

Introduction to Supply Chain Execution Control based on Individualized Trace Data

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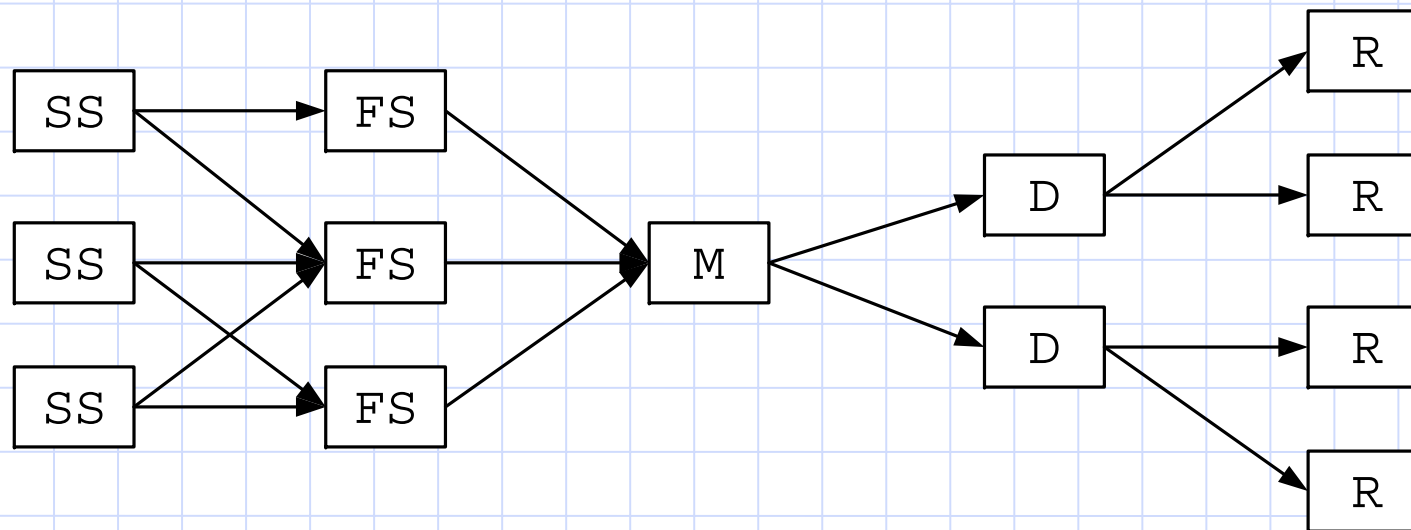
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Introduction

- ◆ Traditional Focus of SCM
 - Planning, Design, Rules
- ◆ Few systems operate precisely as intended.
- ◆ Managers tend to over-control in response to process status data
 - Lurie and Swaminathan 2006
- ◆ Optimization vs. Quality Control
 - CEO Challenge Survey (The Conference Board, 2007)

