBILITY**

## Section B Introduction

### Section B Key Processes:

- Design/manage end-to-end SC connectivity/visibility.
  - Supply chain technology
  - Data, status, document share
  - Legal requirements
- Master data: customer, supplier, item, engineering, and logistics
  - Create, update, cleanse, retire

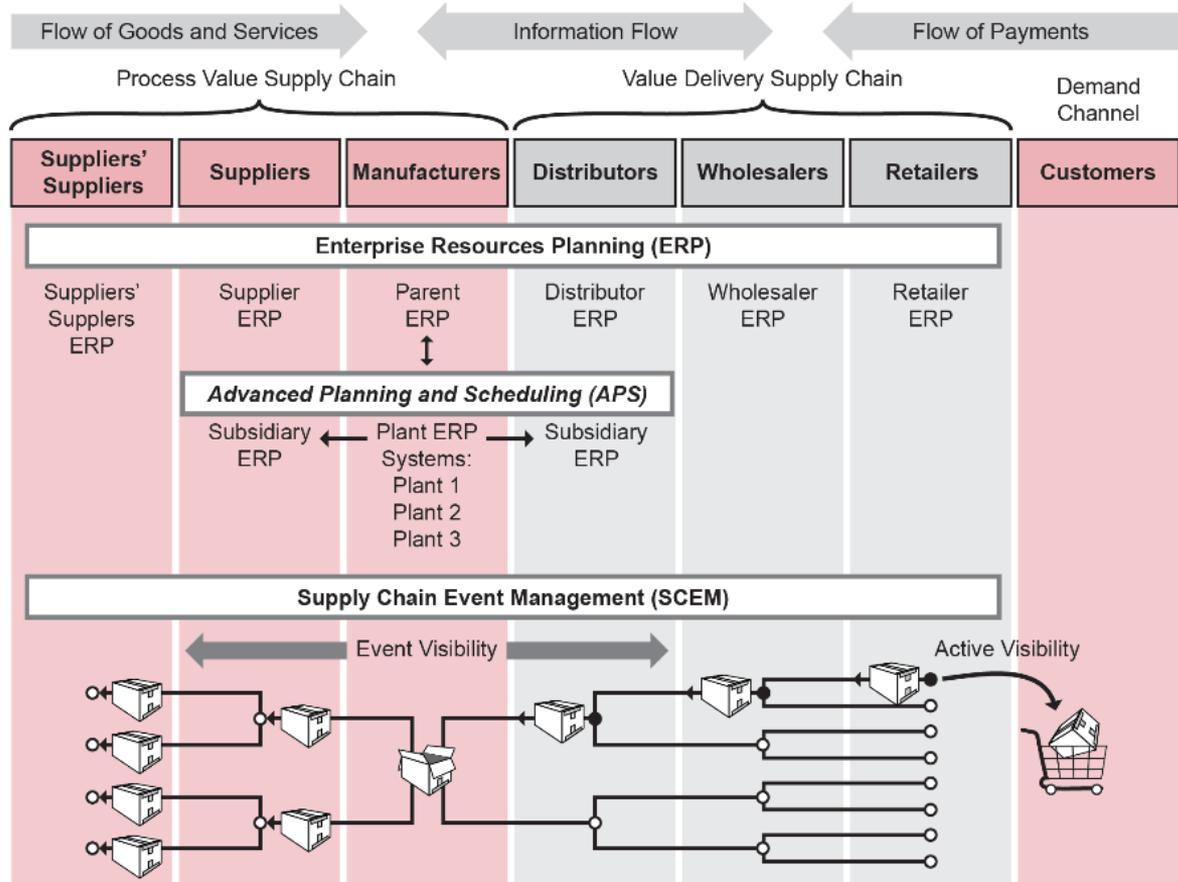
### Section B Topics:

- Topic 1: Supply Chain Technology Applications
- Topic 2: Connectivity, Visibility/Sharing, and Legal
- Topic 3: Supply Chain Master Data

# Topic 1: Supply Chain Technology Applications

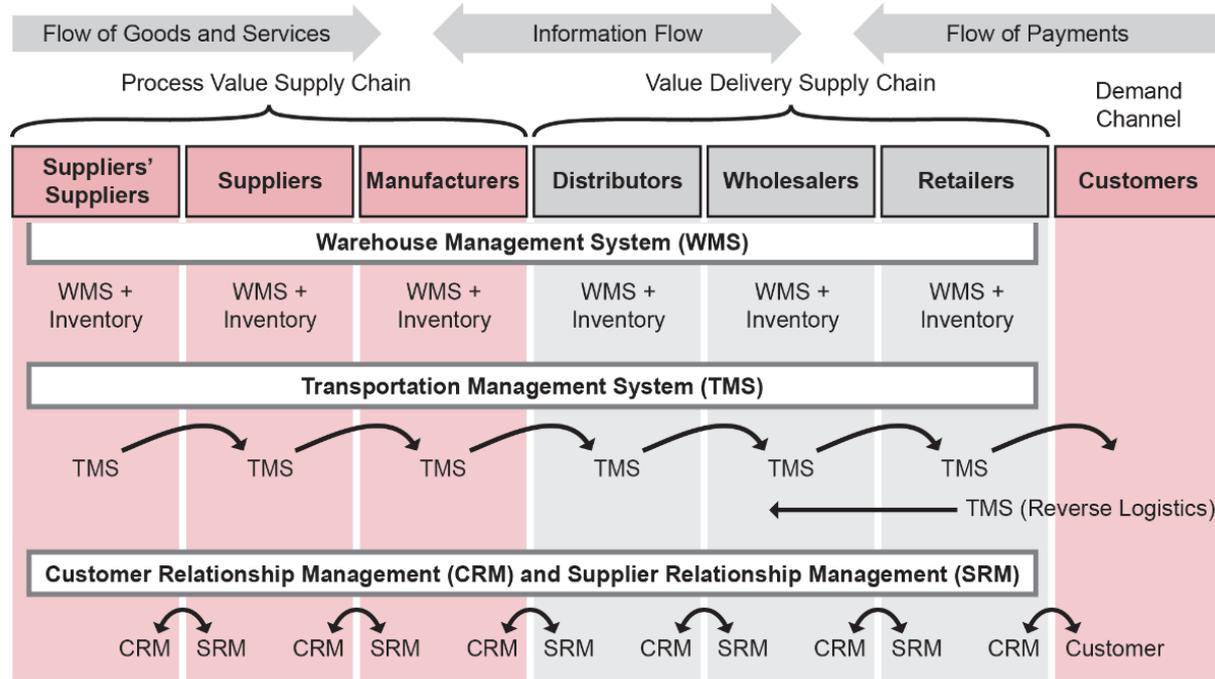
## Comprehensive SC Management System

- Process value chain
- Value delivery chain
- Demand channel



# Topic 1: Supply Chain Technology Applications

## Comprehensive SC Management System (continued)



# Topic 1: Supply Chain Technology Applications

## Enterprise Resource Planning (ERP)

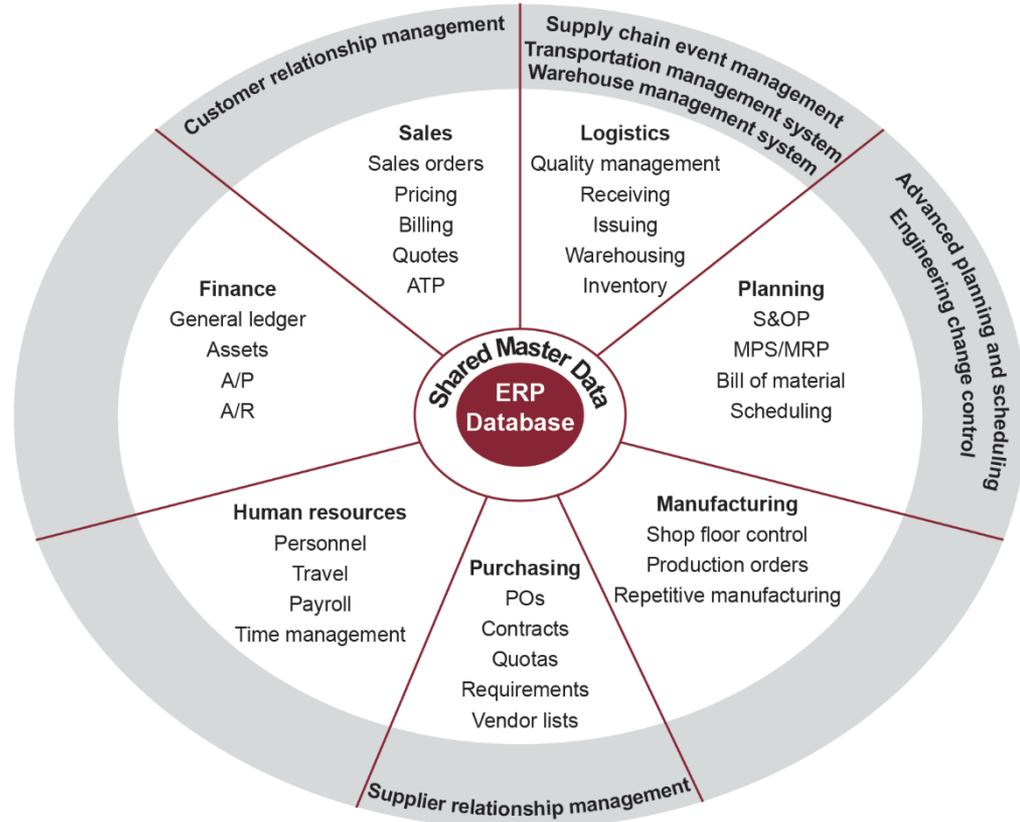
*“Framework for organizing, defining, and standardizing the business processes necessary to effectively plan and control an organization so the organization can use its internal knowledge to seek external advantage.” (Dictionary)*

- Modularized suite
- Automated interactions
- Common data source
- Challenge: linking supply chain partner ERP systems
- Need vision and direction for visibility and efficiency

# Topic 1: Supply Chain Technology Applications

## ERP System Functionality

- Central database creates shared master data.
- Modular suite



# Topic 1: Supply Chain Technology Applications

## ERP System Evolution

Older ERP systems

Implicit business models (former best practices)

Begin with the end in mind.



Get full executive support.



# Topic 1: Supply Chain Technology Applications

## ERP versus Best-of-Breed Systems

### ERP Systems

- Simpler, better integration
- Leveraged data ownership
- Shorter training
- Fewer vendors
- Support contracts
- Often lower total cost of ownership
- Vast resources and staff

### Best-of-Breed Systems

- Faster innovations
- Industry expertise
- Niche applications
- Functional area expertise (e.g., warehousing)

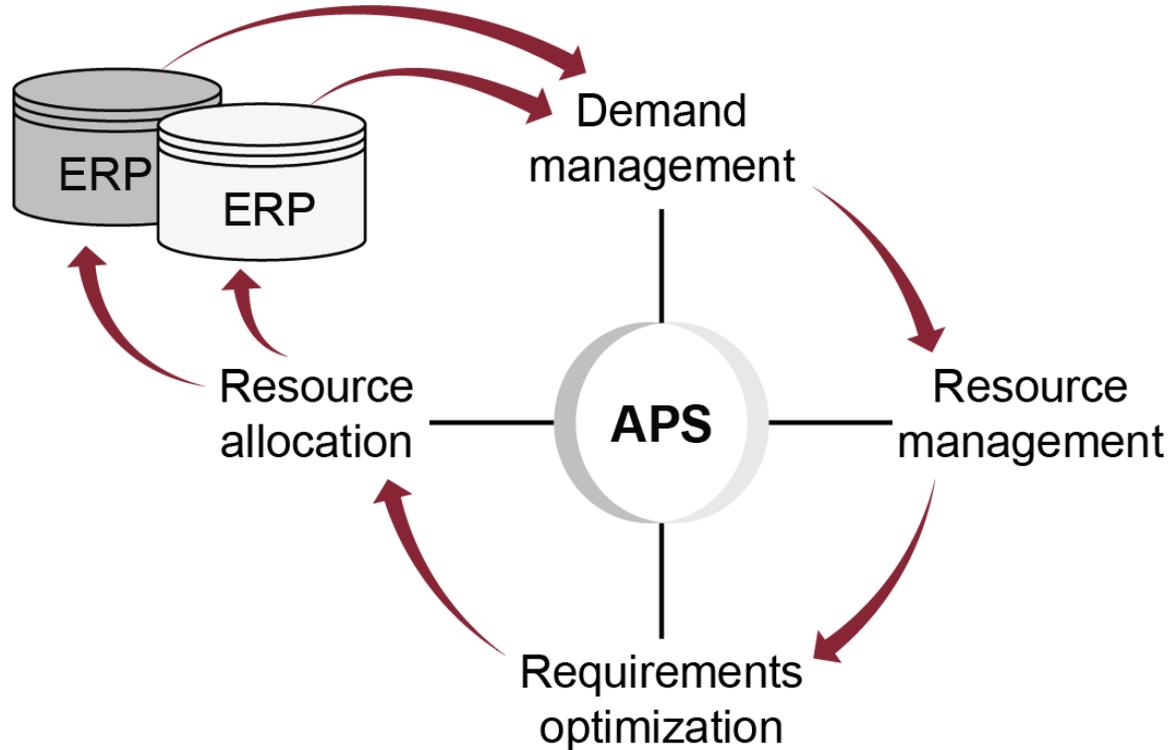
# Topic 1: Supply Chain Technology Applications

## Upgrades, New Releases, New Modules

- Useful new upgrades, ERP releases, and modules:
  - Support an organization's top strategic issues
  - Have better open architecture
  - Provide speed and lower cost of future upgrades
  - Ease supply chain communications
  - Have better business information/metadata
  - Provide faster learning curve
  - Fully integrate currently disjointed systems
  - Are less expensive than increasing cost of old version.
- New system should match  $\geq 80\%$  functionality goals.
  - Customize only remaining 20% (or less), configuration for rest.

