CHAPTER 3:
THE ENHANCED E-R MODEL

Modern Database Management

12th Edition

Jeff Hoffer, Ramesh Venkataraman,
Heikki Topi

Copyright © 2016 Pearson Education, Inc.

OBJECTIVES

- Define terms
- Understand use of supertype/subtype relationships
- Use specialization and generalization techniques
- Specify completeness and disjointness constraints
- Develop supertype/subtype hierarchies for realistic business situations
- Develop entity clusters
- Explain universal (packaged) data model
- Describe special features of data modeling project using packaged data model

Copyright © 2016 Pearson Education, Inc.

SUPERTYPES AND SUBTYPES

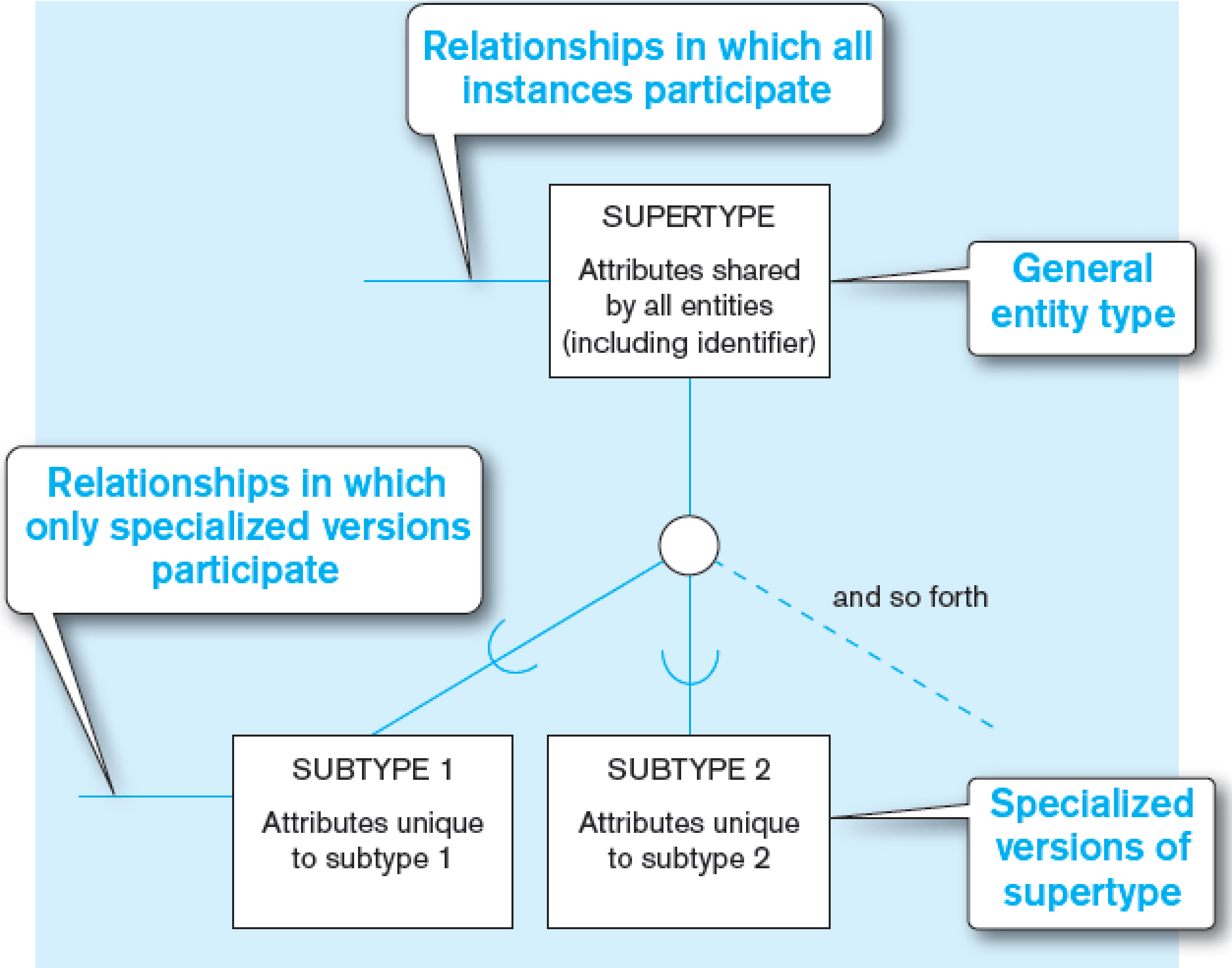
- Enhanced ER model: extends original ER model with new modeling constructs
- Subtype: A subgrouping of the entities in an entity type that has attributes distinct from those in other subgroupings
- Supertype: A generic entity type that has a relationship with one or more subtypes
- Attribute Inheritance:
  - Subtype entities inherit values of all attributes of the supertype
  - An instance of a subtype is also an instance of the supertype

Copyright © 2016 Pearson Education, Inc.