A Physical Supply Network



Second-Tier
Suppliers

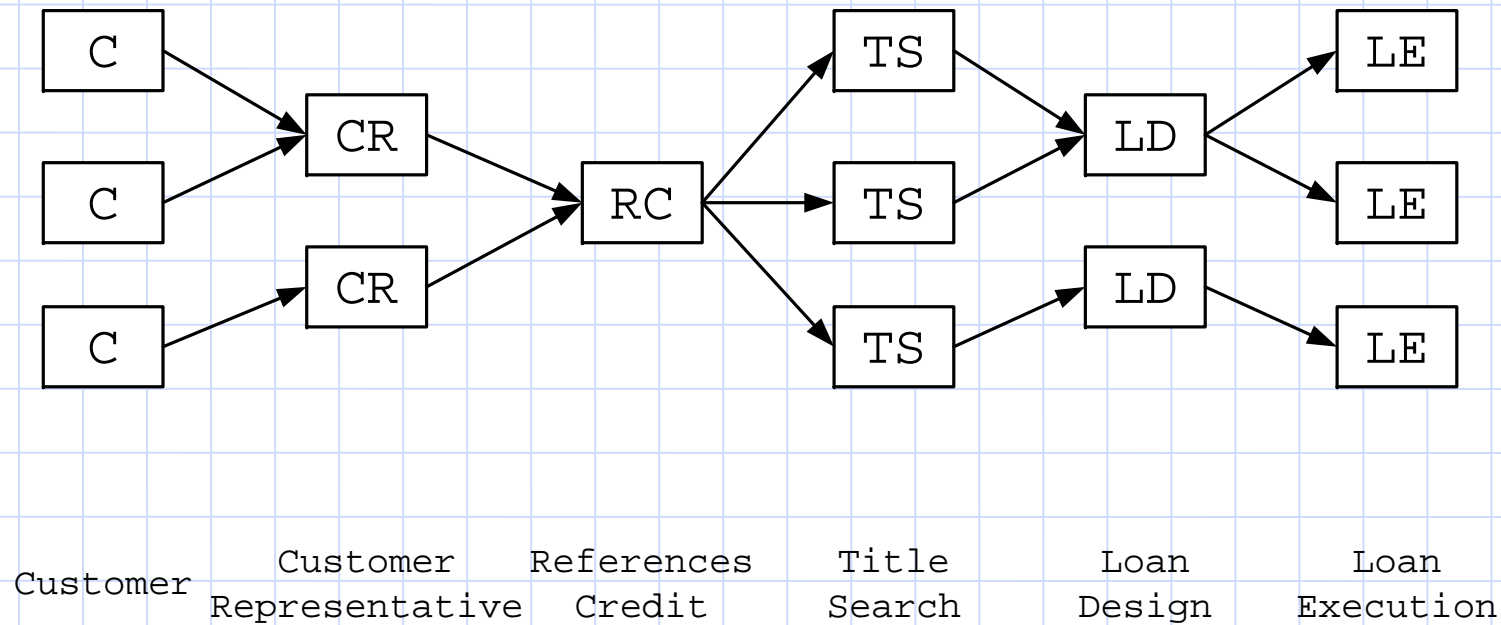
First-Tier
Suppliers

Manufacturer

Distributors

Retailers

A Virtual Supply Network



Usage in Practice

- ◆ How do you tell on a daily or hourly basis which parts of your supplier chains or delivery chains need attention? Can you detect changes ('out of control') in the delivery timeliness before there is a crisis?
- ◆ Are your suppliers' deliveries repeatable? What is their process capability relative to delivery time windows?
- ◆ What stages of the delivery process cause the greatest variation in delivery time? How much can delivery time variation be reduced?

Process Progress Quality Metrics

- ◆ Process: set of items (the *what*) going through a set of states (the *where*) in some order (the *why*) and at some time (the *when*).
- ◆ Timeliness: the time is neither too soon nor too late.
- ◆ Correctness: the sequence of steps experienced by the entity is acceptably correct.

Individualized Trace Data

- ◆ Records that record the location (or state) of an entity at a particular point in time, with the entity identified explicitly through an ID number or code.
- ◆ Enablers: RFID, Real-Time Sensor Technologies, EDI, ERP Systems, Warehouse Systems, Wireless Technologies, etc.

A Mathematical Framework: SIT Space

◆ S: State

◆ I: ID

◆ T: Epoch

◆ SIT Space ::= $2^S \times 2^I \times 2^T$

◆ Read Space ::= $S \times I \times T$

◆ Partially Ordered Set

◆ Order Comparison

Multiscale View in SIT

◆ Power Set

◆ Filter Function

- *Given a set $A \subseteq V$, a filter function F , or filter for short, is a mapping over its powerset $P(A)$, $F : P(A) \rightarrow P(A)$, such that $F(a) \subseteq a$ for all $a \in P(A)$.*
- *Models systematic choice patterns on a large number of read sets*

