Optimizing Delivery of Global Pharmaceutical Packaging Solutions, Using Systems Engineering Patterns

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Drivers for New Legislations & Regulations

Packaging Serialization—An Example of Complex Systems Evolution

➢ Drivers for New Legislation and Regulation-

  – Patient Risk

    ▪ Compromise course of treatment.

  – In countries with reimbursement, fraud growing:

    ▪ Requests for reimbursement for counterfeit or non-existent medication.

  – Counterfeit or Diverted medicines growing problem for patients:

    ▪ WHO (World Health Organization) estimated of counterfeits in the legitimate global drug supply:

      » <1% for developed markets,

      » But in many African countries, and in parts of Asia, Latin America, and countries in transition, a much higher percentage of the medicines on sale may be counterfeit

➢ Additional legislation may effect Serialization

  – Tamper Evident requirements in the EU

Packaging Serialization—An Example of Complex Systems Evolution
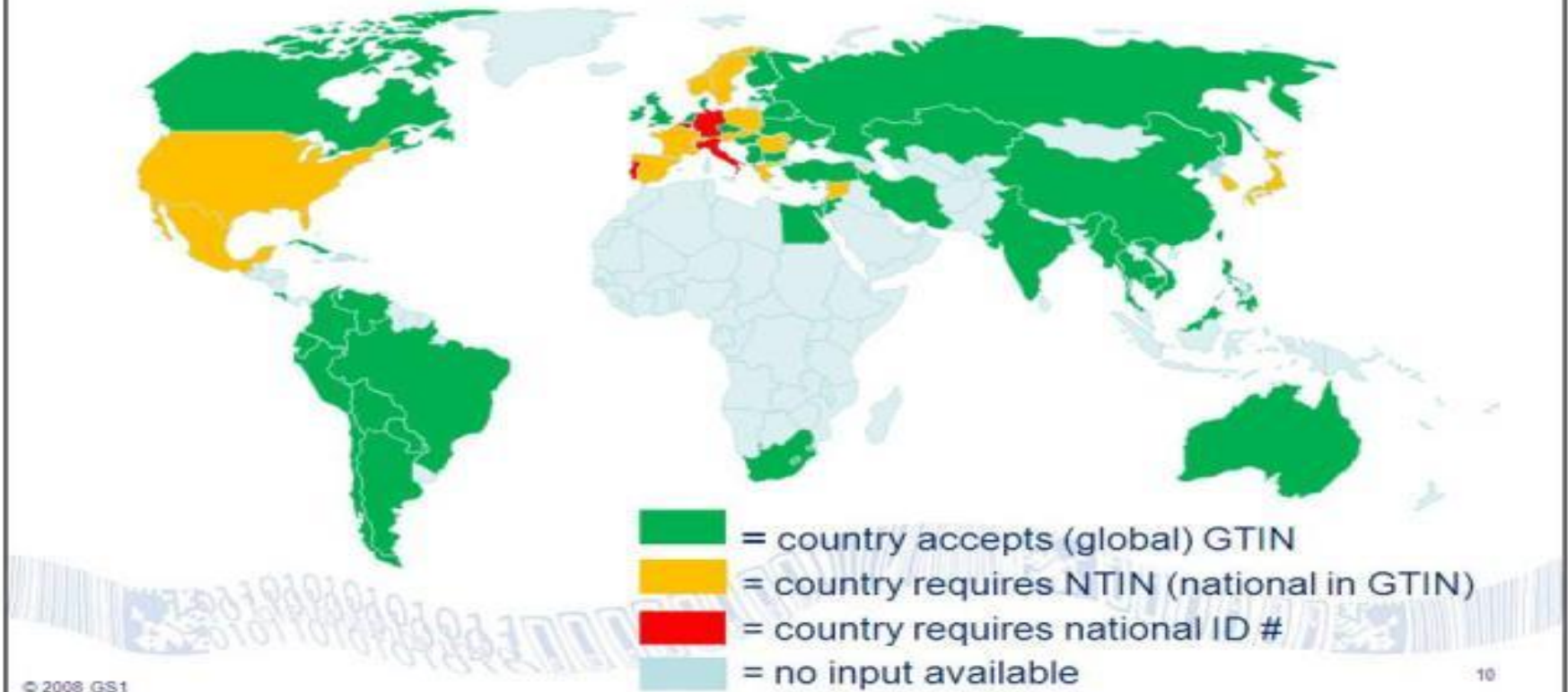
➤ Current or proposed legislation calls for either:

- "Track and Trace":
  - Uniquely serialized product units tracked through entire supply chain—from point to point;
  - Includes tracking unique serial numbers at each level of package hierarchy, including parent-child pairings.
- "Authentication":
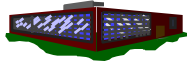 - Only the unit item of sale is uniquely serialized and checked at the point of sale.

Packaging Serialization—An Example of Complex Systems Evolution

GS1 Healthcare **Identification of pharmaceuticals**

= country accepts (global) GTIN
= country requires NTIN (national in GTIN)
= country requires national ID #
= no input available