Figure 3-1 Basic notation for supertype/subtype notation

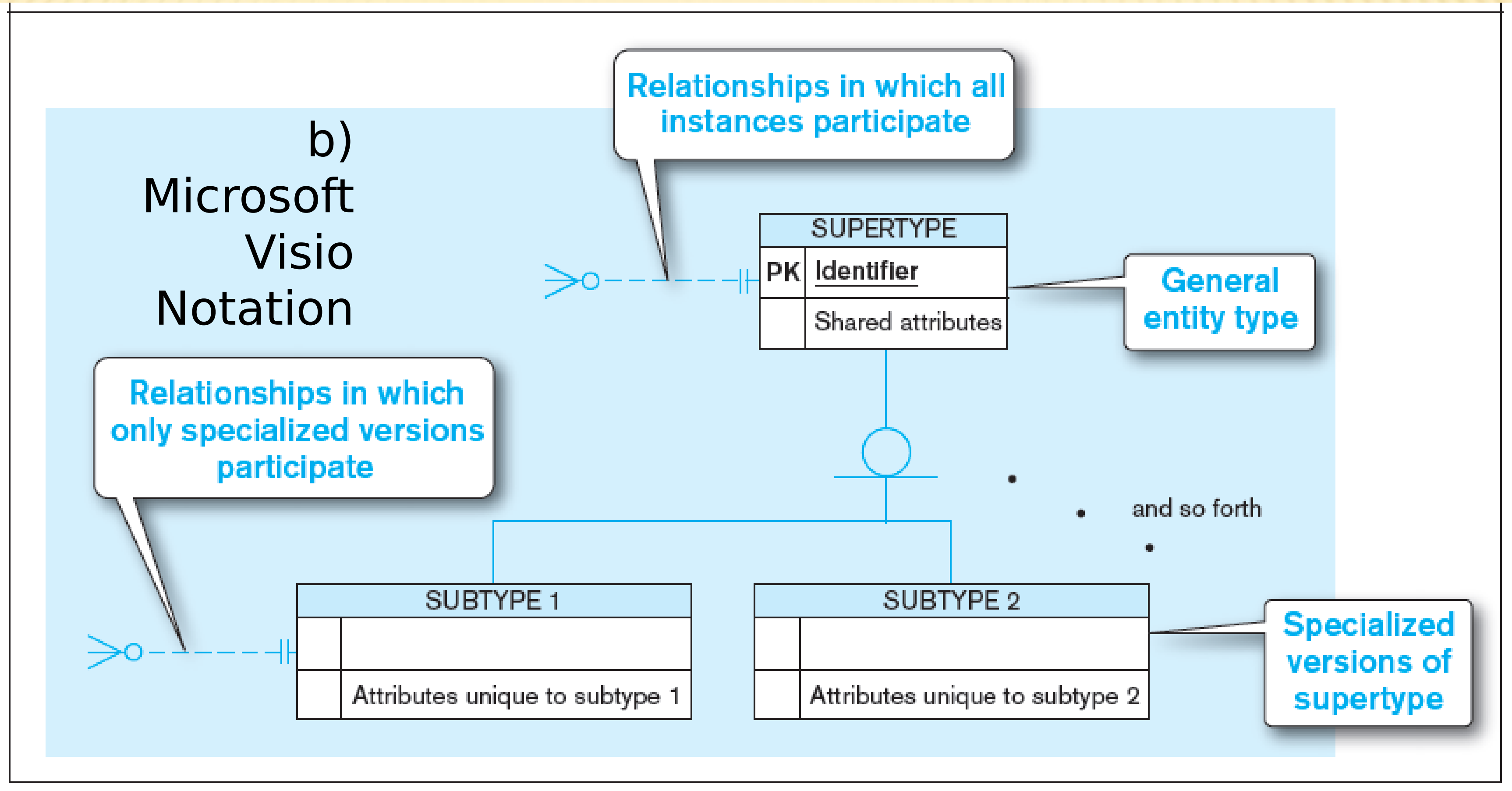
a) EER

notatio
n


Relationships in which all instances participate
SUPERTYPE
Attributes shared by all entities (including identifier)
General entity type
Relationships in which only specialized versions participate
and so forth
SUBTYPE 1
Attributes unique to subtype 1
SUBTYPE 2
Attributes unique to subtype 2
Specialized versions of supertype

Copyright © 2016 Pearson Education, Inc.

Figure 3-1 Basic notation for supertype/subtype notation (cont.)