# Topic 1: Supply Chain Technology Applications

## Advanced Planning and Scheduling (APS)



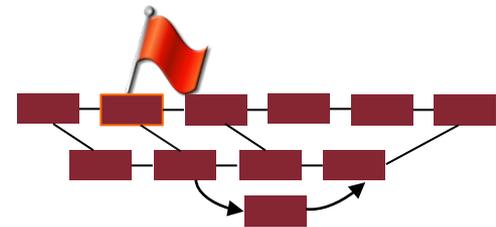
# Topic 1: Supply Chain Technology Applications

## Supply Chain Event Management (SCEM)

- Flags SC events to trigger alerts or actions in other applications
- Monitors SC business processes
- Exception reporting to business intelligence software

Active visibility:

- Monitor
- Measure
- Notify
- Simulate
- Control



# Topic 1: Supply Chain Technology Applications

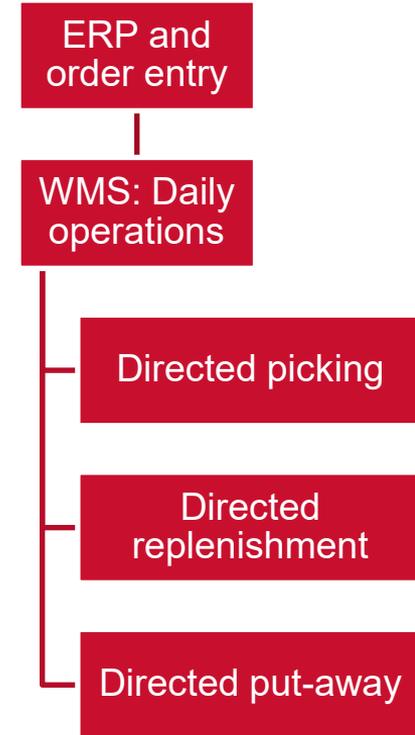
## SCEM Benefits

- Faster response to supply/demand change
- Exception notices on portable devices
- Earlier marketing/sales demand reaction, better forecast
- Improved order accuracy, tracking, and cycle time
- Less management time on shipping/receiving
- Reduced inventories and total SC costs
- Greater labor efficiency and productivity
- Decentralized collaboration
- Increased customer responsiveness, fewer returns
- Real-time communications with ad hoc partners

# Topic 1: Supply Chain Technology Applications

## WMS Functions

- Receiving
- Storage location management and optimization
- Cross-docking
- Inventory control
- Quality control
- Order selection and task management
- Automated replenishment
- Shipping
- Security
- Returns



# Topic 1: Supply Chain Technology Applications

## WMS Interfaces and Benefits

### WMS Interfaces or Portals

- Web-based interfaces/portals.
- Visibility and control:
  - Push and/or pull data and inventory.
- Enables merge-in-transit, cross-company warehousing, etc.

### Benefits of WMS

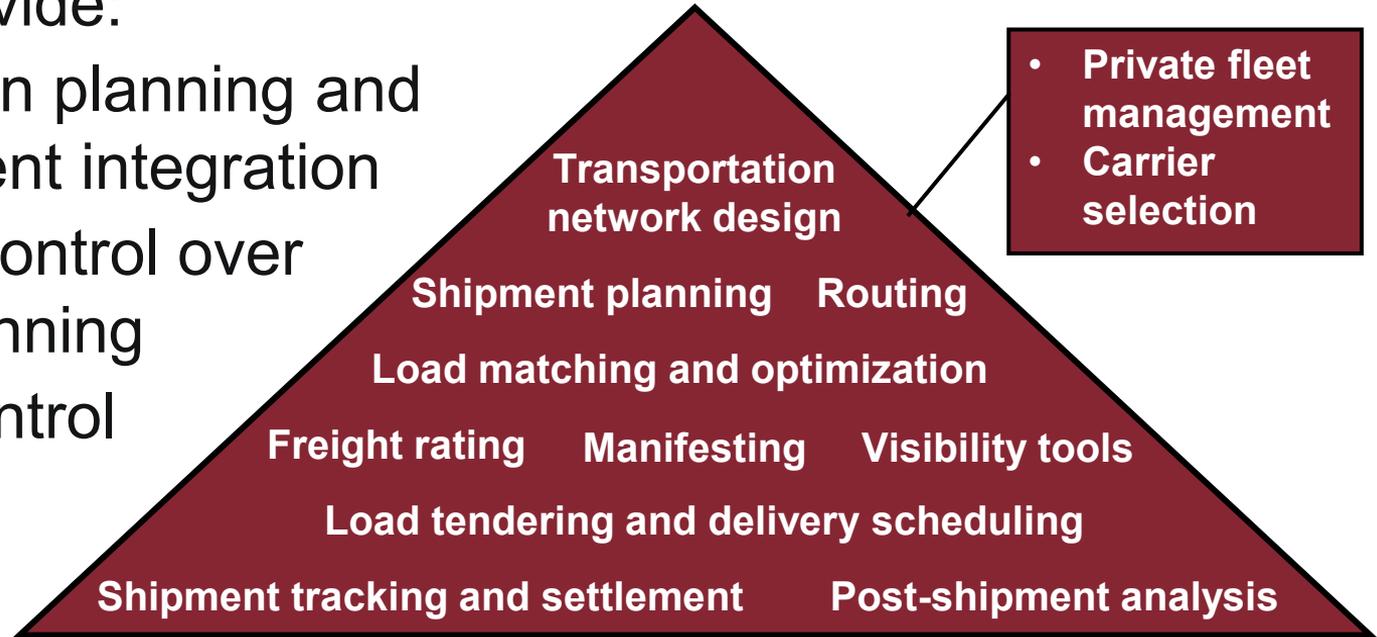
- More productivity, fewer errors
- Competitive (e.g., cross-dock)
- Retail/international handling
- Automated put-away and pick accuracy
- Capacity and distribution efficiency (e.g., pallet discounts)
- Reduced cycle/safety stocks
- Optimized space

# Topic 1: Supply Chain Technology Applications

## TMS Functions

TMS must provide:

- Transportation planning and order fulfillment integration
- Centralized control over shipment planning
- Execution control
- Visibility
- Automation.



# Topic 1: Supply Chain Technology Applications

## TMS Features

### Web-Based Dynamic Updates

- Shipment costs
- Fuel costs
- Maps and routes
- Road conditions
- Traffic
- Weather
- Carrier availability

### Shipper and Carrier Collaboration

- Load planning
- Cost optimization
- Shipment consolidation

### Global Track/Trace

- Cellular GPS
- AIDC (RFID)
- Bills of lading
- Shipping labels
- SKU information
- Waybills
- Driver performance

### Transportation Marketplaces

- E.g., Ace Hardware used its SaaS network to send an RFI to almost 500 carriers, reducing transportation costs by 4%

# Topic 1: Supply Chain Technology Applications

## Benefits of TMS

- Lower costs (less deadheading, demurrage, dwell time)
- Collaborative use of shipping
  - Linked communications
  - Aggregated volumes
  - Capacity procurement
  - Web-based visibility of information and planning
  - Distributed data access to reduce bottlenecks
- Centralized operations that lower support costs
- Real-time, accurate costs (faster, better decisions)

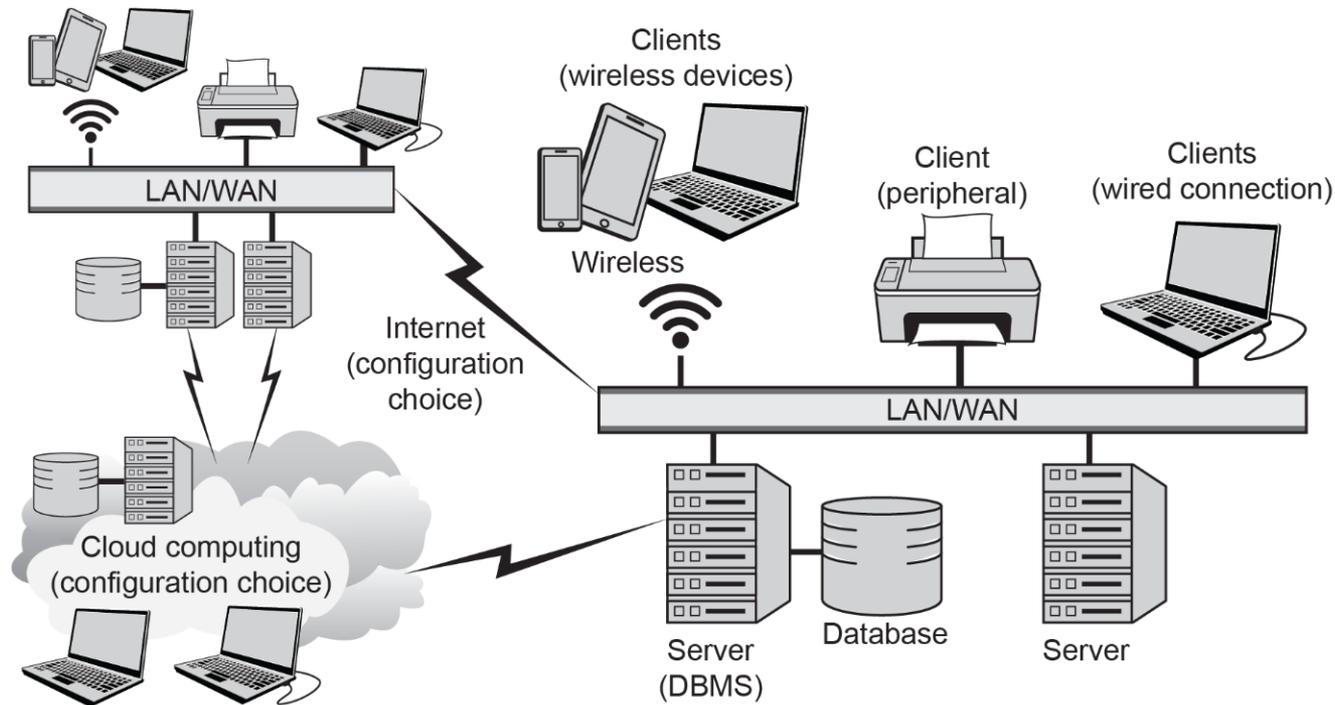
## Information System Architecture Considerations

*The architecture of the information system should be aligned with and match the architecture of the organization.*

1. Organizational functions
2. Communication of coordination requirements
3. Data modeling needs
4. Management and control structures

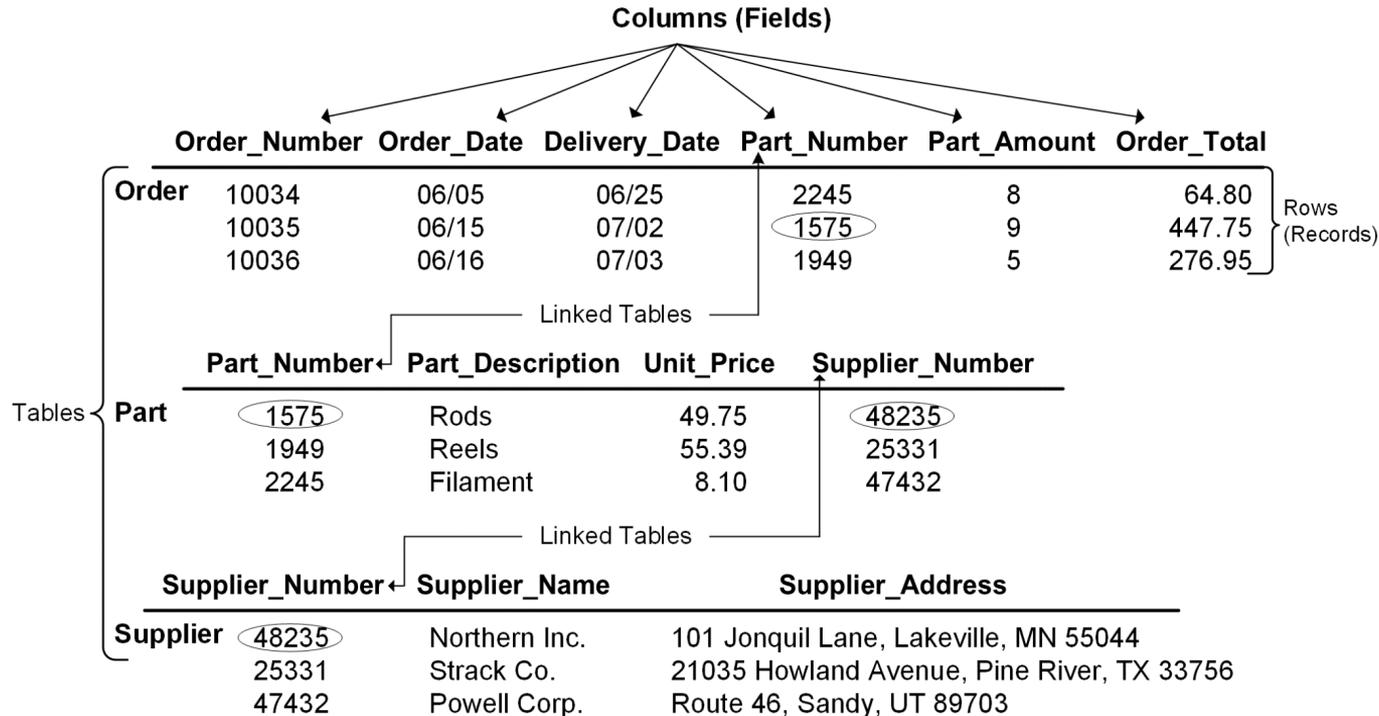
# Topic 2: Connectivity, Visibility/Sharing, and Legal

## Database, Networks, Software, Configuration



# Topic 2: Connectivity, Visibility/Sharing, and Legal

## Databases and Database Management



## Software as a Service (SaaS)

### Basic Criteria

- Vendor
- Logic and data stored in central location
- End-user access to data and software, run and used over the internet

### User Advantages

- Lower initial costs
- Immediate use
- Smaller storage requirements
- Fewer personnel

### Vendor Advantages

- Continuous income
- Single version
- Reduced software piracy and unlicensed use

## Cloud Computing

- The “cloud” is a network of data centers enabling computing resources to be accessed and shared as virtual resources.
- Secure and scalable.
- Can interface with ERP or cloud-only ERP exists.
- IaaS: Infrastructure
  - PaaS: Platform
    - SaaS: Software
- Hybrid solutions most common.
- ISO/IEC 17788:2014

## Organizational and Information System Architecture

### Organizational Strategy

- Align strategies at organizational and extended supply chain levels.
- Translate organizational strategy into commitments to treat information as strategic investment.