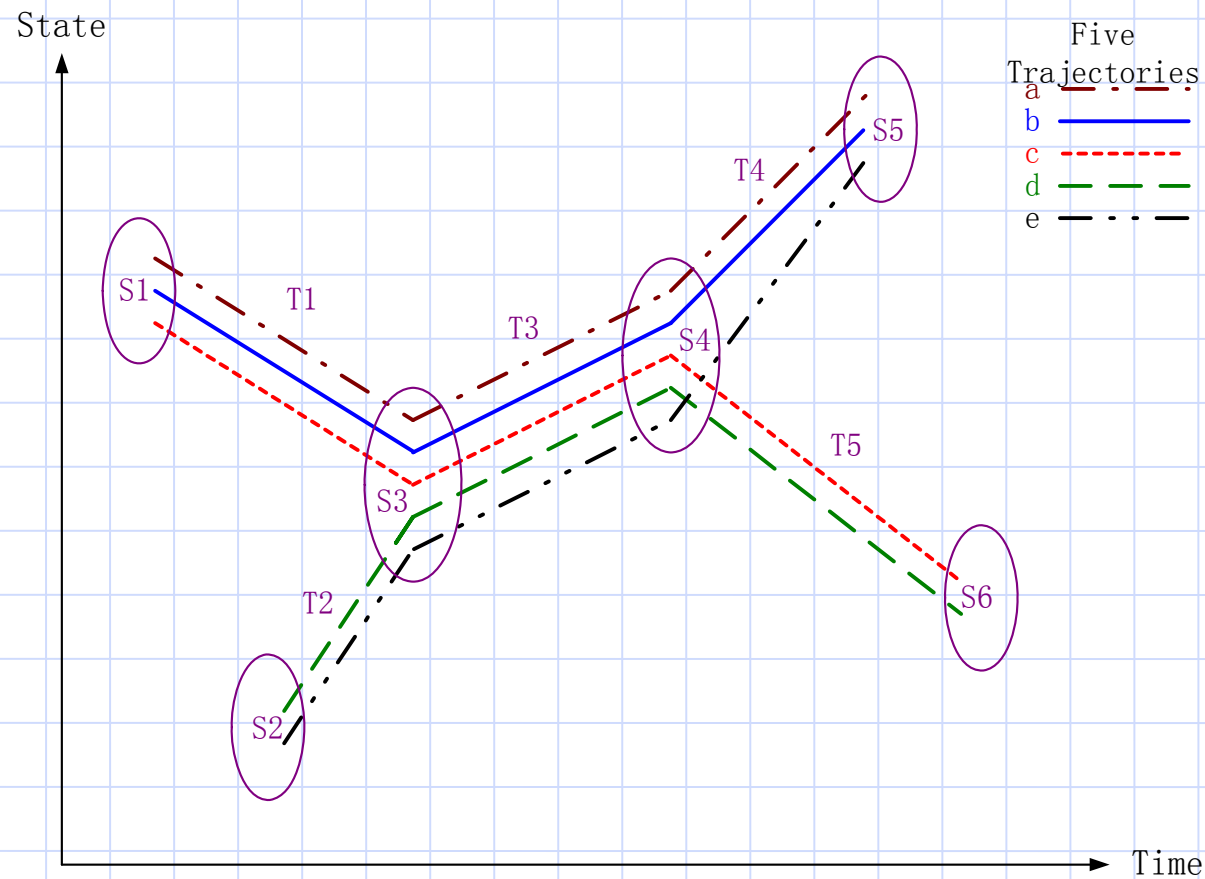
Constructs for Performance Metrics

- ◆ Sojourn Time
- ◆ Transit Time
- ◆ Trace
- ◆ Sequence Specification
- ◆ Sequence Correctness