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10

The Global Pharmaceutical Distribution System

Manufacturer — Manufacturing/Fill Finish

Distribution — Distribution Centers → Primary Wholesaler

"retailer" — Pharmacies Hospitals,…

patient — "Unwitting" Patient

Secondary Wholesaler

Repackager

"Parallel Trade" Wholesaler

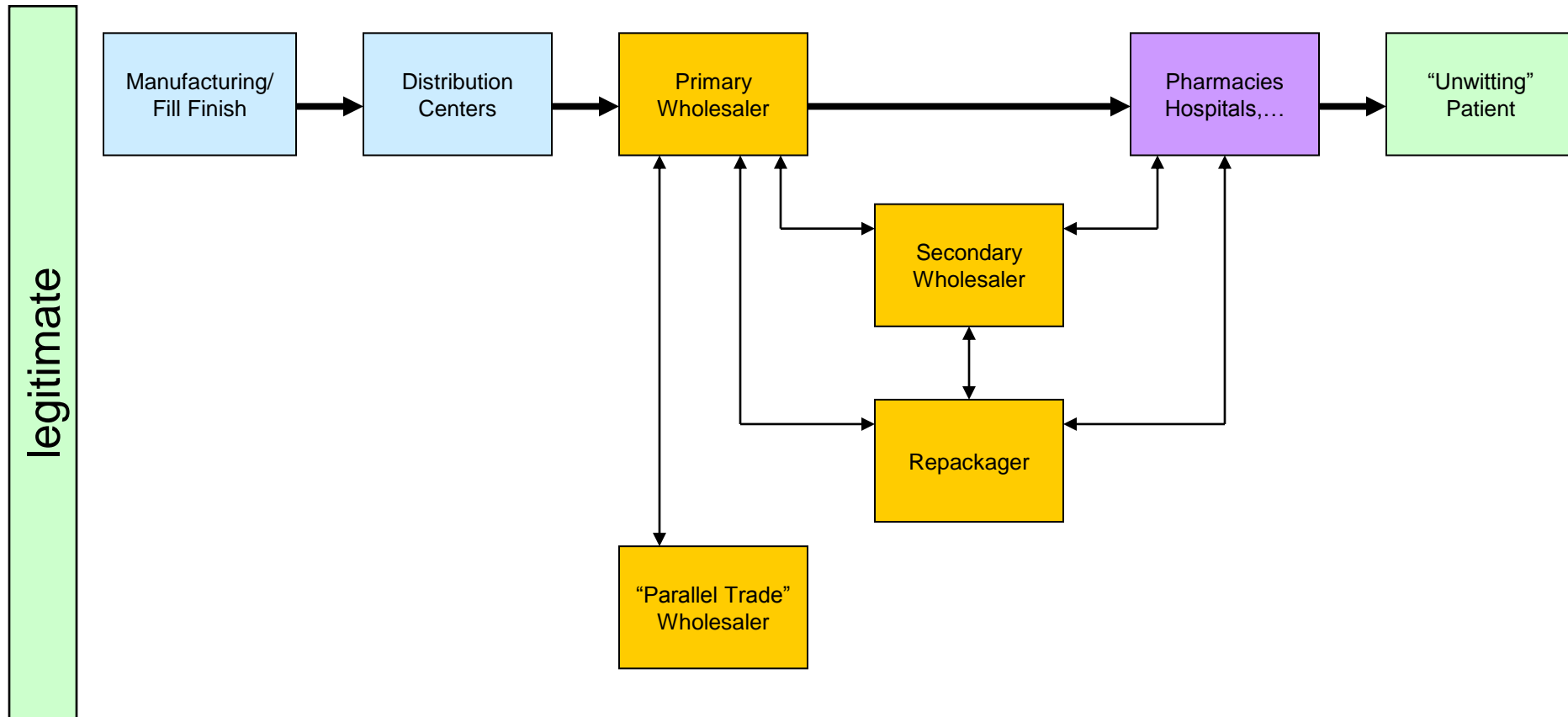legitimate
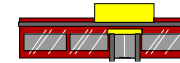
The Global Pharmaceutical Distribution System

➢ The overall system:

– Distributes critical products from production to consumption;

– Manufacturing Sites, Regional Distribution Centers, Retail Distribution Center, Retail Pharmacies or Hospitals;

– May involve re-packaging for market segments;

– Wholesales and retailers also sell to each other;

– Product moves from country to country;

– May also involve contract manufacturing;

– Chain configured differently by enterprise, country, product;
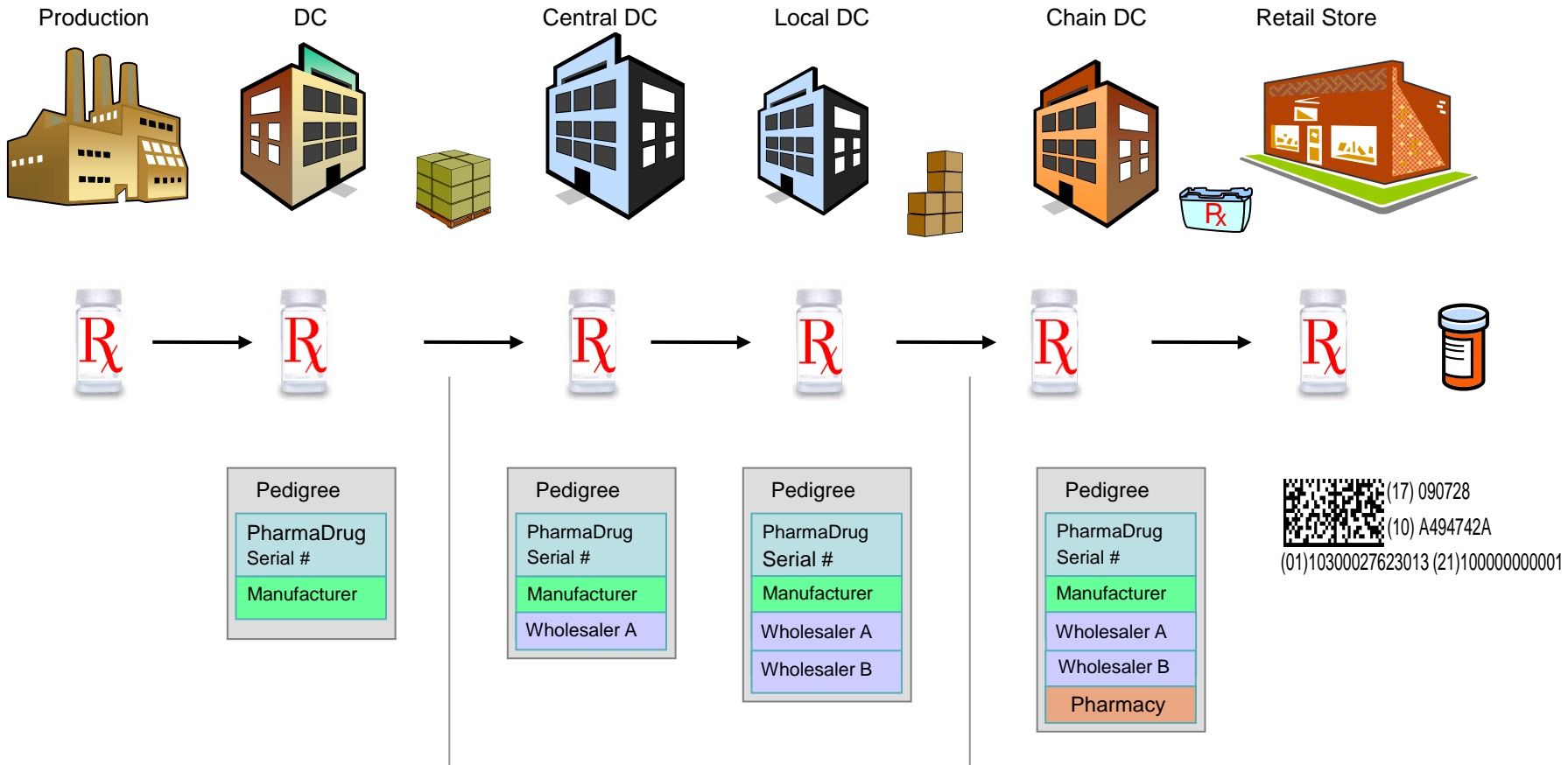
– A complex, dynamically reconfigurable system!