### Information Strategy

- Set guiding principles, priorities, and common goals for network design.
- Envision high-level end-to-end IS structure for firm/SC.
- Do gap analysis.

## Organizational and Information System Architecture

### Information Content Definition

- What data to collect and how to gather, keep accurate, store, access, control, and analyze
- Business modeling for SC

### Information Policies and Controls

- IS design, daily operations, and improvement policies
- Governance and audit
- SC communications and security

## Organizational and Information System Architecture

### Information Infrastructure Design

- Policies and controls translated into cohesive and cost-effective system
- Detailed decisions

### Databases, Networks, Software, and Configuration

- Use of existing, adding, or upgrading
- Vendor search and selection
- Critical DBMS decisions

## Organizational and Information System Architecture

### Information Infrastructure Change

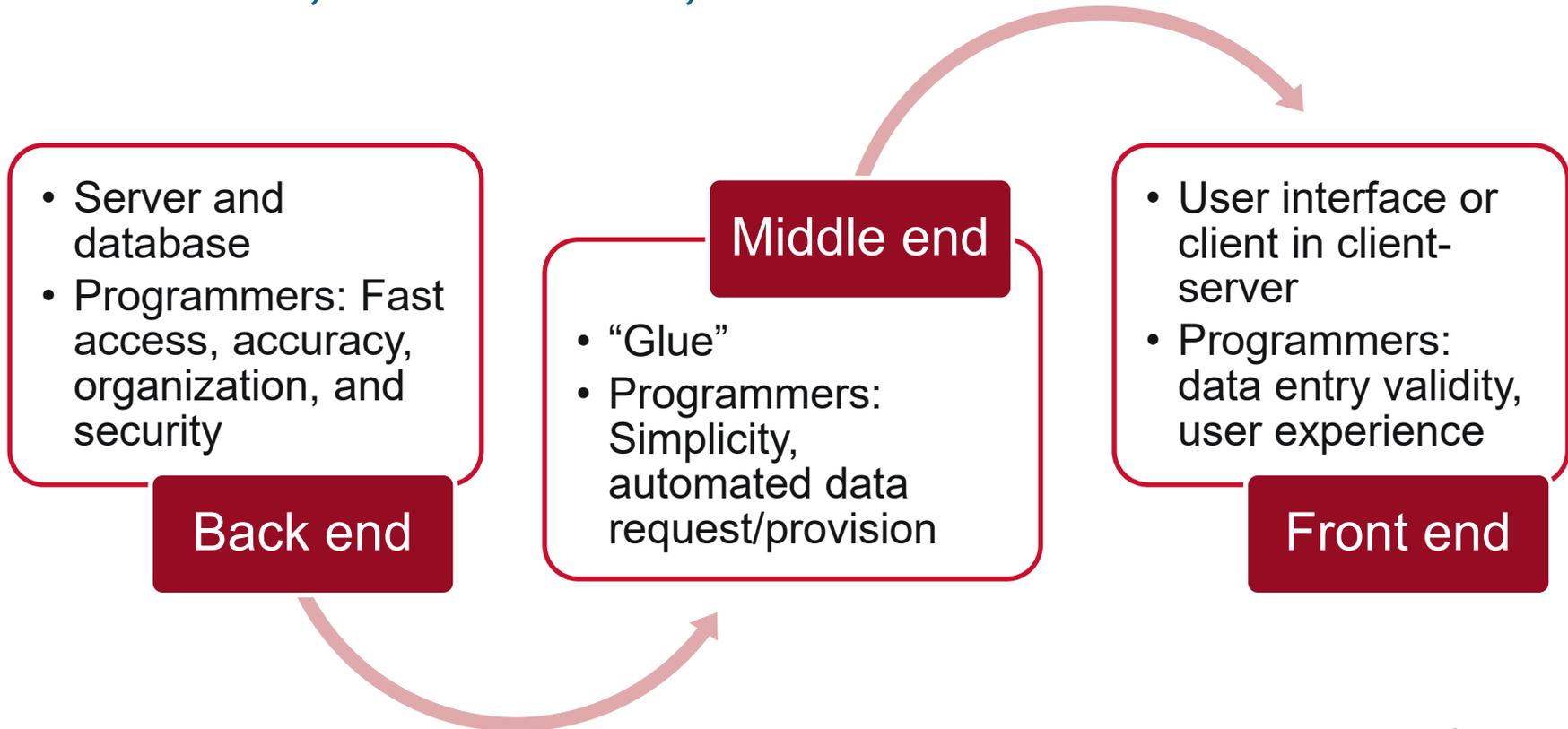
- Continual system change and improvement

### Action Plan, Schedule, and Prioritization

- Regular strategy, tactical update, and operational gap analyses → IT action plans

# Topic 2: Connectivity, Visibility/Sharing, and Legal

## Front End, Middle End, and Back End



# Topic 2: Connectivity, Visibility/Sharing, and Legal

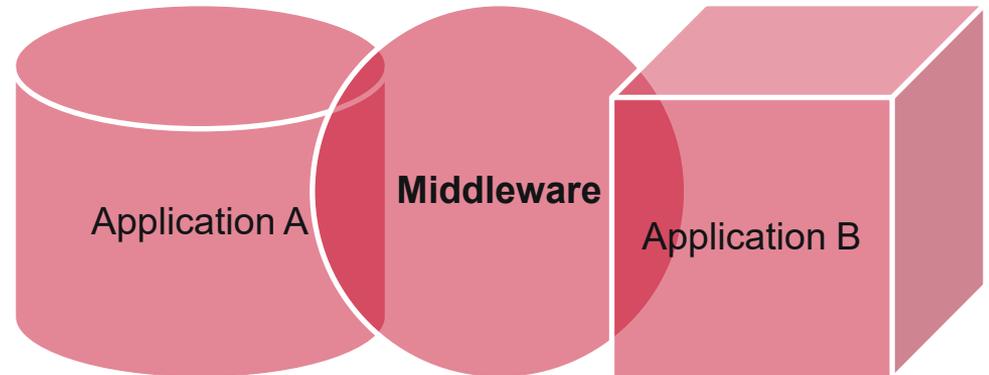
## Middleware

- Sits in the “middle” between two applications (internal or external)
- Why care about middleware?
  - Helps integrate SC
  - Enables partners to share information
  - Avoids duplicate or inconsistent data
  - Breaks down organizational silos
  - Secure transactions
    - Authentication
    - Authorization

Content-level middleware:  
EDT and EDI

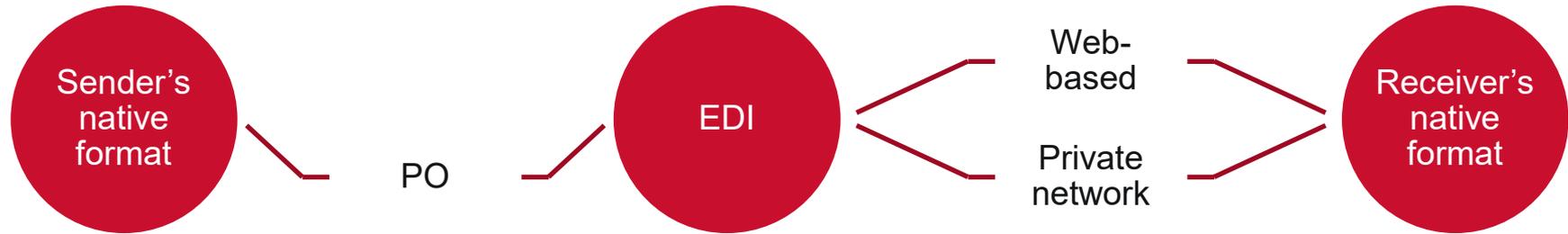
Data-oriented:  
custom linkages

Process-oriented (business  
process management [BPM])



# Topic 2: Connectivity, Visibility/Sharing, and Legal

## Content-Level Middleware: EDT and EDI



- Electronic data transfer (EDT) is synonym; electronic data interchange (EDI) is standardized version.
- Electronic version of document, e.g., purchase order, ASN, or invoice.
- Batch-processed.
- Parties must agree on EDI data format.

## Application Programming Interfaces (APIs)

- Middle end code residing nearer to front end than middleware
- Simple one-to-one interactions (not multiple systems at once)
- Other devices can query the database automatically and frequently.
- Lightweight, developer friendly, platform independent, scalable code.
- Software architecture: Web services
  - Interchangeable “building blocks.”
  - Open standards.
  - For example, airline flight check-in:
    - Get best available database search engine and best seat assignment applications from different vendors.
    - Develop own pricing application but all works together.

## Application Programming Interface Types

### Service-Oriented Architecture (SOA)



**Modular design  
(a service)**



**Loose coupling of applications  
(easy re-configure)**



**Universal functionality  
(all data for processing)**



### Microservices

Cloud native

Loose coupling within an application

Publish/subscribe messaging

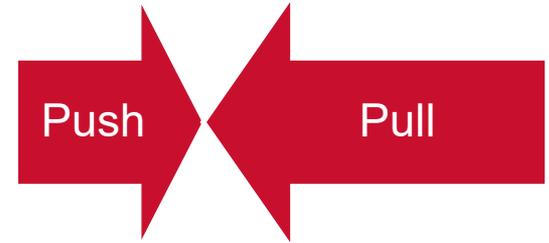
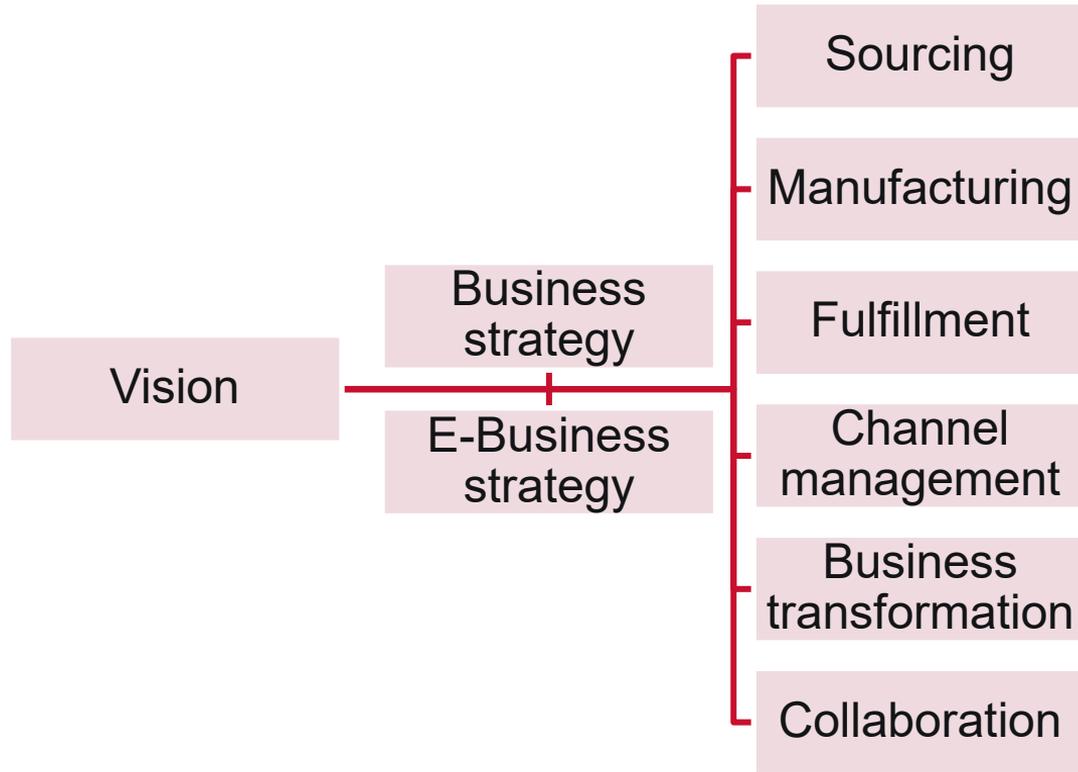
# Topic 2: Connectivity, Visibility/Sharing, and Legal