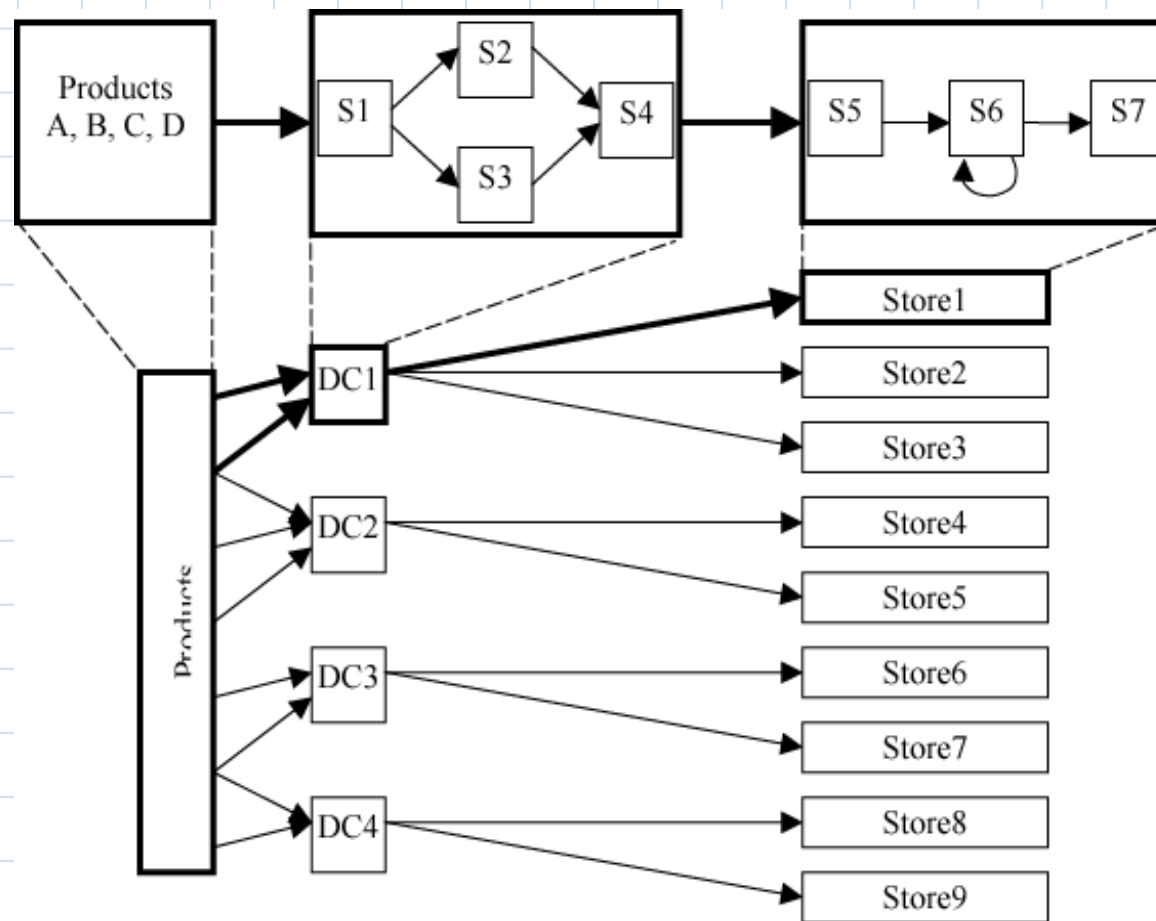
SPC for SIT-based Metrics

- ◆ Control charts for sojourn and transit time
- ◆ Control charts for sequence correctness
- ◆ Sampling and population subgrouping
- ◆ Multiscale subgrouping
- ◆ Multivariate analysis
- ◆ Network-Induced Covariance for Timeliness