b) Microsoft Visio Notation

Relationships in which all instances participate

General entity type

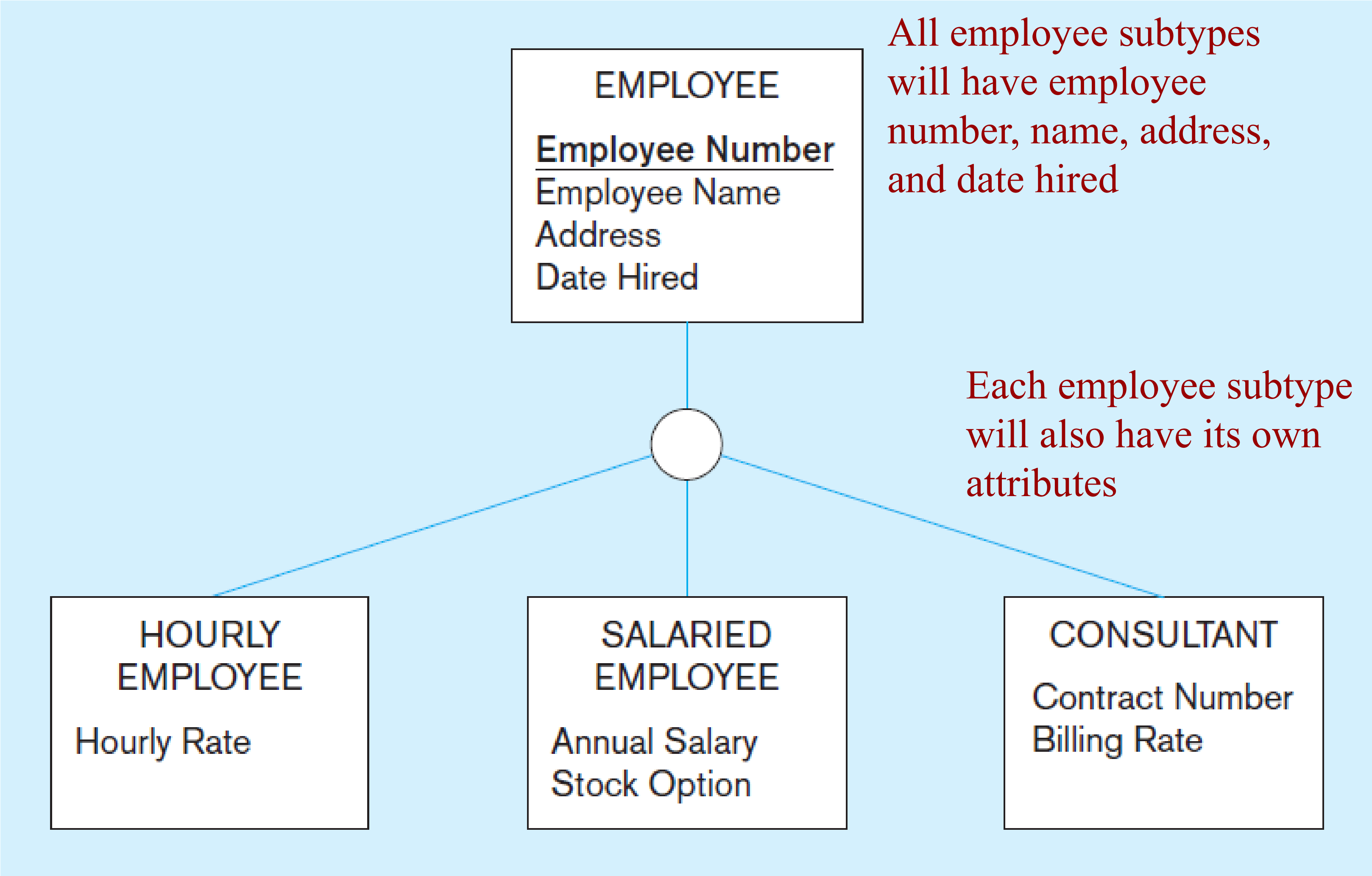
Relationships in which only specialized versions participate

Specialized versions of supertype

Different modeling tools may have different notation for the same modeling constructs.

Copyright © 2016 Pearson Education, Inc.