## Traditional vs. Electronic Business Supply Chain

Characteristic	Traditional Supply Chain	Electronic Business Supply Chain
Ownership	Own vertical SC through mergers	Own core capabilities in virtual SC
Competitive advantage	High market share/assets dominate	Agile firms with few assets dominate
Nucleus firm	Retailer/manufacturing (industrial)	Brand equity or greatest efficiency
Trading	Best deal at expense of other	Share risks and rewards
Competitors	No competitor interaction	Interact if mutual gain can be found
Production	Economies of scale and scope	Engineering competitive SC
Collaboration	Internal silos/costly networking	Partner silos/open networking
Suppliers	Limited by buyer relations (phone)	Marketplaces and partner integration
Customer service	Reactive, with little feedback used	Proactive with better use of feedback
Intermediaries	Fixed, vertically integrated	Avoid some unless they add value

# Topic 2: Connectivity, Visibility/Sharing, and Legal

## E-Business Considerations



## Potential Costs and Challenges with e-Business

Regular reinvestment

Increased materials handling and outbound transportation costs

Hardware/software

Reliance on outside suppliers

Implementation and change management

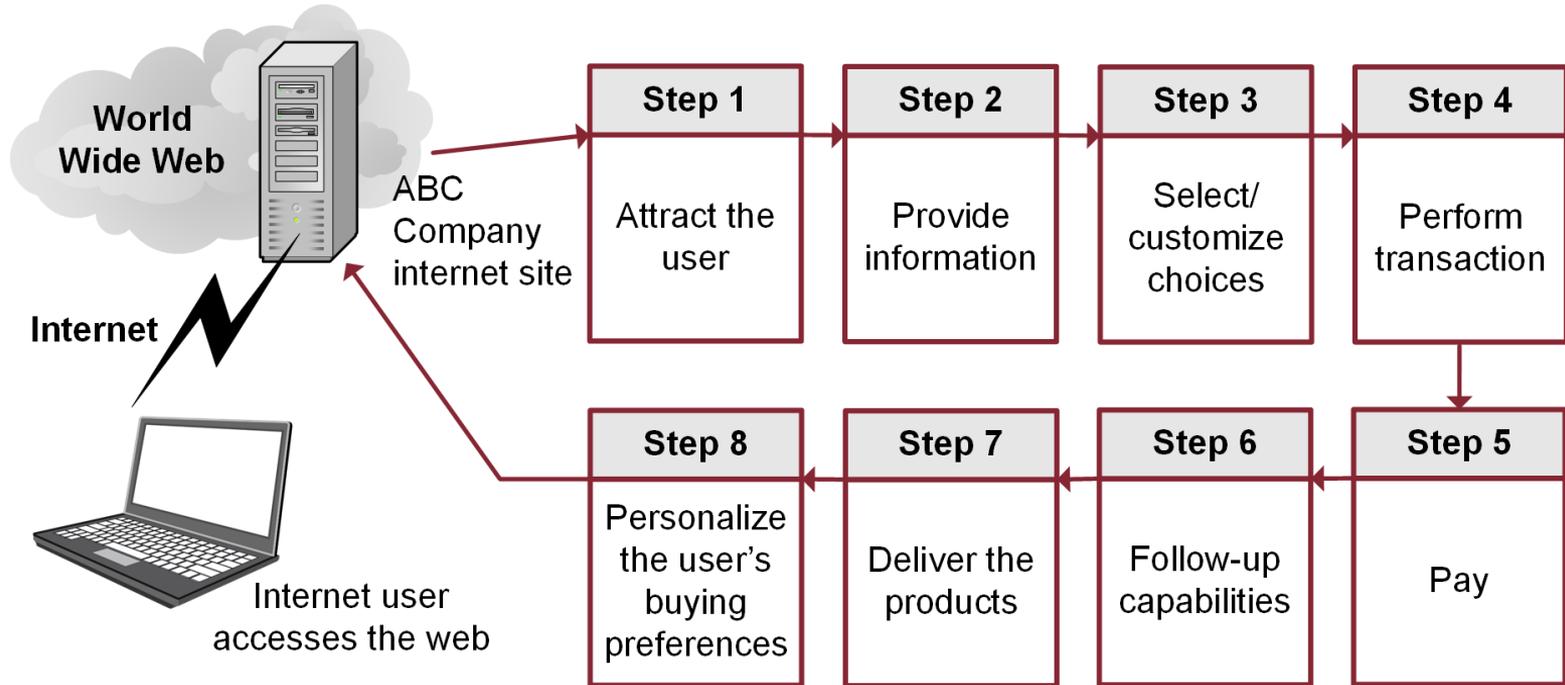
Global localization

System security

Accessibility, ease of use

# Topic 2: Connectivity, Visibility/Sharing, and Legal

## Sell-Side E-Commerce Website



# Topic 2: Connectivity, Visibility/Sharing, and Legal

## Sharing Data Among Trading Partners

	Distributor Integration	Quick Response Program	Continuous Replenishment	Vendor-Managed Inventory
Customer Role	<ul style="list-style-type: none"><li>N/A</li></ul>	<ul style="list-style-type: none"><li>Provide POS data to supplier.</li><li>Submit individual orders.</li></ul>	<ul style="list-style-type: none"><li>Notify suppliers of actual daily sales or warehouse shipments.</li></ul>	<ul style="list-style-type: none"><li>Sell.</li><li>Do joint forecast.</li><li>Manage relationship.</li><li>Help logistics.</li></ul>
Supplier Role	<p>Integrate IS to share:</p> <ul style="list-style-type: none"><li>Inventory data</li><li>Expertise</li><li>Inventory-related DI</li><li>Service-related DI.</li></ul>	<ul style="list-style-type: none"><li>Synchronize supply with demand.</li><li>Forecast.</li></ul>	<ul style="list-style-type: none"><li>Replenish without receiving orders.</li><li>Prevent stockouts.</li><li>Reduce inventory.</li><li>Improve turnover.</li></ul>	<ul style="list-style-type: none"><li>Display, store, deliver, receive, stock, and count.</li><li>Schedule replenishment.</li><li>Keep inventory records.</li><li>Represent supplier at plant.</li></ul>

# Topic 2: Connectivity, Visibility/Sharing, and Legal

## VMI and Consignment Combinations

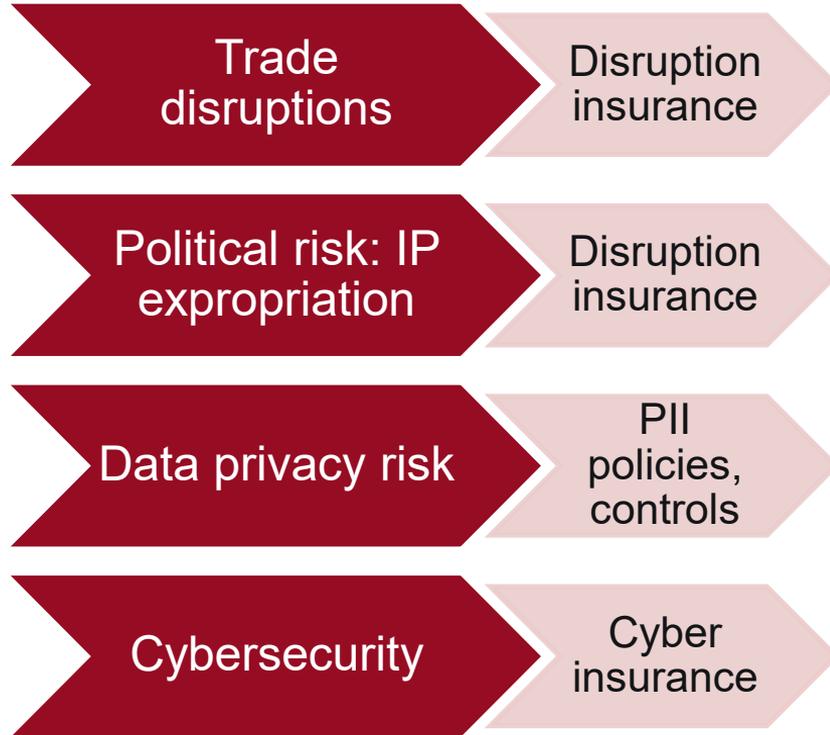
<b>Consignment?</b>	No.	Supplier decides on replenishment. Replenishment goods are immediately invoiced. Buyer owns inventory.	Traditional: Organization owns and manages inventory or sells it to independent distributors who order and manage their own inventory.
	Yes.	Supplier decides on replenishment, but only sold inventory is invoiced. Supplier employs restockers, e.g., Frito Lay pays restockers per bag of chips sold to promote proactive restocking.	Seller wants/needs items on site but may not be fast-selling, e.g., hospital controls stock of pacemakers owned by supplier. When one is used, one is sent to replenish inventory and invoice is sent for the used one.
		Yes.	No.
			<b>VMI?</b>

# Topic 2: Connectivity, Visibility/Sharing, and Legal

## Collaborative Planning, Forecasting, and Replenishment (CPFR®)

Manufacturer Tasks	Collaboration Tasks	Retailer Tasks
<b>Strategy &amp; Planning</b>		
Account planning Market planning	Collaboration arrangement Joint business plan	Vendor management Category management
<b>Demand &amp; Supply Management</b>		
Market data analysis Demand planning	Sales forecasting Order planning/forecasting	POS forecasting Replenishment planning
<b>Execution</b>		
Production & supply planning Logistics/distribution	Order generation Order fulfillment	Buying/re-buying Logistics/distribution
<b>Analysis</b>		
Execution monitoring Customer scorecard	Exception management Performance assessment	Store execution Supplier scorecard

## Legal and Privacy Requirements



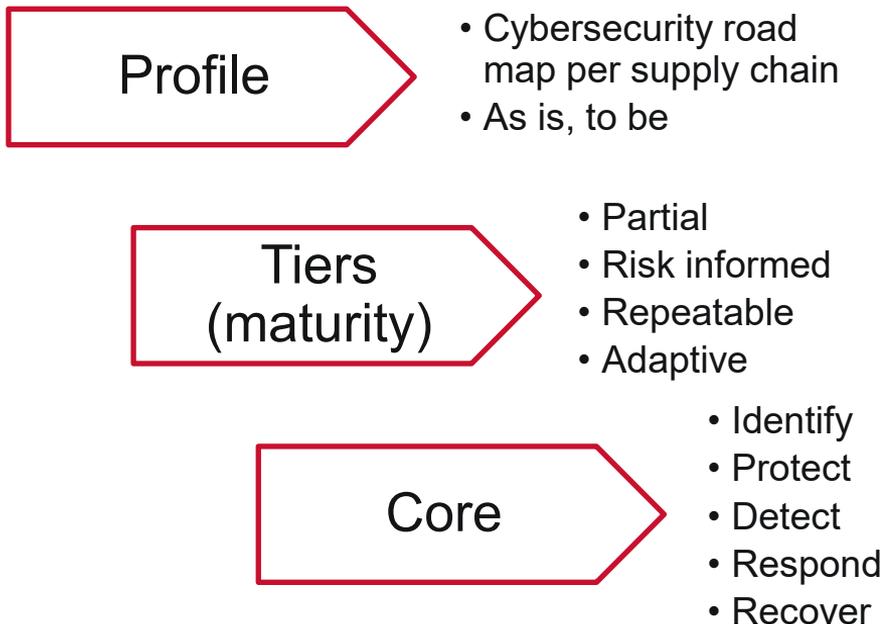
**EU's GDPR Rights**

- Informed how used
- Access personal data
- Correct errors
- Be forgotten
- Get copy
- Opt out

# Topic 2: Connectivity, Visibility/Sharing, and Legal

## Cybersecurity Risks

### NIST Cybersecurity Framework



### MITRE ATT&CK Framework

- Reconnaissance
- Resource development
- Initial access
- Execution
- Persistence
- Privilege escalation
- Defense evasion
- Credential access
- Discovery
- Lateral movement
- Collection
- Command and control
- Exfiltration
- Impact

# Topic 3: Supply Chain Master Data

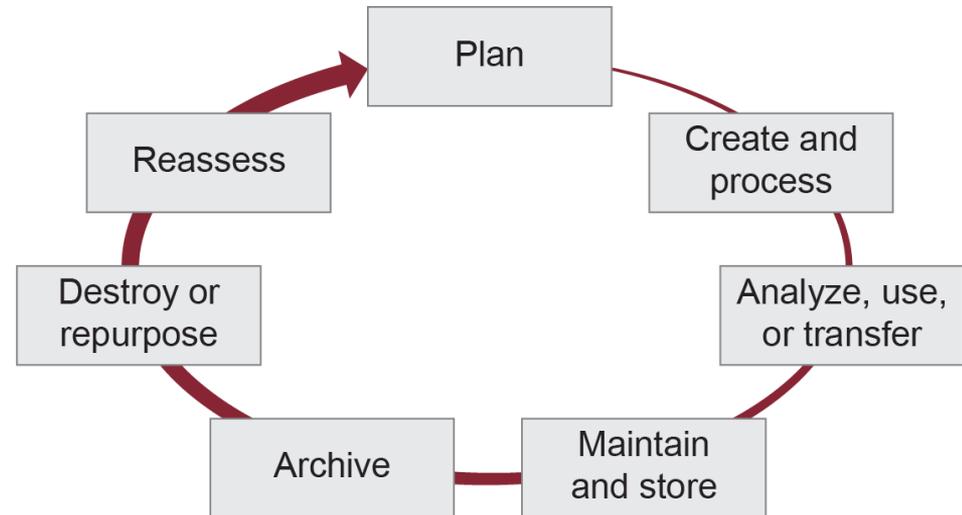
## Master Data Management and Life Cycle