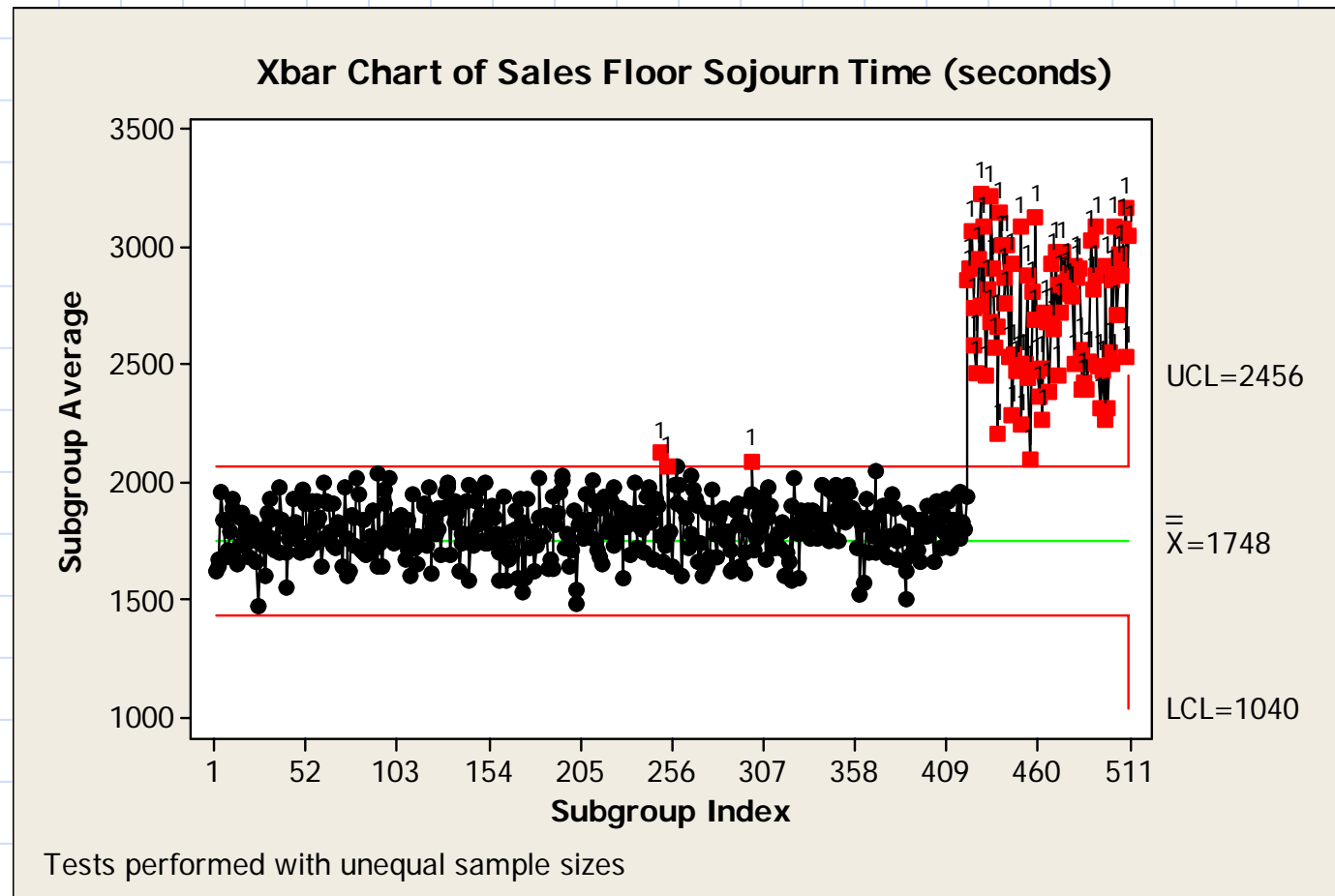
Illustration for Multiscale and Multivariate



Simulated Data based on Real World RFID Data



SPC for Sales Floor Sojourn



SPC for Number of Trips to Sales Floor