Figure 3-2 Employee supertype with three subtypes



All employee subtypes will have employee number, name, address, and date hired

Each employee subtype will also have its own attributes

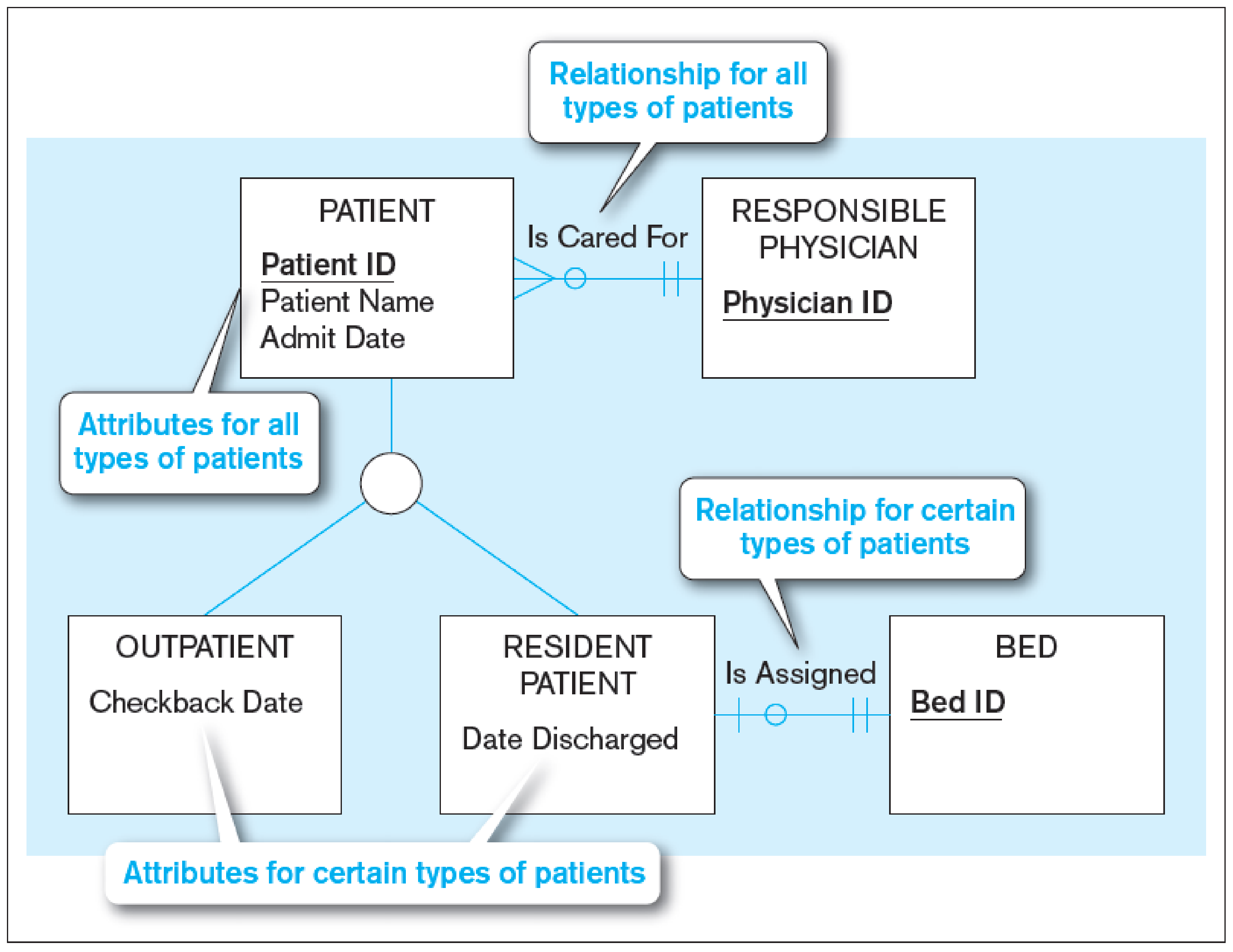
Copyright © 2016 Pearson Education, Inc.

RELATIONSHIPS AND SUBTYPES

- Relationships at the ***supertype*** level indicate that all subtypes will participate in the relationship
- The instances of a ***subtype*** may participate in a relationship unique to that subtype. In this situation, the relationship is shown at the subtype level

Copyright © 2016 Pearson Education, Inc.

Figure 3-3 Supertype/subtype relationships in a hospital



Copyright © 2016 Pearson Education, Inc.

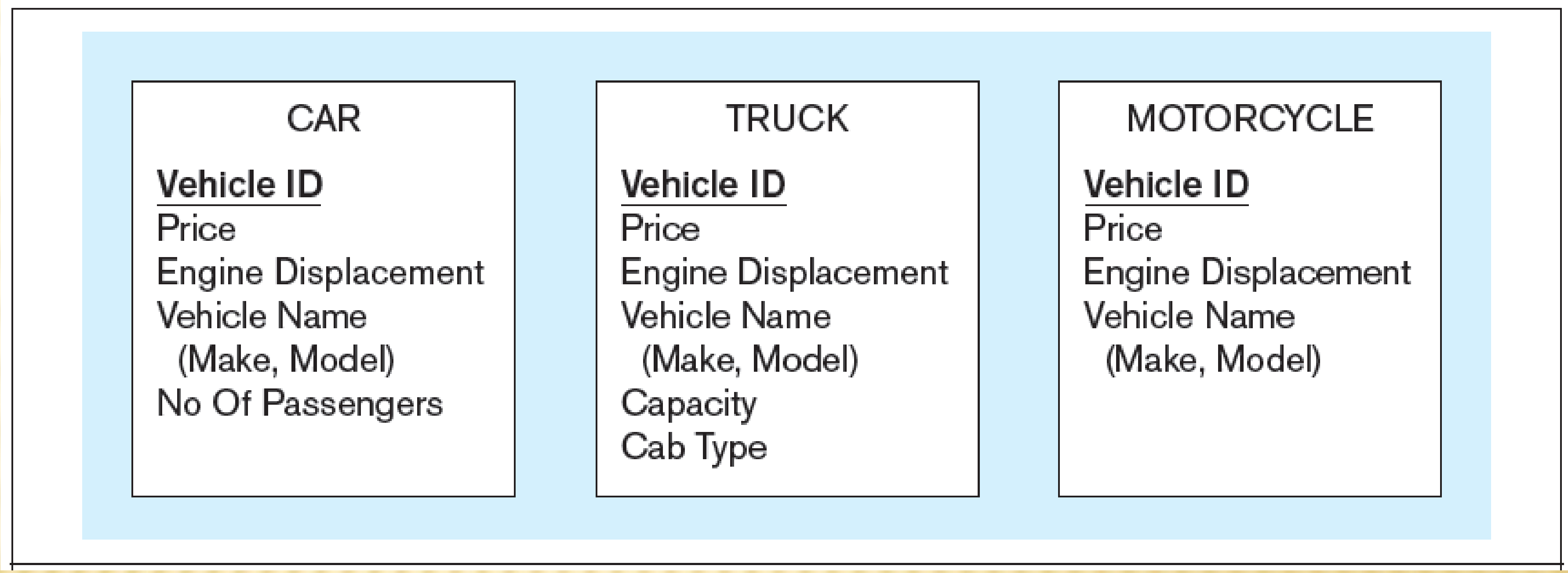
GENERALIZATION AND SPECIALIZATION

- ***Generalization:*** The process of defining a more general entity type from a set of more specialized entity types. BOTTOM-UP
- ***Specialization:*** The process of defining one or more subtypes of the supertype and forming supertype/subtype relationships. TOP-DOWN

Copyright © 2016 Pearson Education, Inc.