### Master Data Management

Governance, methodologies, policies, procedures, and technologies

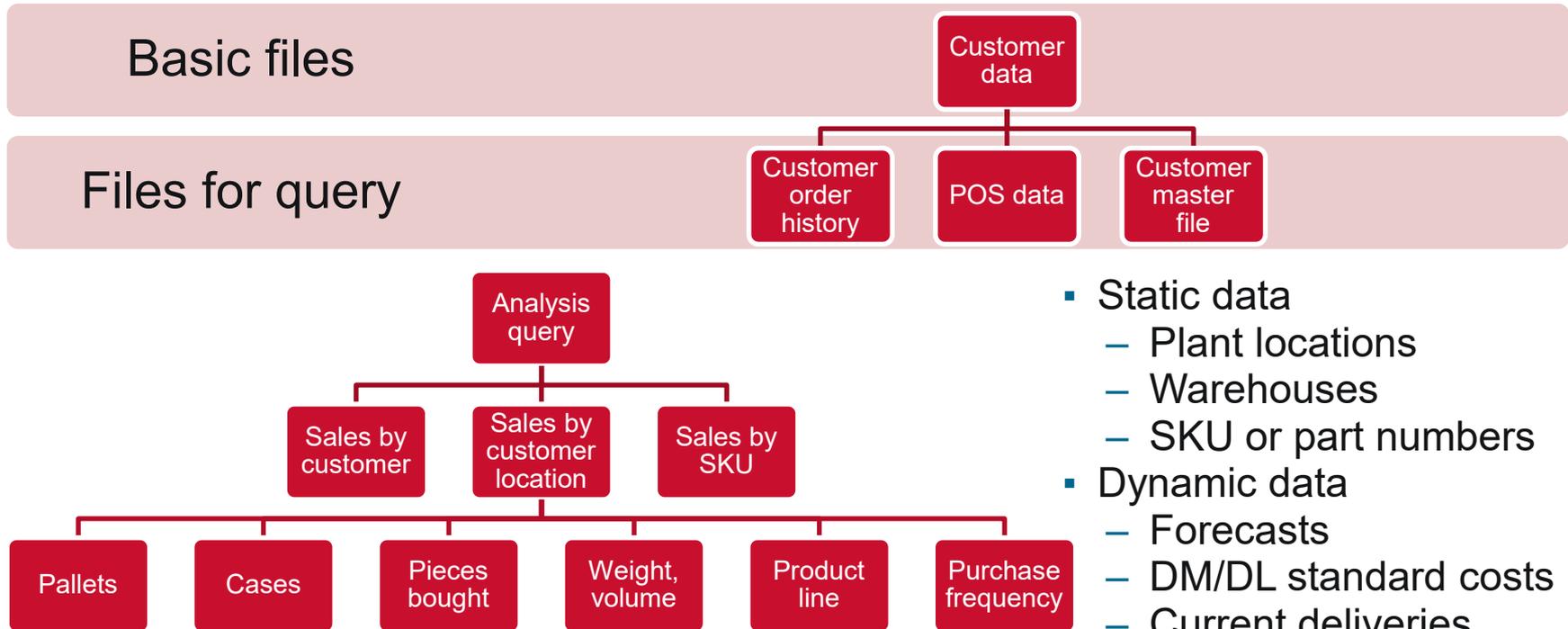
- Coordinates life cycle
- Stewardship
- Accuracy
- Consistency
- Completeness
- Timeliness

### Master Data Life Cycle



# Topic 3: Supply Chain Master Data

## Types of Master Data Used



- Static data
  - Plant locations
  - Warehouses
  - SKU or part numbers
- Dynamic data
  - Forecasts
  - DM/DL standard costs
  - Current deliveries

# Topic 3: Supply Chain Master Data

## Creating Data: Data Capture

- Incremental data volume improvement.
- Partial data better than no data.
- Capture data at the source.
- Passive better than manual capture.
- Overcome fast-paced, hostile, or language barrier areas.
- Capture ancillary data when possible.
- Real-time is best, but batch may suffice.

# Topic 3: Supply Chain Master Data

## Automatic Identification Systems (AIS)

### AIS

- Automatic classification
  - Optimize for storage/transport
- Automatic identification
  - Devices communicate presence

### Types of AIS

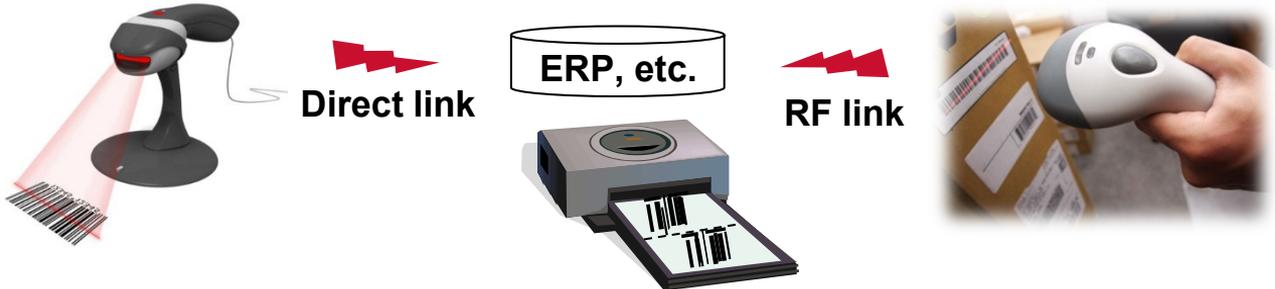
- Warehouse automation
- Bar codes
- RF devices
- RFID
- Smart cards
- Magnetic stripes
- Vision systems

### Impact of AIS on SC

- Paperless, few errors
- Wireless and real-time inputs and payments
- Reduces stockouts
- Enriches customer information/service
- Automated replenishment, inventory visibility
- Track savings, ROI

# Topic 3: Supply Chain Master Data

## Bar Codes and Bar Code Scanners

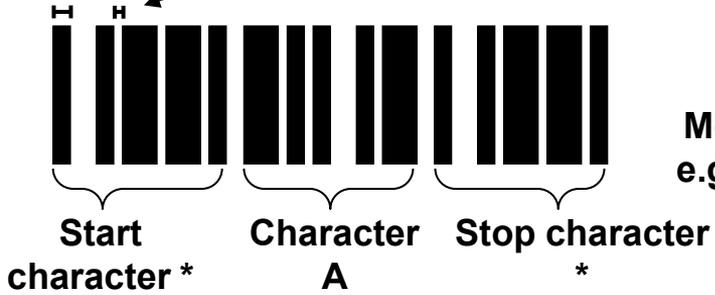


### UPC



Identifies product  
SKU and  
manufacturer

### Width of bars and gaps



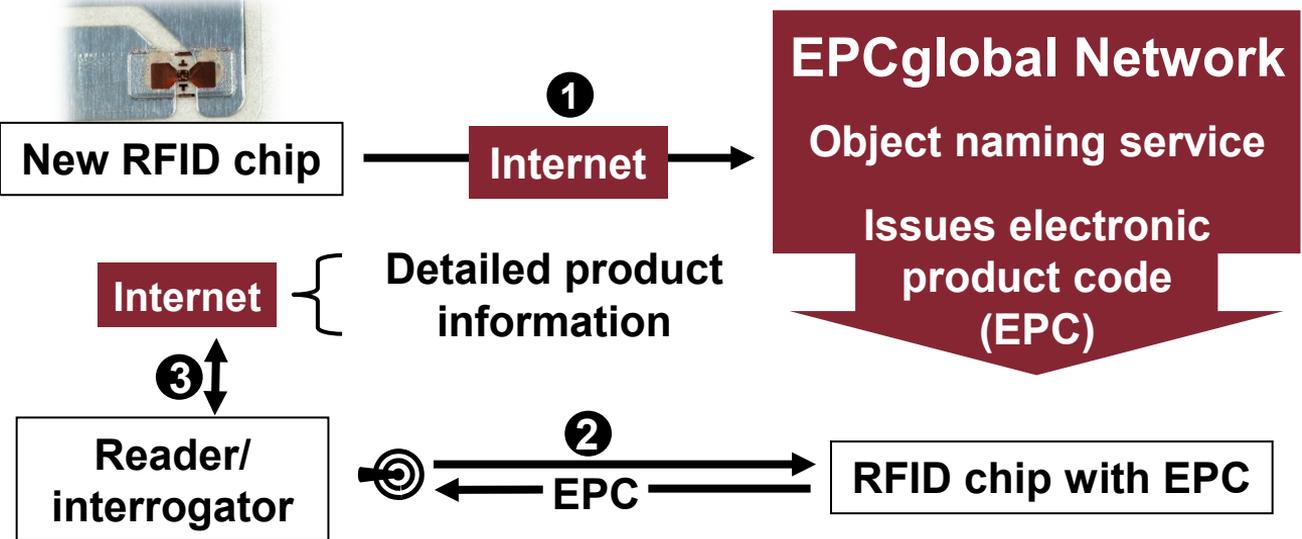
### 2D: QR code



More information,  
e.g., serial number

# Topic 3: Supply Chain Master Data

## Radio Frequency Identification (RFID)



**Internet verification prevents counterfeiting and stores extra product information.**

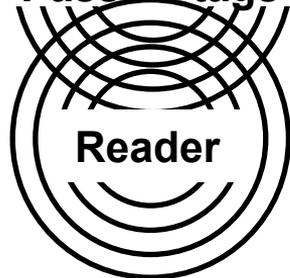
# Topic 3: Supply Chain Master Data

## RFID Tags, Errors, and Adjustments

### Tag types



### Passive tags



### Causes of read errors

- Antenna size
- Reader power
- Frequency used
- Reading cases on conveyor more reliable than whole pallet

### Adjustments

- Readers located for low interference
- Buffers or shields
- Adjusting angle of antennae
- Changing reader/tag to suit facility

Liquids absorb

← Signals →

Metals reflect

# Topic 3: Supply Chain Master Data

## Capturing and Communicating POS Data

### Point-of-sale

- Inventory and sales data adjusted at time and place of sale (bar codes, etc.).
- Information collected about customers at time of sale.
- Mobile devices can collect POS data too.
- Needed for VMI, etc.

### Benefits

- Capture data on SKU, promotions, inventory.
- Replace push with pull.
- Inventory deductions to finance.
- Collect purchasing habits.
- Reduce bullwhip effect.
- Reduce data entry errors.
- Low-cost updates.