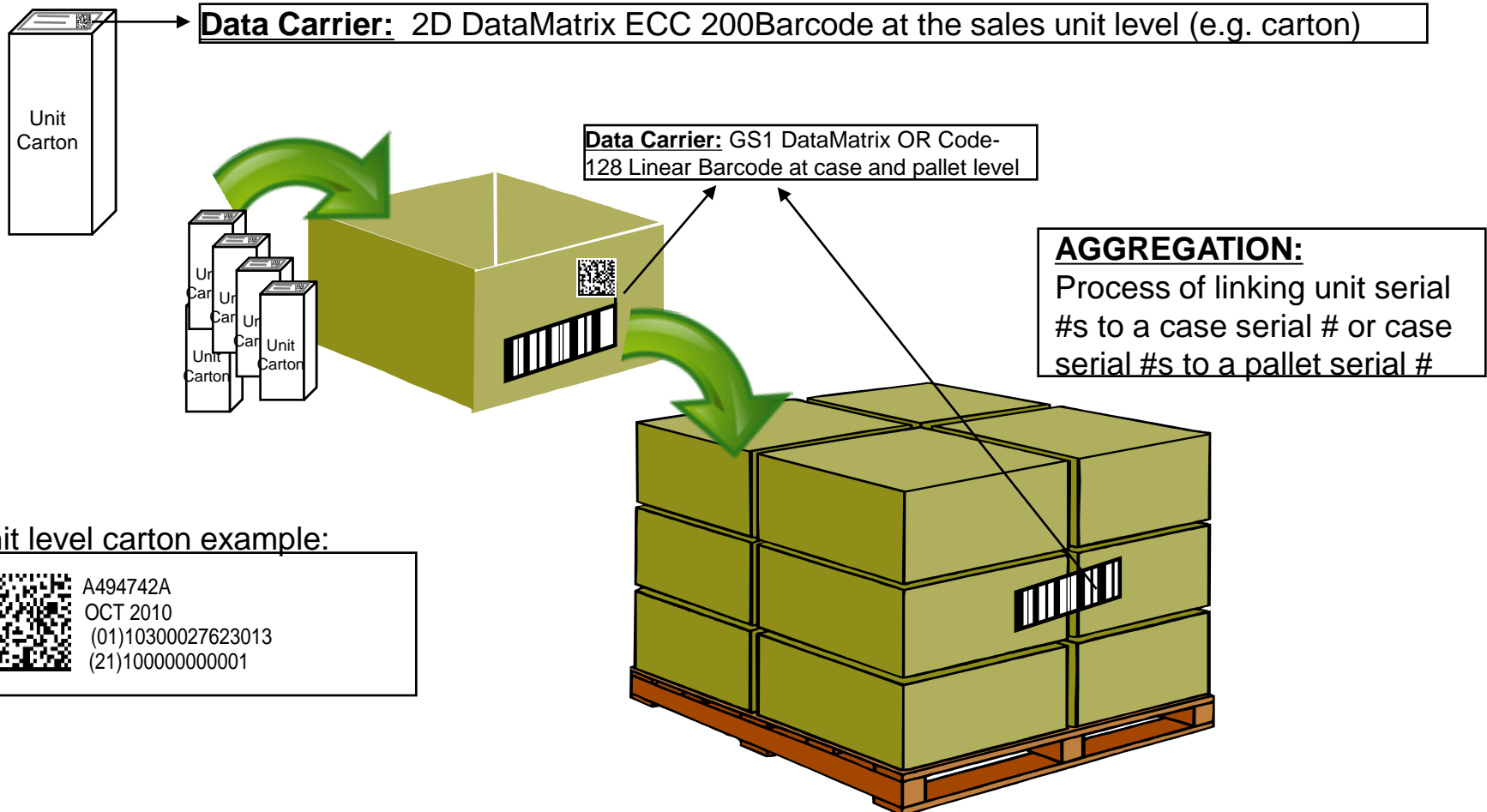# The Global Pharmaceutical Distribution System

The Global Pharmaceutical Distribution System

- Information system issues of packaging:
  - Traditionally complex;
  - Additional complexity now being added by emergence of Pharma Product <u>Serialization</u> . . .
- Information systems coordinate allocation of <u>unique serialized label identifiers</u> for saleable <u>units</u> (bottles, etc.)—uniqueness coordinated across the global enterprise;
- Resulting serial number data stream history made available to downstream distribution points:
  - Parallels the downstream flow of physical packaged product.
  - Synchronized delivery of data with physical delivery of product.

The Global Pharmaceutical Distribution System

Data Carrier: 2D DataMatrix ECC 200Barcode at the sales unit level (e.g. carton)

Unit Carton

Data Carrier: GS1 DataMatrix OR Code-128 Linear Barcode at case and pallet level

Unit Carton

AGGREGATION:
Process of linking unit serial #s to a case serial # or case serial #s to a pallet serial #

Unit level carton example:

A494742A
OCT 2010
(01)10300027623013
(21)100000000001

The Global Pharmaceutical Distribution System

➢ Variable configuration package hierarchy;

- Unit (e.g., Vial, Blister, Bottle, Carton)
- Bundle
- Case
- Pallet
- Order

➢ Varies by product type

➢ Distribution system breaks down and re-builds packaging hierarchy at various points in the supply chain.