Figure 3-4 Example of generalization

a) Three entity types: CAR, TRUCK, and MOTORCYCLE



CAR

<u>Vehicle ID</u>
Price
Engine Displacement
Vehicle Name
(Make, Model)
No Of Passengers

TRUCK

<u>Vehicle ID</u>
Price
Engine Displacement
Vehicle Name
(Make, Model)
Capacity
Cab Type

MOTORCYCLE

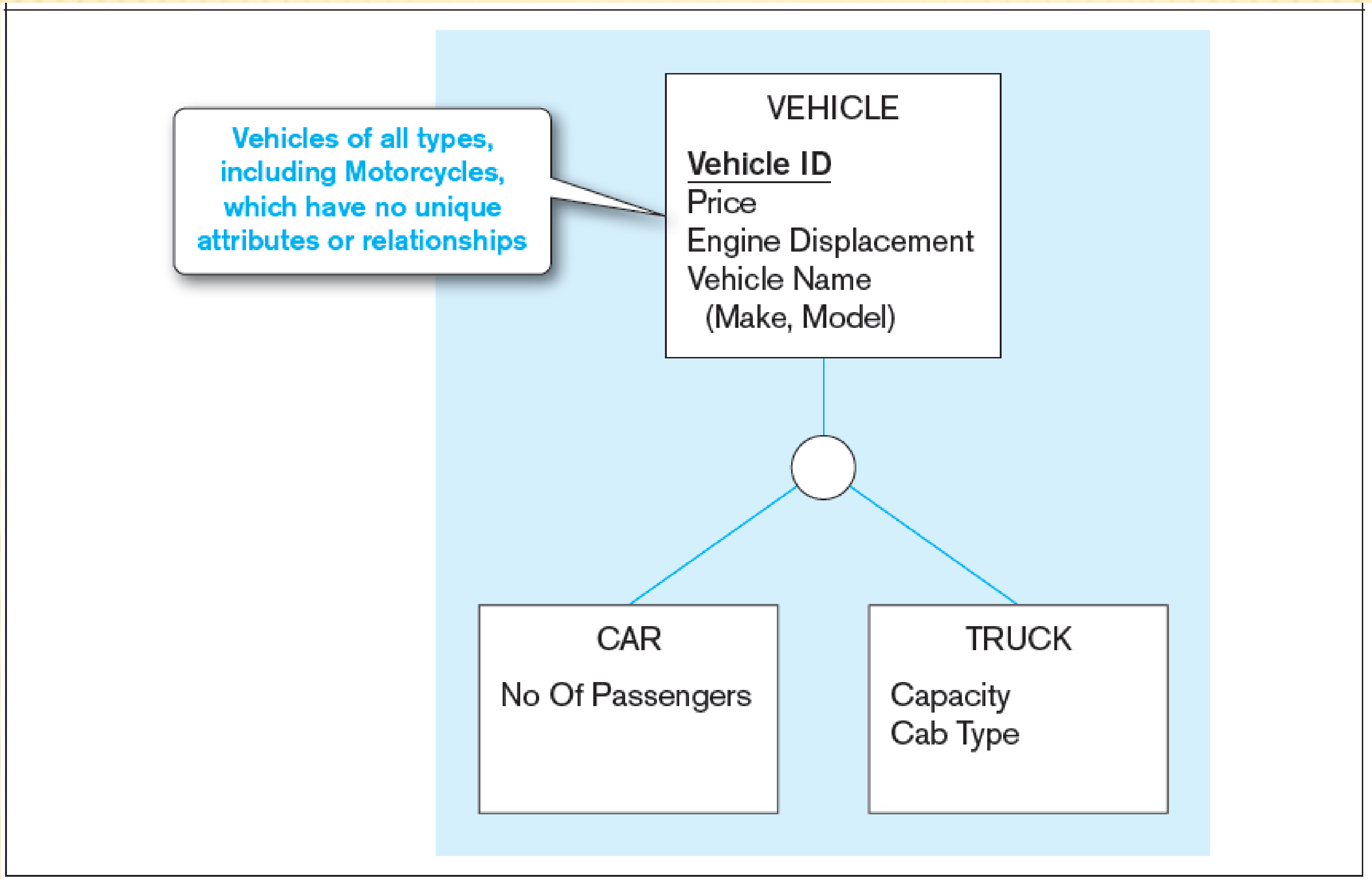
<u>Vehicle ID</u>
Price
Engine Displacement
Vehicle Name
(Make, Model)

All these types of vehicles have common attributes

Copyright © 2016 Pearson Education, Inc.