# Topic 3: Supply Chain Master Data

## Model and Data Validation

**Test with historical data.**

**Test with current data.**

**Measure error related to aggregation.**

# Topic 3: Supply Chain Master Data

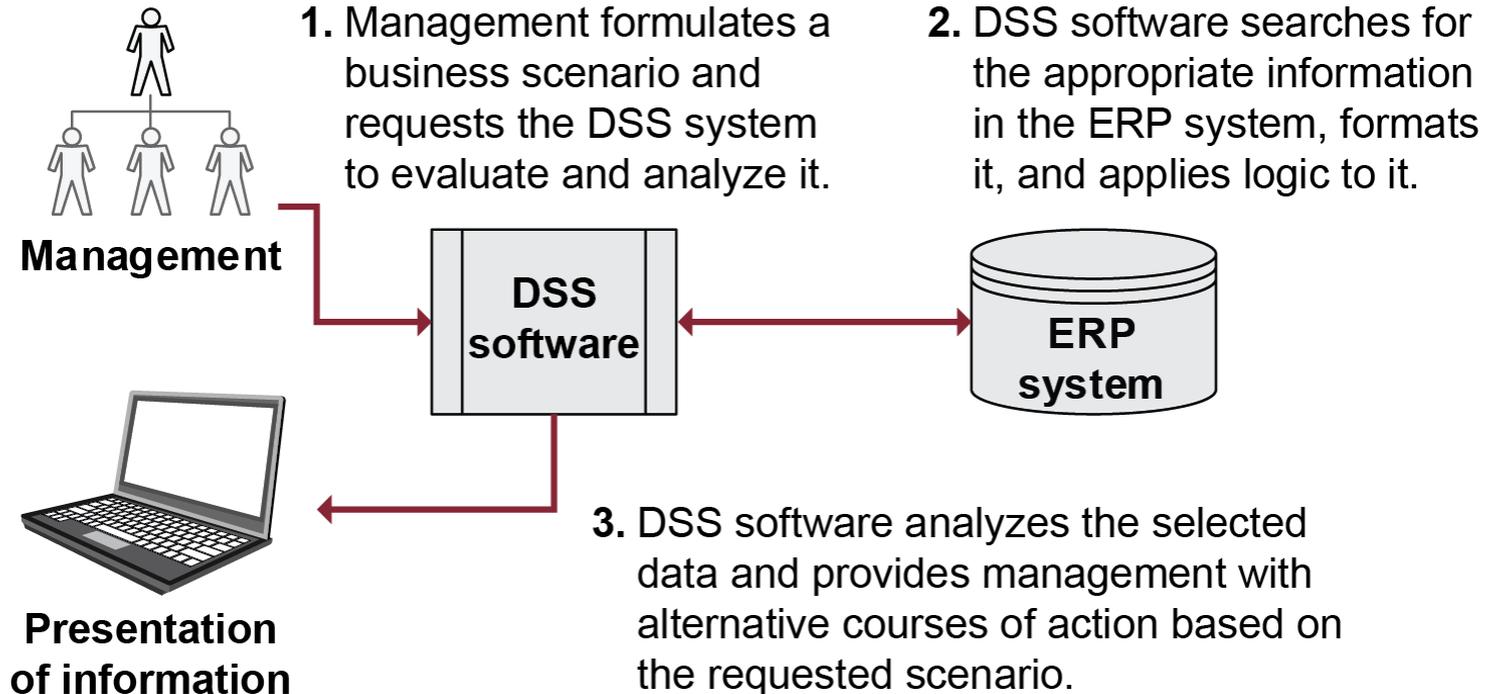
## Data Aggregation

**Smooths peaks and valleys: Pooling random variables reduces variance of aggregated variable.**

**Easier to interpret less data.**

# Topic 3: Supply Chain Master Data

## Decision Support Systems (DSS)



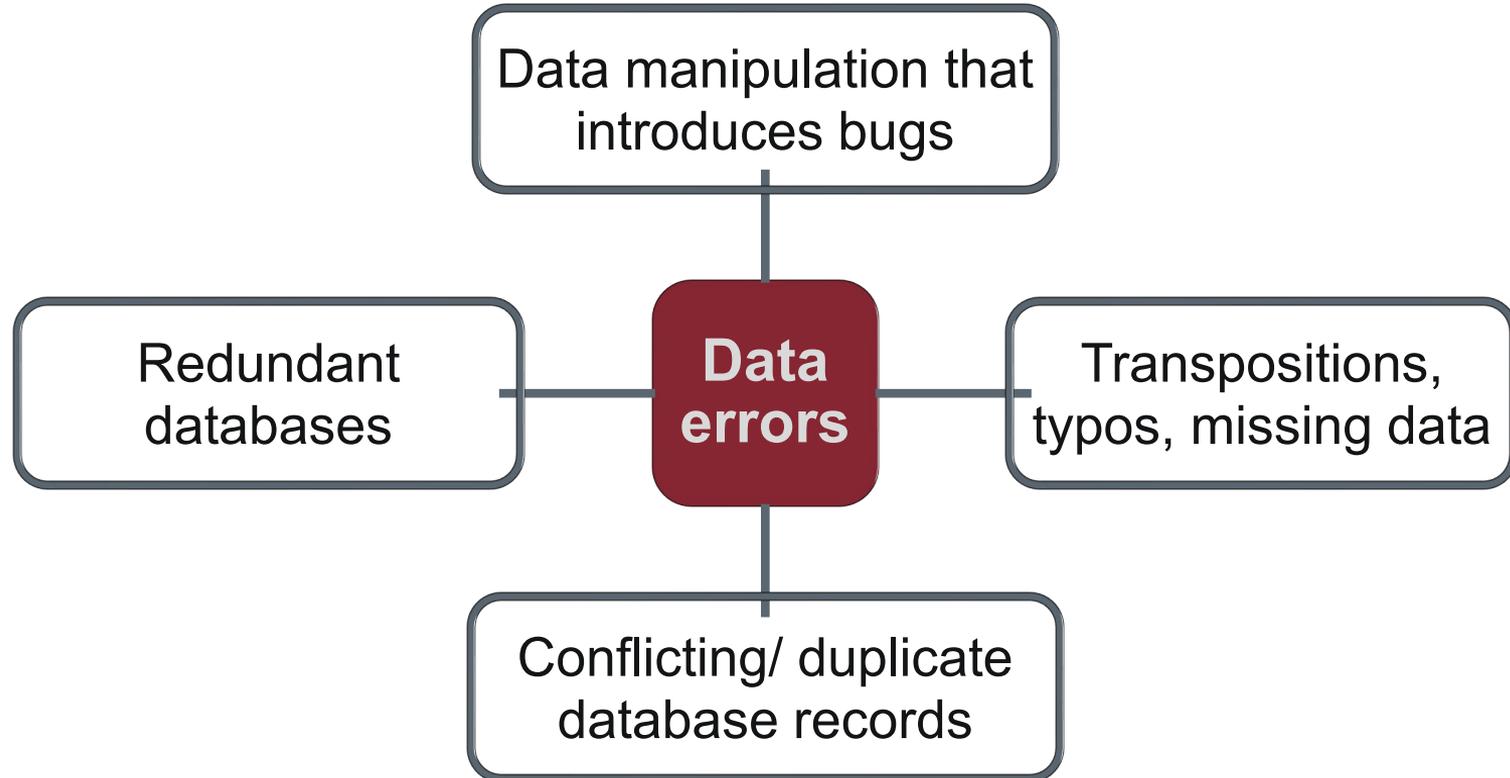
# Topic 3: Supply Chain Master Data

## Big Data and Data Analytics

- Big data
  - Massive amount of structured and unstructured data
  - Identify problem areas in supply chain early
  - How best to collect, use, and leverage?
- Data acquisition and analytics goal: Seamless links among processes and partners
  - Collecting information
  - Timely, controlled access
  - Reducing visibility gaps
  - Improving planning effectiveness
  - Ensuring and maintaining data accuracy

# Topic 3: Supply Chain Master Data

## Causes of Errors



# Topic 3: Supply Chain Master Data

## Ways to Improve Data Accuracy

- *Sharing POS/transaction data across SC*
- *Real-time transfer when feasible*
- *Immediate data entry/automation if feasible*



# Topic 3: Supply Chain Master Data

## Maintaining Data Accuracy



Role-based  
policies, procedures



Software limits for adding,  
deleting, modifying



Data maintenance and  
continuous user training

**CSCP** CERTIFIED SUPPLY CHAIN  
PROFESSIONAL

**SECTION C:  
SUPPLY CHAIN METRICS AND  
REPORTS**

## Section C Introduction

### Section C Key Processes:

- Develop and maintain reports, analytics, and metrics.
  - Incorporate supply chain operations reference (SCOR) metrics.
  - Utilize dashboards and balanced scorecards.
  - Define financial metrics and reports.
  - Define operational metrics and reports.

### Section C Topics:

- Topic 1: Supply Chain Metrics, Reports, and SCOR
- Topic 2: Financial and Operational Metrics and Reports

## Measuring Performance

### Performance Measures

- You get what you measure
- Objective, consistent, and quantified
- Measure at least 2 parameters (e.g., quality, time)
- Set targets to gauge relative success
- Customize

### Internal Measurement Benefits

**Control of processes and employees**

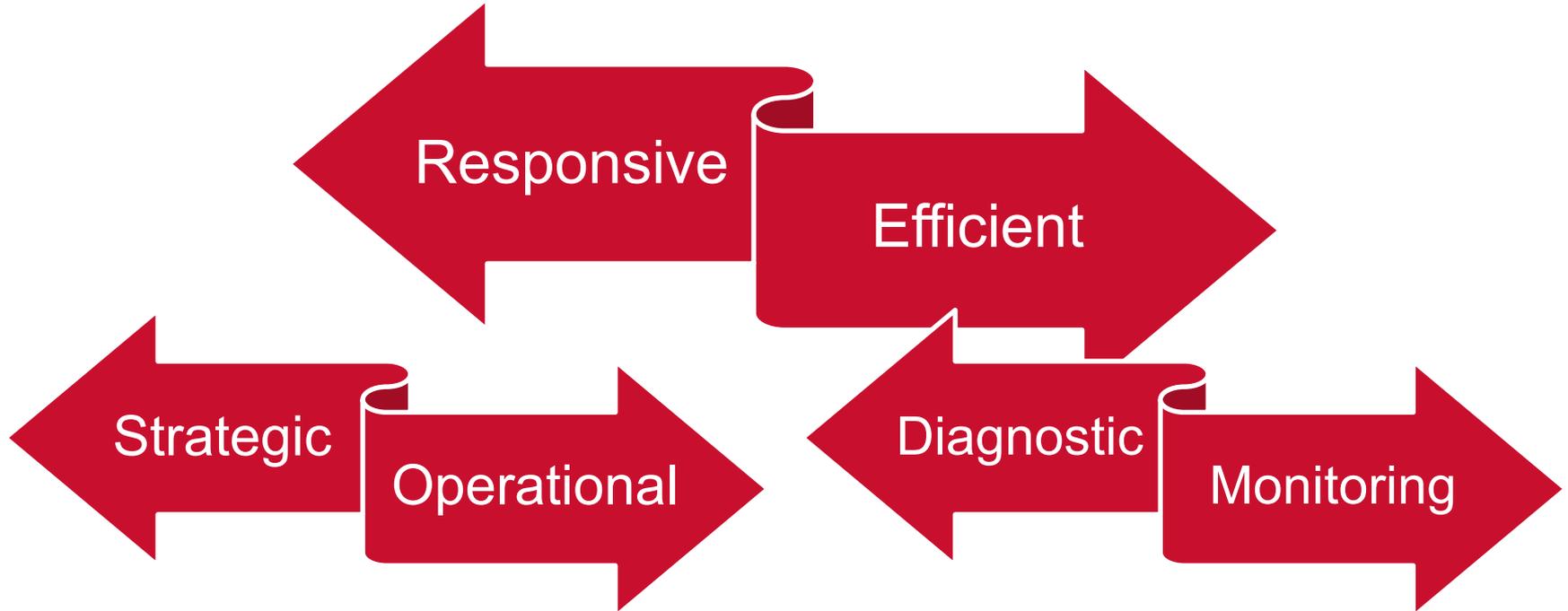
**Reporting to managers and external sources**

**Communication of expectations and problems**

**Learning and continuous improvement**

# Topic 1: Supply Chain Metrics, Reports, and SCOR

## Metric Selection Framework



# Topic 1: Supply Chain Metrics, Reports, and SCOR

## Balanced Scorecard (BSC)

### Customer Perspective

- Present performance, future prospects

Goal	Measure	Target	Actual

### Innovation & Learning Perspective

- Training and product development

Goal	Measure	Target	Actual

### Business Process Perspective

- Productivity, prospecting, flexibility, etc.

Goal	Measure	Target	Actual

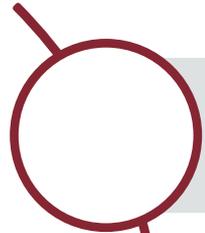
### Financial Perspective

- Traditional, historical only, necessary

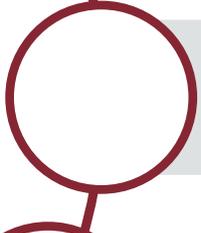
Goal	Measure	Target	Actual

# Topic 1: Supply Chain Metrics, Reports, and SCOR

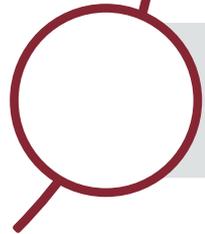
## Key Elements in Balanced Scorecard (BSC) Initiative



Communicate strategic purpose of scorecard to partners.



Develop goals and measures consistent with internal and SC strategies.

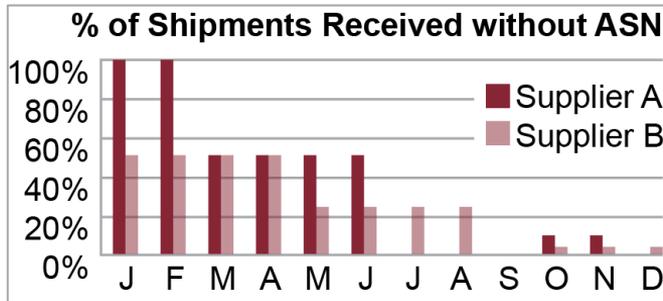


Create schedules and assign responsibilities.

# Topic 1: Supply Chain Metrics, Reports, and SCOR

## Custom Scorecard for 3PL (Service Quality)

Category	Target	Jan	Feb
<b>ASN Compliance</b>			
% Shipments Received Without ASN: Supplier A	0%	100%	100%
% Shipments Received Without ASN: Supplier B	0%	50%	50%
<b>Inventory Count</b>			
# of Parts Physically Counted	—	28	28
Inventory Accuracy Based on Physical Count	100%	80%	85%



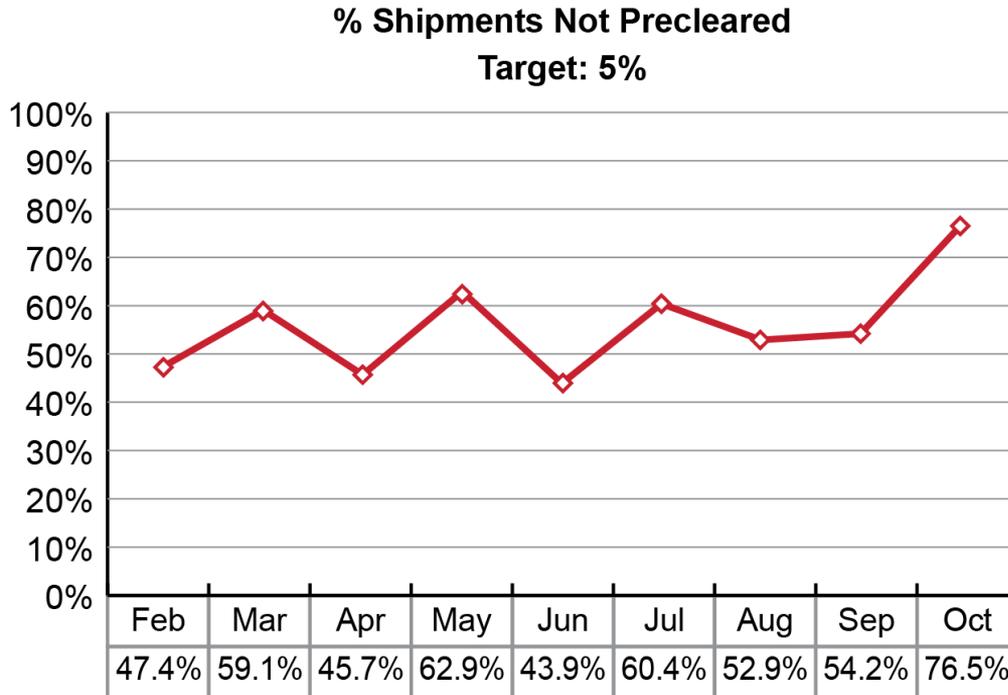
Source: Laura Gram



Source: Laura Gram

# Topic 1: Supply Chain Metrics, Reports, and SCOR

## Performance Metrics



Average actual is about 50%, target is 5%, so:

- Review measurement and target to see if accurate and feasible
- Mandate supplier process correction and/or set more realistic target.