The Global Pharmaceutical Distribution System

➤ Packaging lines:

- Packages or re-packages products;

- Insertion of complex, regulated literature;

- Companies have multiple lines across globe;

- Lines at production sites, others at distribution sites;

- Lines configured for specific products;

- Regulatory approval for specific countries, products;

- Thousands of product variants at some sites;

- Differ by product, literature, inserts, labeling.

Value Proposition
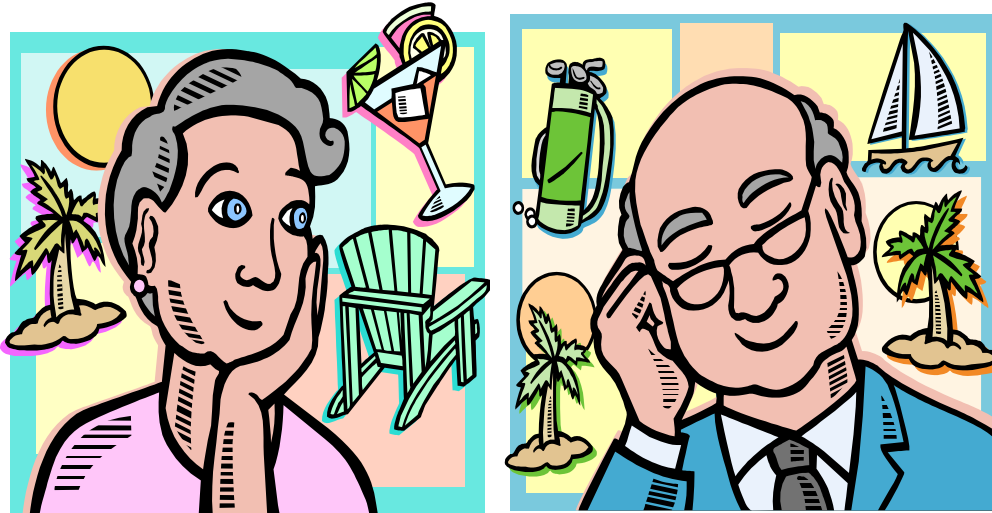
- ➢ Additional related applications:
  - Uniquely serialized product may also support other business processes.
- ➢ Examples:
  - Complaint investigations;
  - Recalls;
  - Marketing applications.
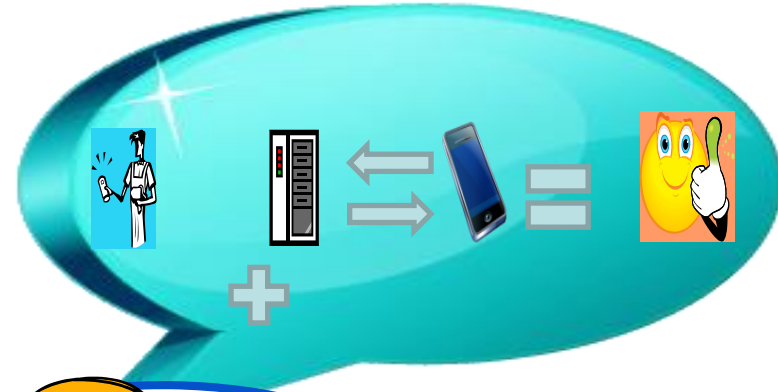
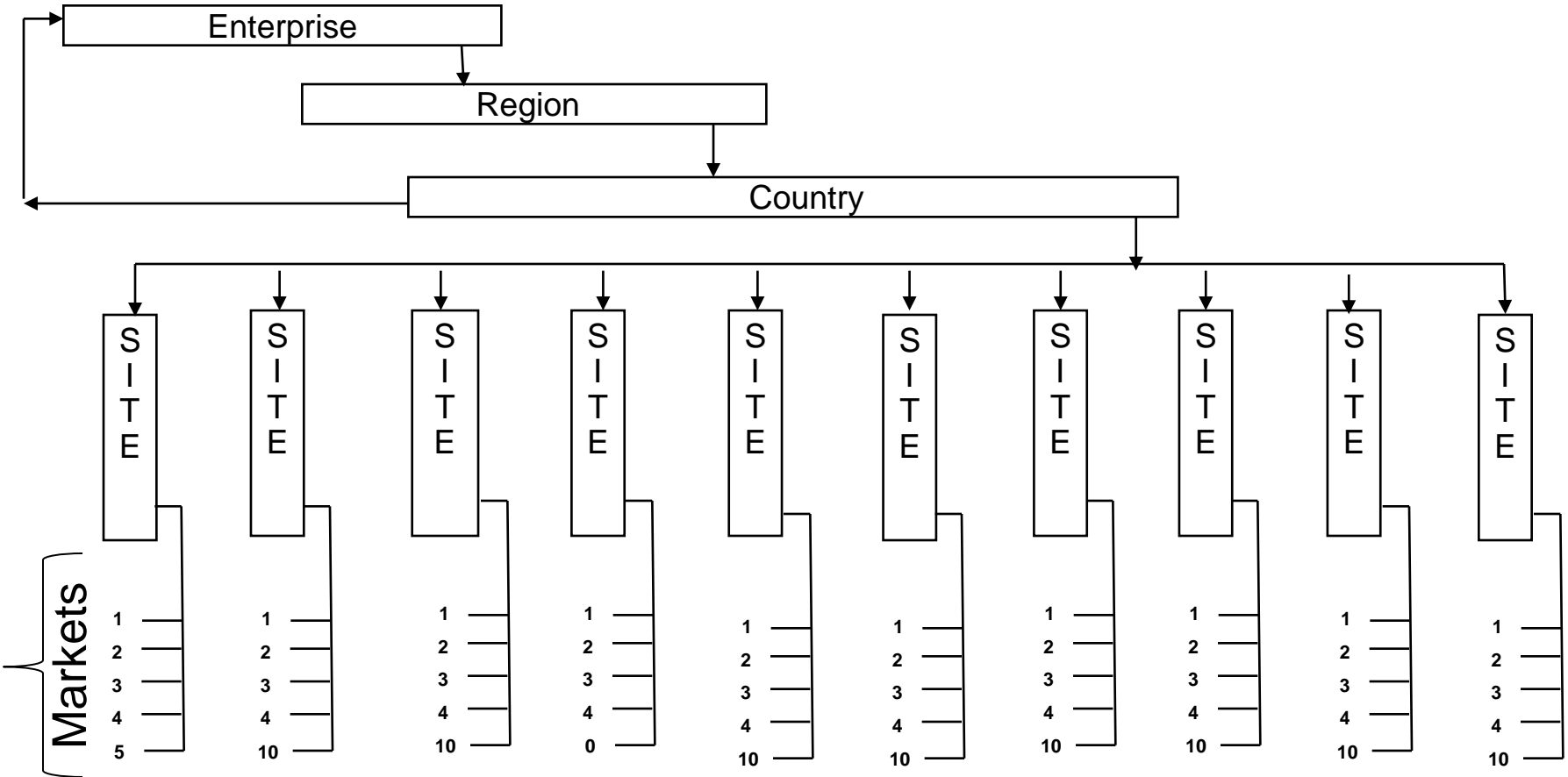# Packaging Serialization—An Example of Complex Systems Evolution