Figure 3-4 Example of generalization (cont.)

b) Generalization to VEHICLE supertype



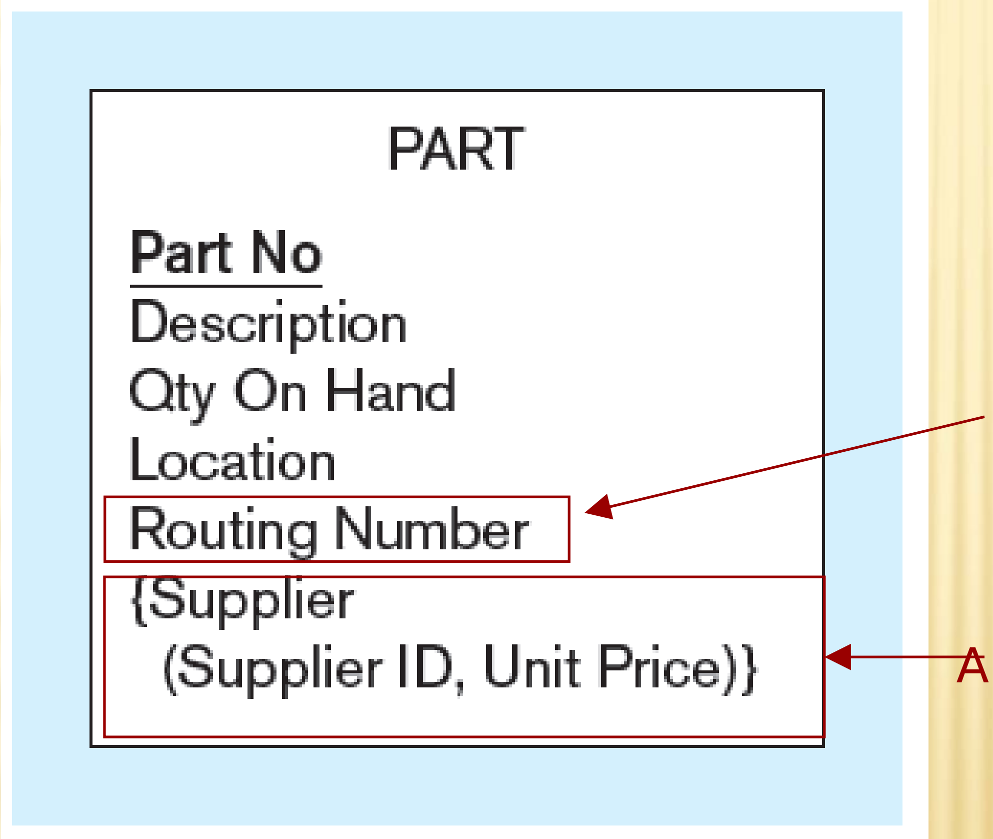
So we put the shared attributes in a supertype

Note: no subtype for motorcycle, since it has no unique attributes

Copyright © 2016 Pearson Education, Inc.