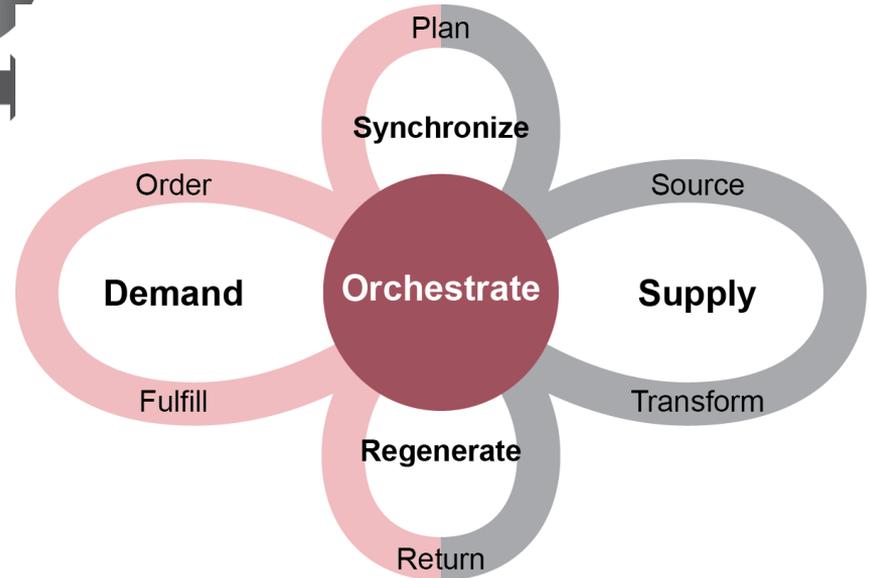
# Topic 1: Supply Chain Metrics, Reports, and SCOR

## SCOR DS



Source: ASCM, "Introduction to Supply Chain Management Using SCOR." Available from SCOR-DS website. Used with permission.

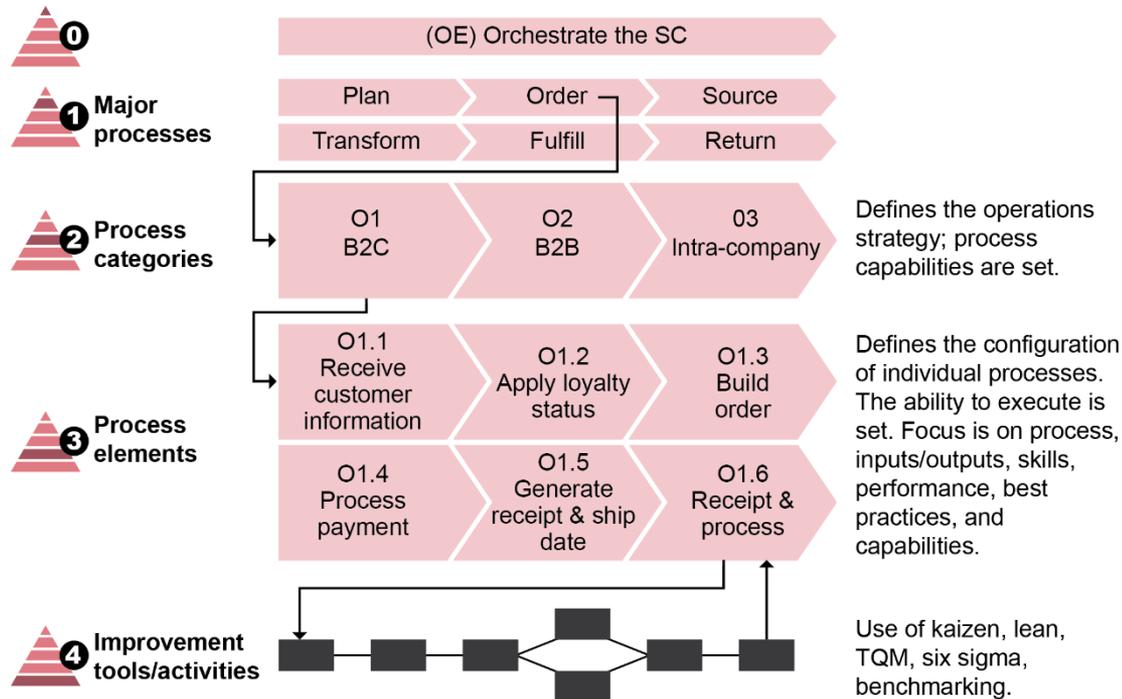
- Moving beyond linear supply chain depictions to supply networks
- Never-ending flow of processes with no artificial starts or ends



Source: Copyright ASCM. Used with permission.

# Topic 1: Supply Chain Metrics, Reports, and SCOR

## SCOR DS Hierarchical Process Model



- Performance: levels 1 to 3 in KPI tree
- Level 4 is specified by organization but linked to higher levels

Source: SCOR DS. Copyright ASCM. Used with permission.

# Topic 1: Supply Chain Metrics, Reports, and SCOR

## SCOR DS Four Major Sections

### Performance

- Supply chain strategy attributes (e.g., reliability, agility)
- KPI tree with related metrics

### Processes

- Management process standard descriptions
- As-is, what-if, and to-be states

### Practices

- Unique way to configure process
- Pillars
  - Analytics and technology (BP.049 Lean Planning)
  - Process (BP.009 Kanban)
  - Organization (BP.160 Lean)

### People

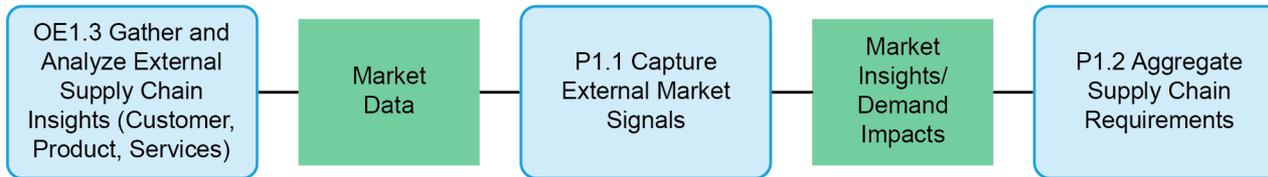
- Standard skill definitions, experiences, and training
- Competency levels
  - Novice
  - Beginner
  - Competent
  - Proficient
  - Expert

# Topic 1: Supply Chain Metrics, Reports, and SCOR

## Learning How to Use SCOR DS for Transformations

- *SCOR DS scope: order entry through paid invoice*
- *Learn more at SCOR DS website ([www.scor.ascm.org](http://www.scor.ascm.org)).*
- *Study and adapt standard process workflows to needs:*

Workflow



Source: ASCM, "P1.1 Capture External Market Signals." Available from SCOR DS web site.  
Used with permission.

# Topic 1: Supply Chain Metrics, Reports, and SCOR

## SCOR DS Resilience Performance Attributes

Performance Attribute	Definition
<b>Reliability (RL)</b>	“The ability to perform tasks as expected. Reliability focuses on the predictability of the outcome of a process. Typical metrics for the Reliability attribute include delivering a product on time, in the right quantity, and at the right quality level.”
<b>Responsiveness (RS)</b>	“The speed at which tasks are performed and the speed at which a supply chain provides products to the customer. Examples include cycle-time metrics.”
<b>Agility (AG)</b>	“The ability to respond to external influences and marketplace changes to gain or maintain a competitive advantage.”

# Topic 1: Supply Chain Metrics, Reports, and SCOR

## SCOR DS Economic Performance Attributes

Performance Attribute	Definition
<b>Costs (CO)</b>	“The cost of operating the supply chain processes. This includes labor costs, material costs, and management and transportation costs.”
<b>Profit (PR)</b>	“The Profit attribute describes the financial benefit realized when the revenue generated from the business activity exceeds the expenses, costs, and taxes involved in sustaining the activity.”
<b>Assets (AM)</b>	“The ability to efficiently utilize assets. Assets’ strategies in a supply chain include inventory reduction and insourcing rather than outsourcing.”

# Topic 1: Supply Chain Metrics, Reports, and SCOR

## SCOR DS Sustainability Performance Attributes

<b>Performance Attribute</b>	<b>Definition</b>
<b>Environmental (EV)</b>	“The Environmental attribute describes the ability to operate the supply chain with minimal environmental impact, including materials, water, and energy.”
<b>Social (SC)</b>	“The Social attribute describes the ability to operate the supply chain aligned with the organization’s social values, including diversity and inclusion, and training metrics.”

# Topic 1: Supply Chain Metrics, Reports, and SCOR

## Benchmarking Tools: SCORmark example

- Versus competitors
  - Superior: >90%
  - Advantage: >70%
  - Parity: > 50%
- Benchmark metrics readily available, e.g.,
  - SCORmark: Compare against 1,000 organizations and 2,000 supply chains.

Attribute	Metrics	Target Performance	Your Organization	Parity (50%)	Advantage (70%)	Superior (90%)	Gap to Target
<b>Reliability</b>	Perfect customer order fulfillment	Advantage	70%	X 77%	85%	93%	-15%
<b>Responsiveness</b>	Customer order fulfillment cycle time	Parity	6	9.1	7 X	4	3.1
<b>Agility</b>	Supply chain agility, strategic (days)	Parity	35	X 30	25	20	-5
<b>Cost</b>	Total supply chain management cost (% of revenue)	Advantage	8%	8.70% X	5%	2.40%	-3%
<b>Profitability</b>	EBIT (as a % of revenue)	Parity	16%	14%	X 17%	20%	2%
<b>Assets</b>	Cash-to-cash cycle time (days)	Superior	52	55.4 X	30.5	0	-52
<b>Environmental</b>	Waste generated (metric tons)	Parity	14.3	X 13.4	11.2	9.2	-0.9
<b>Social</b>	Training (hours per year)	Advantage	80	X 82.1	91.5	100.1	-11.5

X Your organization

Source: Adapted from SCOR-Professional Training. Used with permission. Values are for example only.

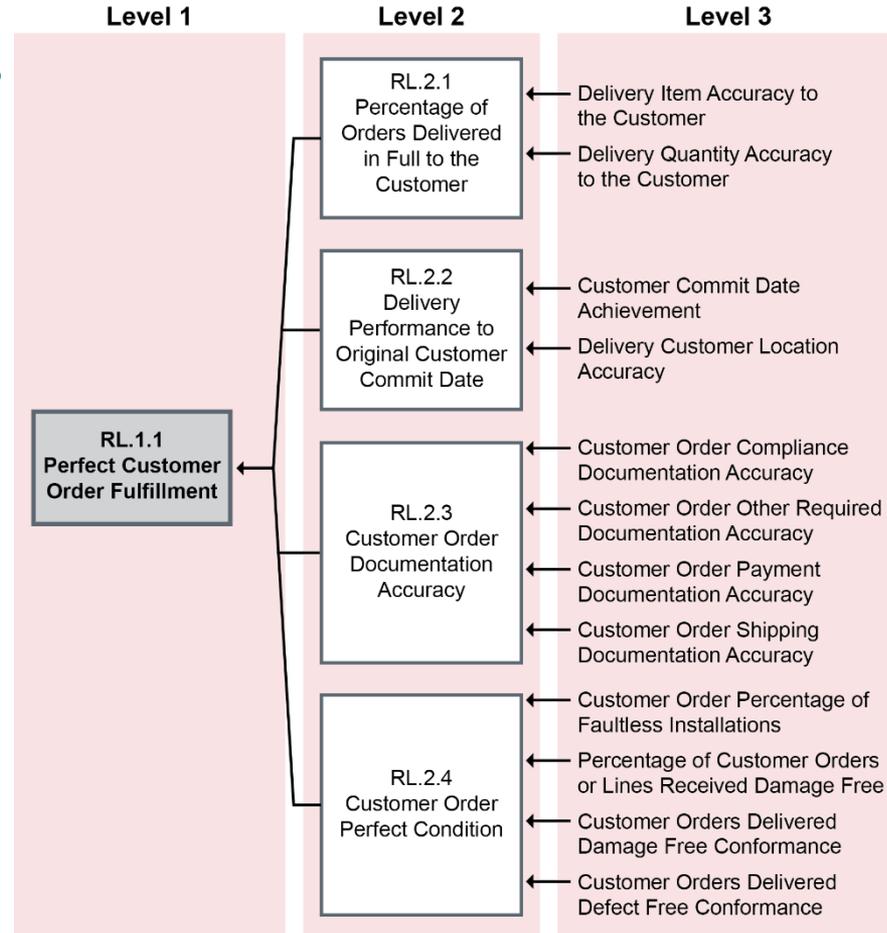
# Topic 1: Supply Chain Metrics, Reports, and SCOR