> "Hypothet Pharmaceuticals" has packaging operations in 10 countries, serving 160 markets;

> Different products and presentations (strengths, sizes, counts) result in 5,000 SKUs;

> There are 100 packaging lines—not all lines serve all products or markets;

> Hypothet also has agreements with 3 Contract Manufacturers, with locations in 6 countries serving 80 markets.

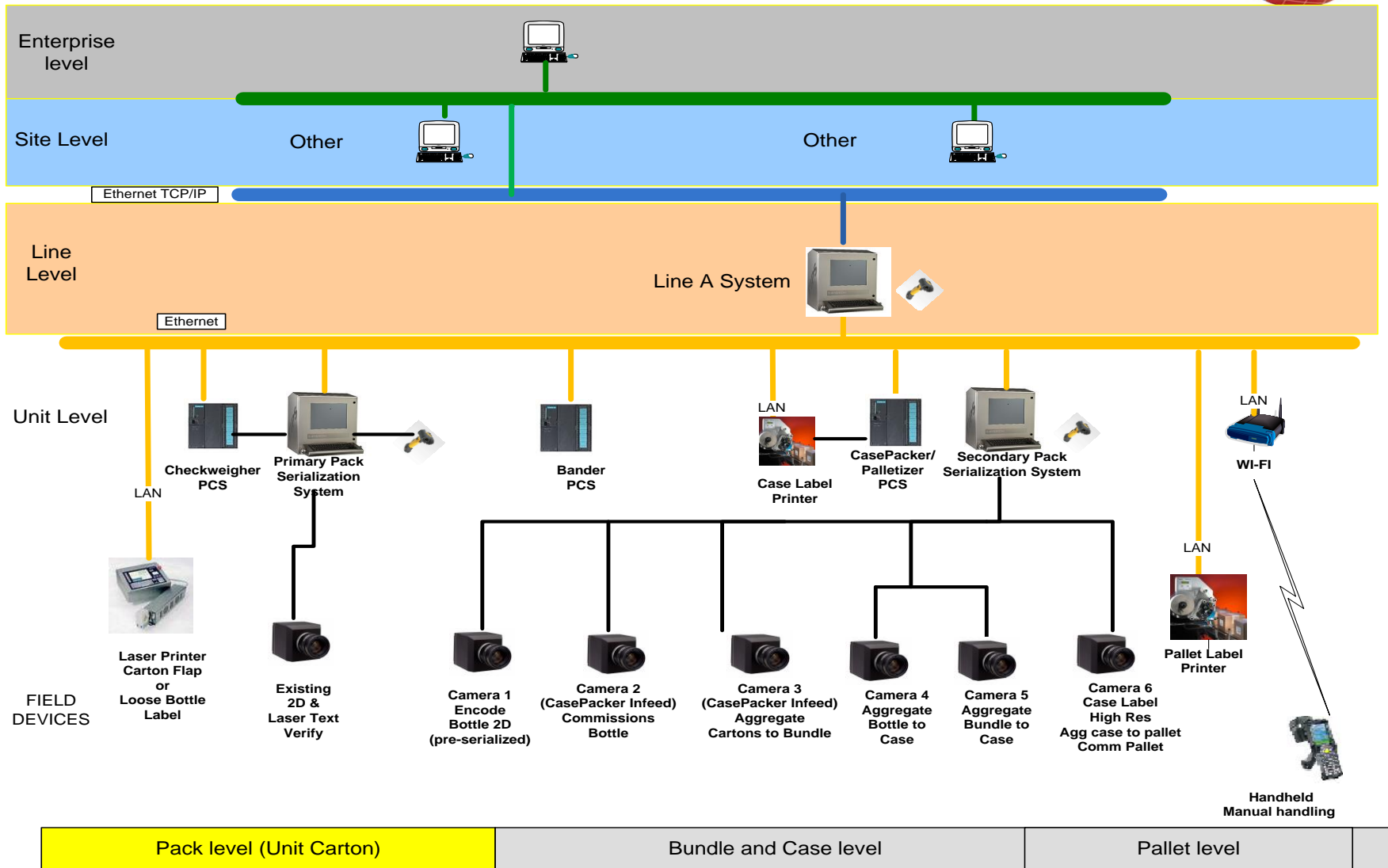> Must deal with transition period (years) on both serialized and non-serialized products

Packaging Serialization—An Example of Complex Systems Evolution

Hypothet Pharmaceuticals

Typical Architecture

Presentation for the INCOSE Symposium 2010 Chicago, IL USA

# Packaging Serialization—An Example of Complex Systems Evolution

➢ Two challenges face the enterprise:

- – Understanding the requirements and design of end-to-end Packaging Serialization Systems well enough to develop or purchase a solution that can be applied within regulatory timelines;

- – Understanding the delivery process to implement the technical solution across the breadth of global lines and locations.

- – At the right time at the right price!