Figure 3-5 Example of specialization

a) Entity type PART

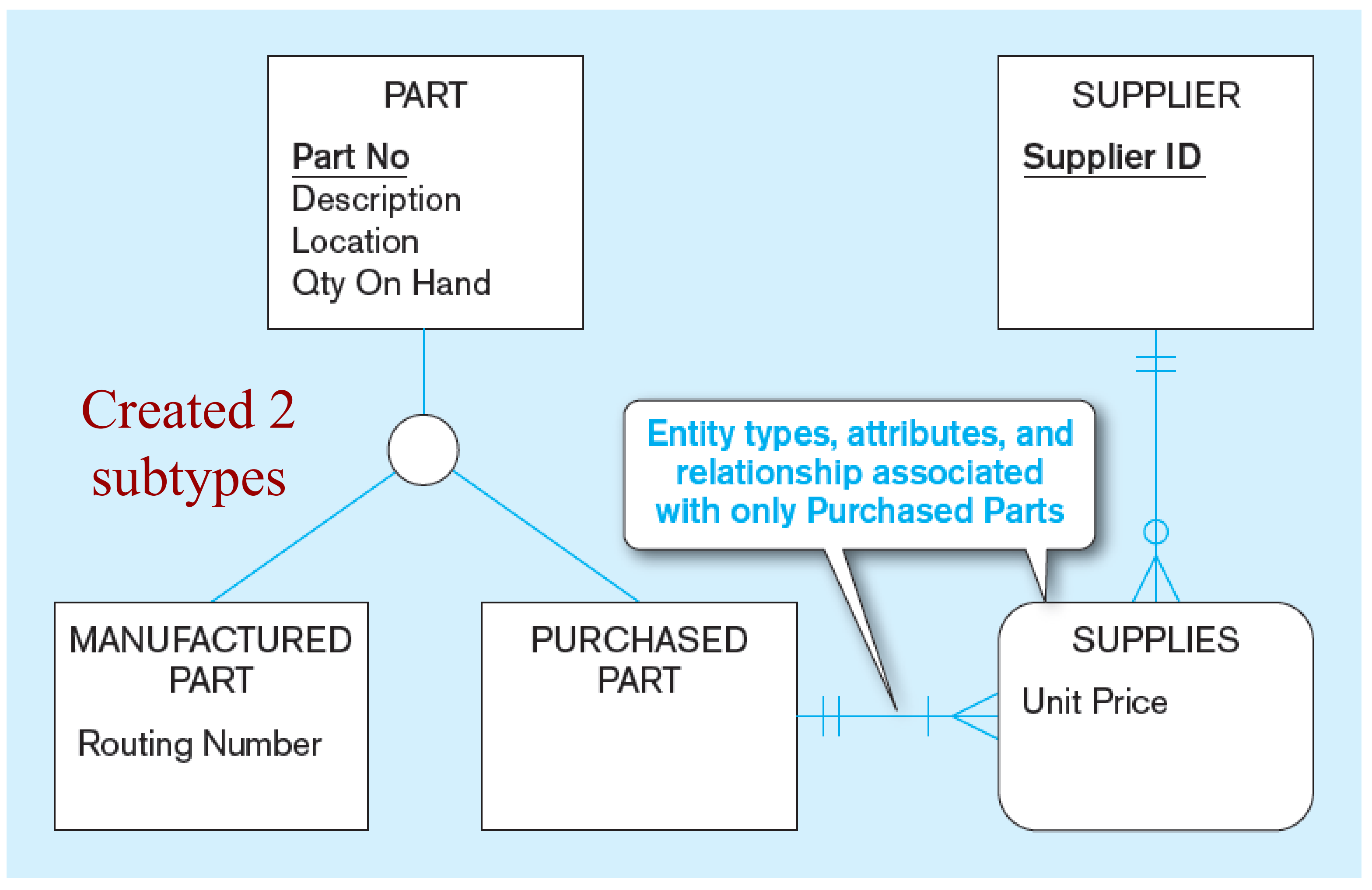


Only applies to manufactured parts

Applies only to purchased parts

Figure 3-5 Example of specialization (cont.)

b) Specialization to MANUFACTURED PART and PURCHASED PART



Entity types, attributes, and relationship associated with only Purchased Parts

Created 2 subtypes

Note: multivalued composite attribute was replaced by an associative entity relationship to another entity

Copyright © 2016 Pearson Education, Inc.

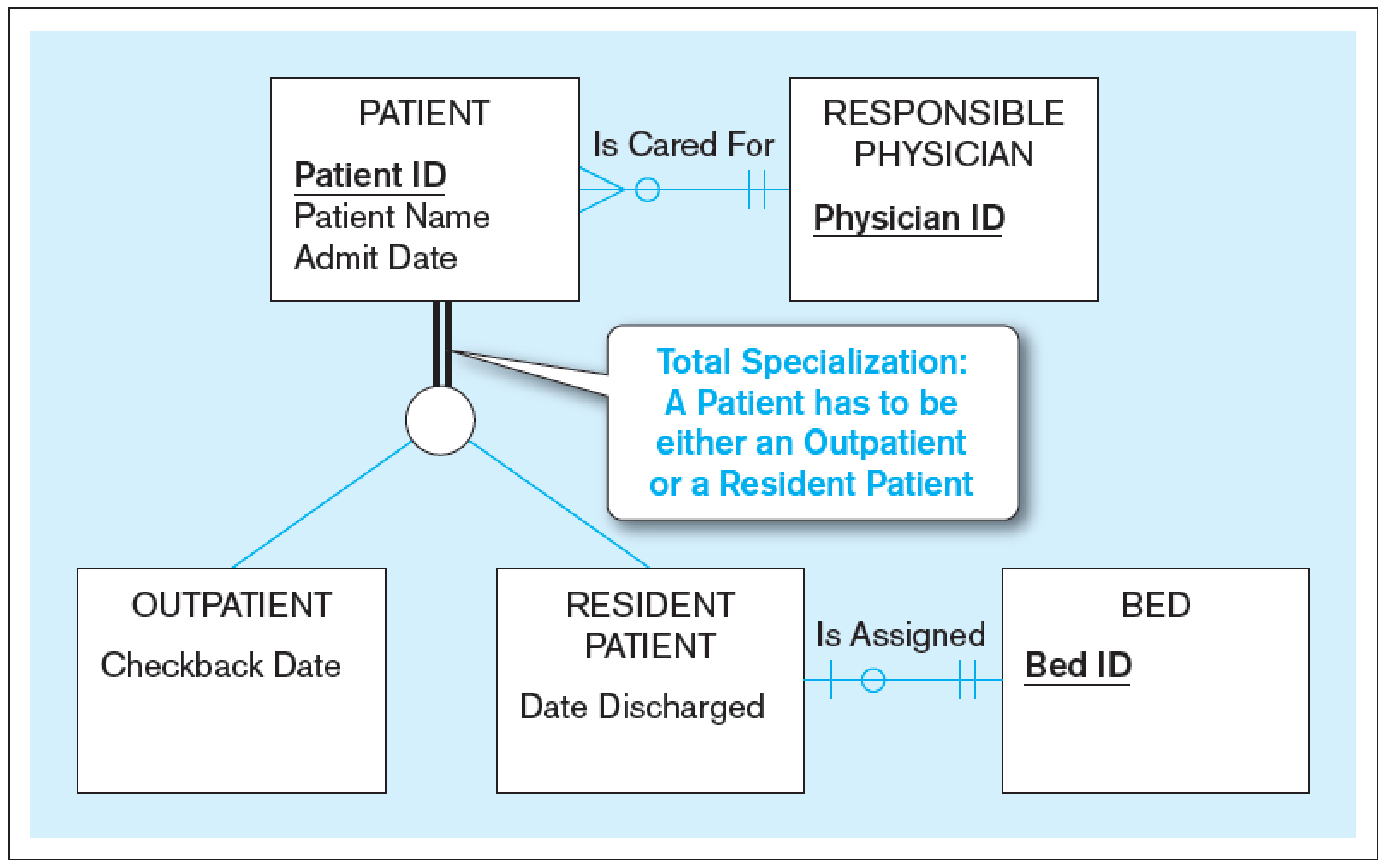
CONSTRAINTS IN SUPERTYPE/SUBTYPE RELATIONSHIPS