## SCOR DS Performance Metrics

Resilience	Economic	Sustainability
<b>Reliability</b> <ul style="list-style-type: none"><li>• Perfect customer order fulfillment</li><li>• Perfect supplier order fulfillment</li><li>• Perfect return order fulfillment</li></ul>	<b>Costs</b> <ul style="list-style-type: none"><li>• Total supply chain management cost</li><li>• Cost of goods sold</li></ul>	<b>Environmental</b> <ul style="list-style-type: none"><li>• Materials used</li><li>• Energy consumed</li><li>• Water consumed</li><li>• Waste generated</li></ul>
<b>Responsiveness</b> <ul style="list-style-type: none"><li>• Customer order fulfillment cycle time</li></ul>	<b>Profit</b> <ul style="list-style-type: none"><li>• Earnings before interest and taxes (EBIT) as a percent of revenue</li><li>• Effective tax rate</li></ul>	
<b>Agility</b> <ul style="list-style-type: none"><li>• Supply chain agility (strategic or operational)</li></ul>	<b>Assets</b> <ul style="list-style-type: none"><li>• Cash-to-cash cycle time</li><li>• Return on fixed assets</li><li>• Return on working capital</li></ul>	<b>Social</b> <ul style="list-style-type: none"><li>• Diversity and inclusion</li><li>• Wage level</li><li>• Training</li></ul>

# Topic 1: Supply Chain Metrics, Reports, and SCOR

## SCOR DS KPI Trees



# Topic 1: Supply Chain Metrics, Reports, and SCOR

## Performance Targets and SCOR DS

### Speed (SCOR DS responsiveness)

- Customer query time, order lead time, actual vs. theoretical lead time, cycle time, minimum and average delivery time

### Dependability (SCOR DS reliability)

- Percent orders delivered late, average lateness, proportion in stock, mean deviation from promised arrival

### Flexibility (SCOR DS agility)

- Time to develop new products, range of products, machine changeover time, average batch size

### Quality (SCOR DS reliability)

- Number of defects per unit, level of customer complaints, scrap level, warranty claims, MTBF, customer satisfaction

### Cost (SCOR DS cost and assets)

- Efficiency, variance vs. budget, value added, labor productivity, cost per operation hour, resource utilization

# Topic 1: Supply Chain Metrics, Reports, and SCOR

## Perfect Customer Order Fulfillment

$$\text{Perfect Customer Order Fulfillment} = \frac{\text{Total Perfect Orders}}{\text{Total Number of Orders}}$$



# Topic 1: Supply Chain Metrics, Reports, and SCOR

## Responsiveness: Customer Order Fulfillment Cycle Time

- Customer Order Fulfillment Cycle Time =  
Sum of Actual Cycle Times for  
All Orders Delivered  

---

Total Number of Orders Delivered
- Customer Order Fulfillment Cycle Time =  
Order Fulfillment Process Time + Order Fulfillment Dwell  
Time

## Agility

- Strategic supply chain agility (days)
  - Number of days to meet a 25% unplanned change in demand
  - Sum planned lead times for source, transform, order, fulfill, and plan
- Operational supply chain agility (% increase or decrease)
  - Sustained percentage increase or decrease in quantities that can be sustained over operational planning horizon (30 to 60 days)
  - Assume no expedite costs
  - Operational Supply Chain Agility =  $\frac{\text{New Planned Volume}}{\text{Original Planned Volume}}$

# Topic 1: Supply Chain Metrics, Reports, and SCOR

## Costs

- Total Supply Chain Management Cost as Percent of Revenue =  
$$\frac{(\text{Order Management Costs} + \text{Material Acquisition Costs} + \text{Inventory Carrying Costs} + \text{Supply Chain Related Finance and Planning Costs} + \text{Total Supply-Chain-Related IT Costs})}{\text{Total Product Revenue}}$$
- Cost of Goods Sold =  
$$\text{Direct Material Cost} + \text{Direct Labor Cost} + \text{Indirect Costs Related to Production (Overhead)}$$

# Topic 1: Supply Chain Metrics, Reports, and SCOR

## Profit

- Earnings Before Interest and Taxes as a Percent of Revenue = 
$$\frac{\text{Revenue} - \text{COGS} - \text{Operating Expenses}}{\text{Revenue}}$$
- Effective Tax Rate
  - Average tax rate paid by organization
  - A tax-efficient supply chain can significantly impact this rate.

# Topic 1: Supply Chain Metrics, Reports, and SCOR

## Assets

- Cash-to-Cash Cycle Time = Days' Sales Outstanding + Inventory Days of Supply – Days' Payables Outstanding

- Days' Sales Outstanding = 
$$\frac{\text{Five-Point Annual Average of Gross A/R}}{\left(\frac{\text{Total Gross Annual Sales}}{365 \text{ days}}\right)}$$

- Inventory Days of Supply = 
$$\frac{\text{Five-Point Rolling Average of Gross Value of Inventory at Standard Cost}}{\left(\frac{\text{Annual COGS}}{365 \text{ days}}\right)}$$

- Days' Payables Outstanding = 
$$\frac{\text{Five-Point Rolling Average of Gross A/P}}{\left(\frac{\text{Total Gross Annual Material Purchases}}{365 \text{ days}}\right)}$$

# Topic 1: Supply Chain Metrics, Reports, and SCOR

## Assets

- Return on Fixed Assets =  
$$\frac{(\text{Supply Chain Revenue} - \text{Total Supply Chain Management Cost})}{\text{Supply Chain Fixed Assets}}$$
- Return on Working Capital =  
$$\frac{(\text{Supply Chain Revenue} - \text{Total Supply Chain Management Costs})}{(\text{Inventory} + \text{A/R} - \text{A/P})}$$

# Topic 1: Supply Chain Metrics, Reports, and SCOR

## Sustainability Metrics

### Environmental

- Materials Used = total weight or volume of materials used to produce and package main products and services
- Energy Consumed = in joules
- Water Consumed = in megaliters
- GHG Emissions = metric tons of equivalent CO<sub>2</sub>
- Waste Generated = total weight

### Social

- Diversity and Inclusion = percentage of individuals in organization's governance bodies per gender, age group, and other diversity indicators
- Wage Level = ratio of entry-level wage by gender to minimum wage
- Training = number of hours

# Topic 1: Supply Chain Metrics, Reports, and SCOR

## Digital Capabilities Model for Supply Networks

Capability	Description	SCOR DS Linkages
Connected customer	Inspire at start of customer life cycle; service at the end.	Order, orchestrate
Product development	Do proactive product life-cycle management.	Orchestrate
Synchronized planning	Leverage human and process capabilities for planning efficiency.	Plan, orchestrate
Intelligent supply	Leverage technologies to reduce costs.	Source, orchestrate
Smart operations	Digital transformation for connectivity, agility, and proactivity.	Transform, orchestrate
Dynamic fulfillment	Add order fulfillment speed and agility.	Fulfill, return, orchestrate

## Standard Costing

*A cost accounting system that uses cost units determined before production for estimating the cost of an order or product*

- **COST = VOLUME × RATE**

# Topic 2: Financial and Operational Metrics and Reports

## Balance Sheet for Two Years

Example: Buy house for \$200,000 with \$20,000 down

- \$200,000 assets = \$180,000 liabilities + \$20,000 equity

		In Millions (000,000)	
		Year 2	Year 1
<b>BALANCE SHEETS</b>			
<b>December 31,</b>			
What the organization owns	<b>Assets</b>	Statement of financial value at a point in time (end of year)	
Assets expected to be converted to cash within one year	Current Assets		
	Cash and Cash Equivalents	\$96.5	\$56.3
	Inventory	59.9	60.4
	Accounts Receivable	48.4	44.3
	<b>Total Current Assets</b>	<b>204.9</b>	<b>161.1</b>
Long-term assets not easily converted to cash	Fixed Assets		
	Gross Property, Plant, and Equipment	70.0	60.0
	Less: Accumulated Depreciation	12.1	7.5
	Net Property, Plant, and Equipment	57.9	52.5
	<b>Total Assets</b>	<b>\$262.8</b>	<b>\$213.6</b>
Amounts owed to others	<b>Liabilities</b>		
Amounts owed this year	Current Liabilities		
Amounts owed beyond one year	Accounts Payable	20.0	19.6
	Short-Term Notes Payable	7.5	6.0
	<b>Total Current Liabilities</b>	<b>27.5</b>	<b>25.6</b>
	Long Term Liabilities		
	Long-Term Debt	60.0	60.0
	<b>Total Liabilities</b>	<b>87.5</b>	<b>85.6</b>
Funds from owners and operations (what is left after liabilities are deducted)	<b>Owners' Equity</b>		
	Common Stock (Par Value)	11.0	10.0
	Additional Paid-In Capital	66.0	54.0
	Retained Earnings	98.3	64.0
	<b>Total Owners' Equity</b>	<b>175.3</b>	<b>128.0</b>
What owners have contributed	<b>Total Liabilities and Owners' Equity</b>	<b>\$262.8</b>	<b>\$213.6</b>
Reinvested funds from operations			

Assets = Liabilities + Owners' Equity

# Topic 2: Financial and Operational Metrics and Reports

## Income Statement for Two Years

- Depreciation shown here will be added back on cash flow statement

<b>INCOME STATEMENTS</b>		(000,000s) except per share amts.	
For the Years Ending		Year 2	Year 1
Expenses from providing goods/services that generate revenue	<b>Revenue (Sales)</b>	<b>\$302.6</b>	<b>\$276.9</b>
Revenue – COGS = Gross Profit	Direct Labor	38.3	37.6
General expenses from running business that cannot be directly linked to specific units of goods/services sold	Direct Materials	101.5	99.7
Lowers fixed asset value for taxes	Factory Overhead	26.6	26.1
Payments on debt	Less: Cost of Goods Sold (COGS)	166.4	163.4
Shows effect of taxes on profits	<b>Gross Profit</b>	<b>136.2</b>	<b>113.5</b>
Gross Profit – Operating Expenses	Less: Operating Expenses		
– Depreciation	Selling Expenses	30.3	24.9
– Interest Exp.	General and Administrative	27.2	22.2
– Income Taxes	Lease Expense	12.1	8.3
= Net Income	Less: Total Operating Expenses	69.6	55.4
	Less: Depreciation	4.6	4.0
	Less: Interest Expense	3.9	3.9
	<b>Net Income (Profit) Before Taxes</b>	<b>58.1</b>	<b>50.3</b>
	Less: Income Taxes	16.3	14.1
	<b>Net Income (Profit)</b>	<b>\$41.8</b>	<b>\$36.2</b>
	Net Income (as a Pct. of Revenue)	14%	13%
	<b>Net Income Per Share-Basic</b>	<b>\$3.95</b>	<b>\$3.78</b>

# Topic 2: Financial and Operational Metrics and Reports

## Statement of Cash Flows for Two Years

- Cash pays the bills, debts, salaries, and dividends.
- Inventory is less liquid.

Year	In Millions (000,000)	
	Year 2	Year 1
<b>CASH FLOW STATEMENTS</b>		
<b>Operating Section</b>		
After-Tax Net Income	\$41.8	\$36.2
Depreciation Add-Back	4.6	4.0
{(Increase)/Decrease in Inventory	0.5	(8.6)
{(Increase)/Decrease in Accounts Receivable	(4.1)	(4.1)
Increase/(Decrease) in Accounts Payable	0.4	1.8
<b>Cash Flow from Operations</b>	<b>43.2</b>	<b>29.3</b>
<b>Investing Section</b>		
Capex Spend (Capital Expenditures)	(10.0)	(10.0)
<b>Cash Flow from Operations and Investment</b>	<b>33.2</b>	<b>19.3</b>
<b>Financing Section</b>		
Additional Equity Capital	13.0	7.0
Less Dividends Paid	(7.5)	(5.0)
Increase/(Decrease) in Long-Term Debt	-	-
Increase/(Decrease) in Short-Term Notes	1.5	(1.5)
<b>Cash Flow from Operations, Investments, and Financing</b>	<b>40.2</b>	<b>19.8</b>
Beginning Cash Balance	56.3	36.5
<b>Ending Cash Balance</b>	<b>\$96.5</b>	<b>\$56.3</b>

A viable firm needs positive cash flow from operations in most years.

Depreciation is deducted on the income statement but doesn't reduce cash (added back).

Increase in inventory or accounts receivable reduces cash.

Increase in accounts payable increases cash.

Increase in business investments decreases cash.

Increase in new debt or equity provides cash.

Net Income  
 +/- Change in (Δ)  
 Operating  
 +/- Δ Investing  
 +/- Δ Financing  
 + Beginning Cash  
 = Ending Cash

Change in cash balance over a period of time

# Topic 2: Financial and Operational Metrics and Reports

## Supply Chain Financial Metrics

### Supply chain profit

Supply chain management cost reduction and efficiency efforts impact profit, e.g.,  $\text{Contribution Margin} = \text{Sales} - \text{Variable Costs}$ .

### Supply chain cost

Cost areas include order processing, inventory, transportation, warehousing and materials handling, and network integration.

### Supply chain total cost

An aggregation of the costs of all organizations that participate in a given supply chain.

### Altman Z-score

A combination of four or five weighted ratios to measure bankruptcy risk.

### Customer creditworthiness

The goal of monitoring customer creditworthiness is to ensure that invoices are paid on time.

# Topic 2: Financial and Operational Metrics and Reports

## Operational Metrics: Day-to-Day Operations Check

### Quality

- Accuracy
- Manufacturing goods to quality standards
- Avoidance of damage to goods
- Supplier Performance

Index =

$$\frac{\text{Material Cost} + \text{Nonconformance Cost}}{\text{Material Cost}}$$

### Productivity

- Output of production
- Resource inputs used as efficiently and effectively as possible

### Asset Management

- Ability of organization to maximize its operational assets
- Primary concerns are inventory and facility capacity