Domain Diagram

Add Serialization To Typical Line

Serialized Line

A Systems Engineering View of the Problem
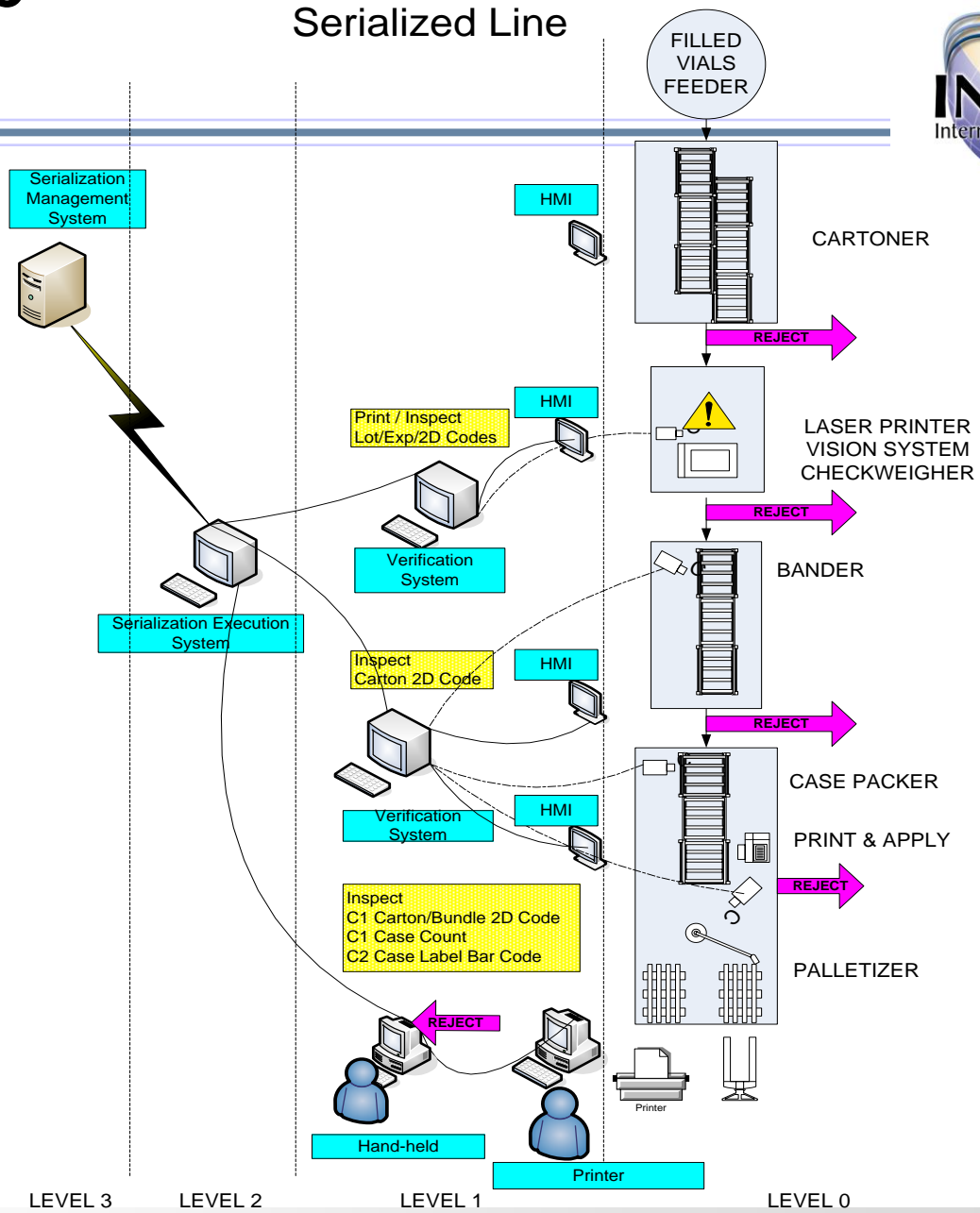
- ➢ The requirements and design variability challenge:
  - – Accommodate unique local needs essential to specific legal and regulatory authorities and product lines, but . . .
  - – Preserve as much common content as possible across the globe, to maximize leverage.
- ➢ "Variable sameness":
  - – Similar to the challenges of product lines, platforms, and configurable enterprise systems;
  - – For good business reasons, be both standard and unique at the same time.

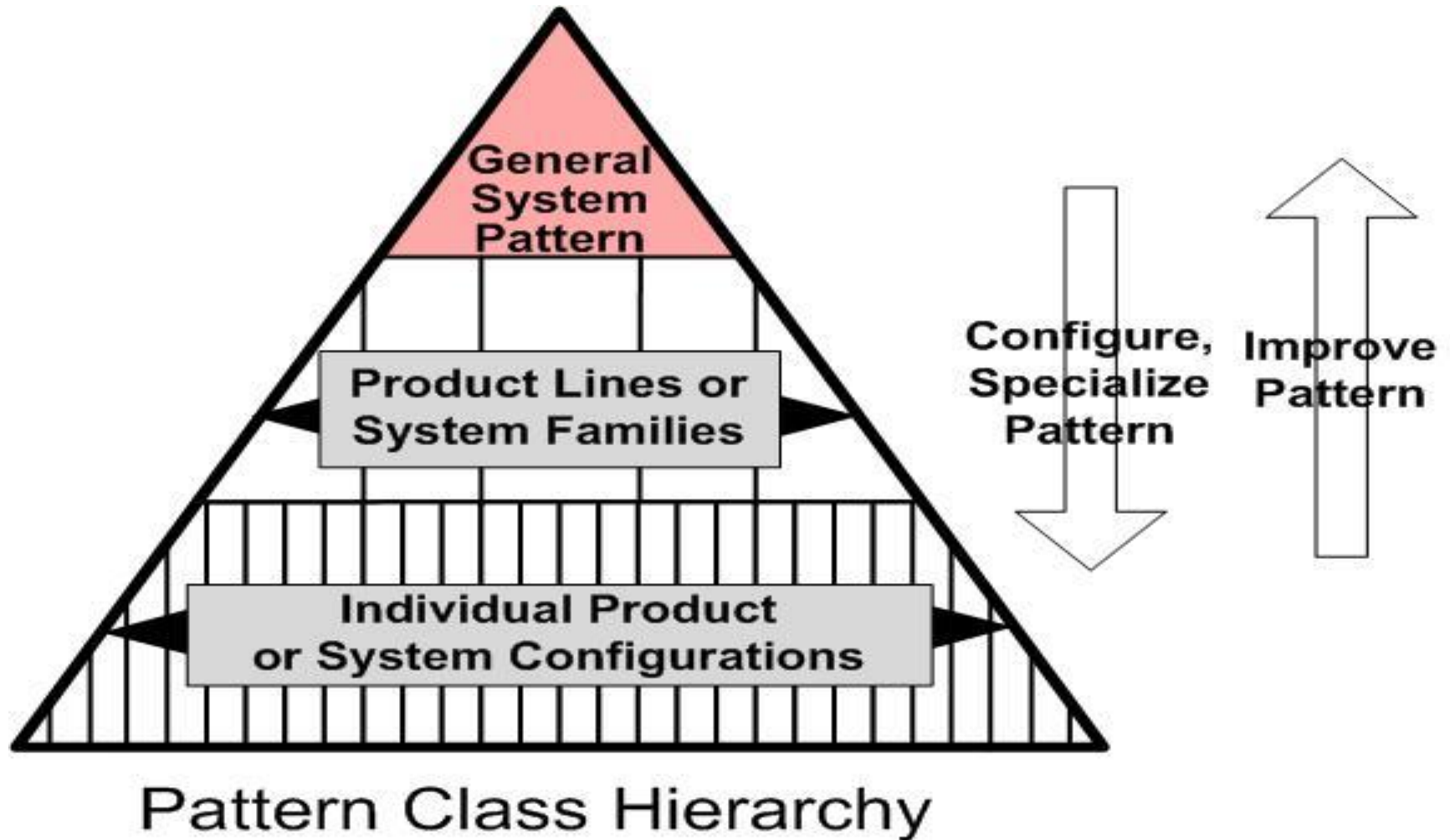# A Systems Engineering View of the Problem

- ➢ The delivery system challenge:
  - – Processes to deliver, install, and qualify changes to existing pharma packaging lines, which are themselves complex systems;
  - – Individual sites include differences in business practices, local support contractors, equipment, and other related processes.

- ➢ Understanding the delivery process as a configurable system in its own right:
  - – In this global program, we created systems engineering models of both the delivered system (what) and the delivery system (how).

Applying Systems Engineering Patterns

Pattern Class Hierarchy

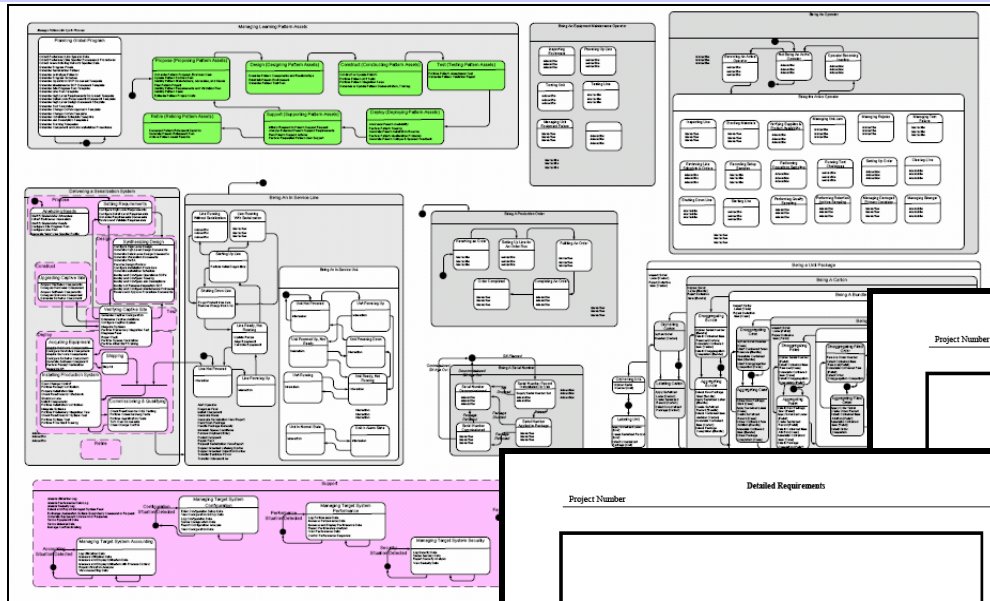# A Systems Engineering View of the Problem

➢ Common <u>design solution</u> content begins with common system <u>requirements</u>:

– Two different countries' solutions need to share at least some common <u>requirements</u> if they are to share some common <u>design</u>;

– Pattern of common requirements, configurable to local needs:

Pattern Class Hierarchy

Applying Systems Engineering Patterns
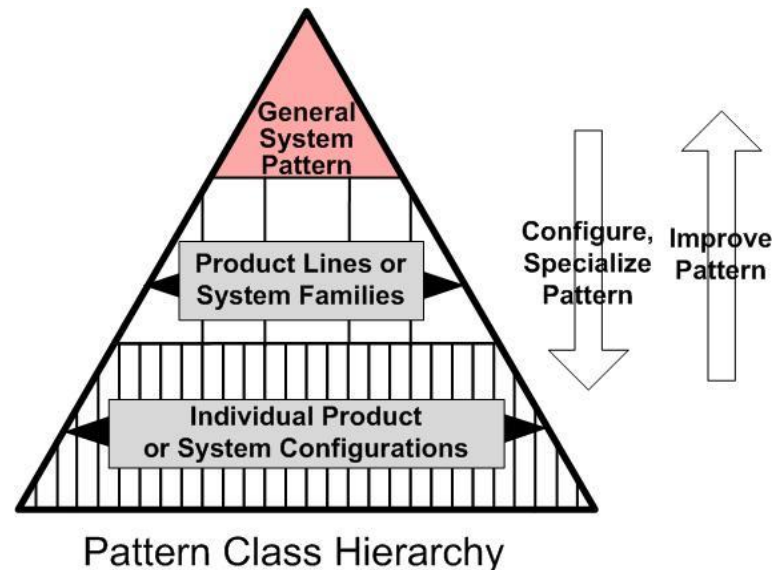
➢ Configurable Model-Based Requirements, Designs:

- – Lilly developed configurable Patterns for packaging systems and their delivery process;

- – Using Pattern-Based Systems Engineering (PBSE);

- – Patterns are configurable "Models" of requirements and designs;

- – These configurable models include multiple structured information components . . .

Applying Systems Engineering Patterns

Applying Systems Engineering Patterns

➢ Components of the configurable SE models:

– Domain Model: system boundary, diagram, external interfaces, actors;

– Stakeholder Feature Model: stakeholders, features, attributes;

– State Model: states, transitions, events;

– Interactions Model: Functional interactions, roles, attributes;

– System Requirements Model: Statements, attributes;

– Physical Architecture: physical components, relationships, attributes;

– Additional model components: Verification methods, etc.

Applying Systems Engineering Patterns

➤ # Pharma manufacturer's use of PBSE:

– Lilly-specific patterns are considered a proprietary IP asset, but . .

– The general methodology is more widely known, and illustrated by . . .

➤ # Simplified examples:

– <u>Feature</u>: **Package Serialization**—*The feature of generating labelled packages with unique serial number label data and matching information system records, in support of fraud reduction and other applications.*

– <u>State</u>: **Line Running**—*The operational state in which the packaging line is applying serialization data to packages.*

– <u>Interaction</u>: **Apply Package Label Data**—*The interaction of the packaging line with packages, during which label data is applied to the packages.*

– <u>Requirement</u>: *"The system shall apply package label data as indicated by the [Label Data Parameter and Format Table] to the package, at a line rate of up to [Max Packaging Line Rate]."*

Our Approach
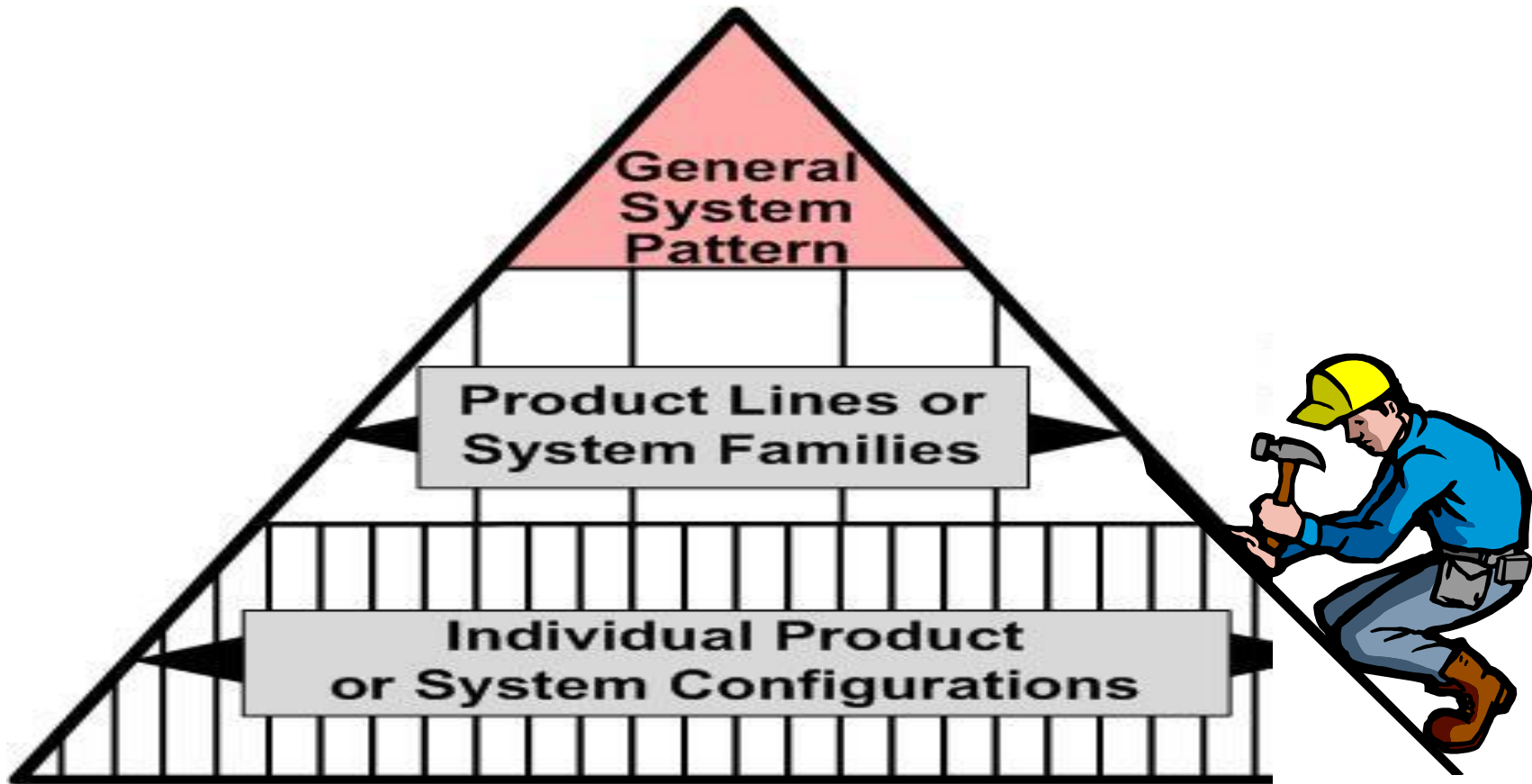
Our Approach

➢ Constructing patterns:

- The investment of effort to construct this pattern was on the same order of magnitude as the effort projected to specify a single packaging line;

- But, we obtained a re-usable pattern asset;

- This also helped leverage a global procurement process that might otherwise be addressed one purchase order at a time, increasing ability to leverage suppliers.

Our Approach

➢ Validating and applying patterns:

- – We validated the Packaging Serialization Pattern by using it to describe the requirements and design of a reconfigurable captive test packaging line;

- – Reviewed results by company engineers as well as system suppliers;

- – Pattern used to generate requirements for the RFP against which bidders wrote proposals, as the basis of contracts, and to generate acceptance tests;

- – Requirements were found to be significantly more complete than would have typically been delivered for a complex new system without using these techniques.

Our Approach

➤ Additional work:

  – Work still underway on the development and use of the configurable delivery process pattern.

  – Incorporation of learning into the pattern we plan to use **numerous** times.

References

1. Global supply chain standards: www.gs1.org

2. Schindel, W. 2005a. "Requirements statements are transfer functions: an insight from model-based systems engineering", *Proceedings of INCOSE 2005 Symposium*, July, 2005.

3. ---. 2005b. "Pattern-Based Systems Engineering: An Extension of Model-Based SE", INCOSE IS2005 Tutorial TIES 4.

4. Schindel, W., and Smith, V. 2002. "Results of applying a families-of-systems approach to systems engineering of product line families", SAE International, Technical Report 2002-01-3086, November, 2002.