- ***Completeness Constraints***: Whether an instance of a supertype ***must*** also be a member of at least one subtype
  - Total Specialization Rule: Yes (double line)
  - Partial Specialization Rule: No (single line)

Copyright © 2016 Pearson Education, Inc.

Figure 3-6 Examples of completeness constraints

a) Total specialization rule

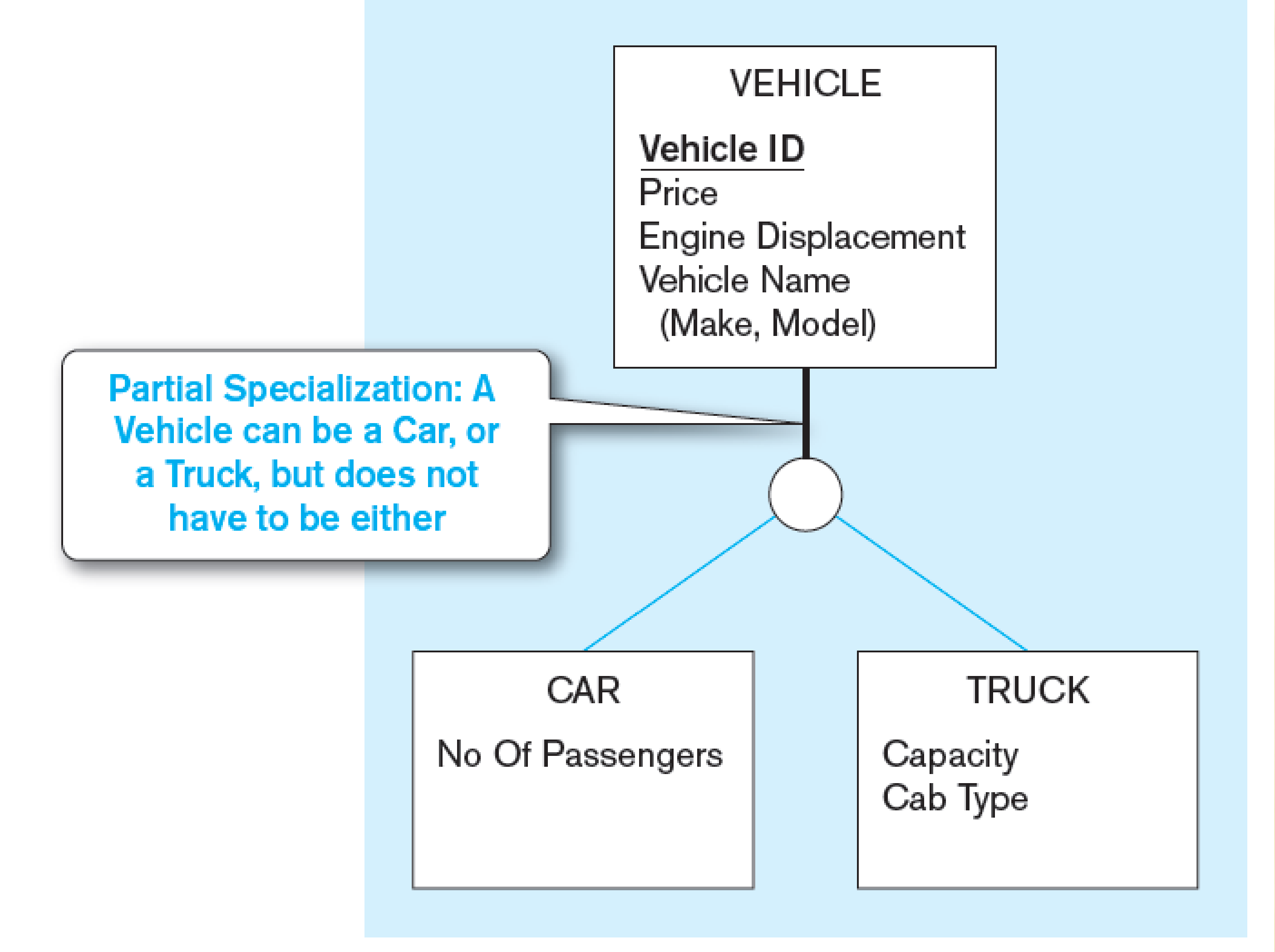


Total Specialization: A Patient has to be either an Outpatient or a Resident Patient

Copyright © 2016 Pearson Education, Inc.

Figure 3-6 Examples of completeness constraints (cont.)

b) Partial specialization rule



Copyright © 2016 Pearson Education, Inc.

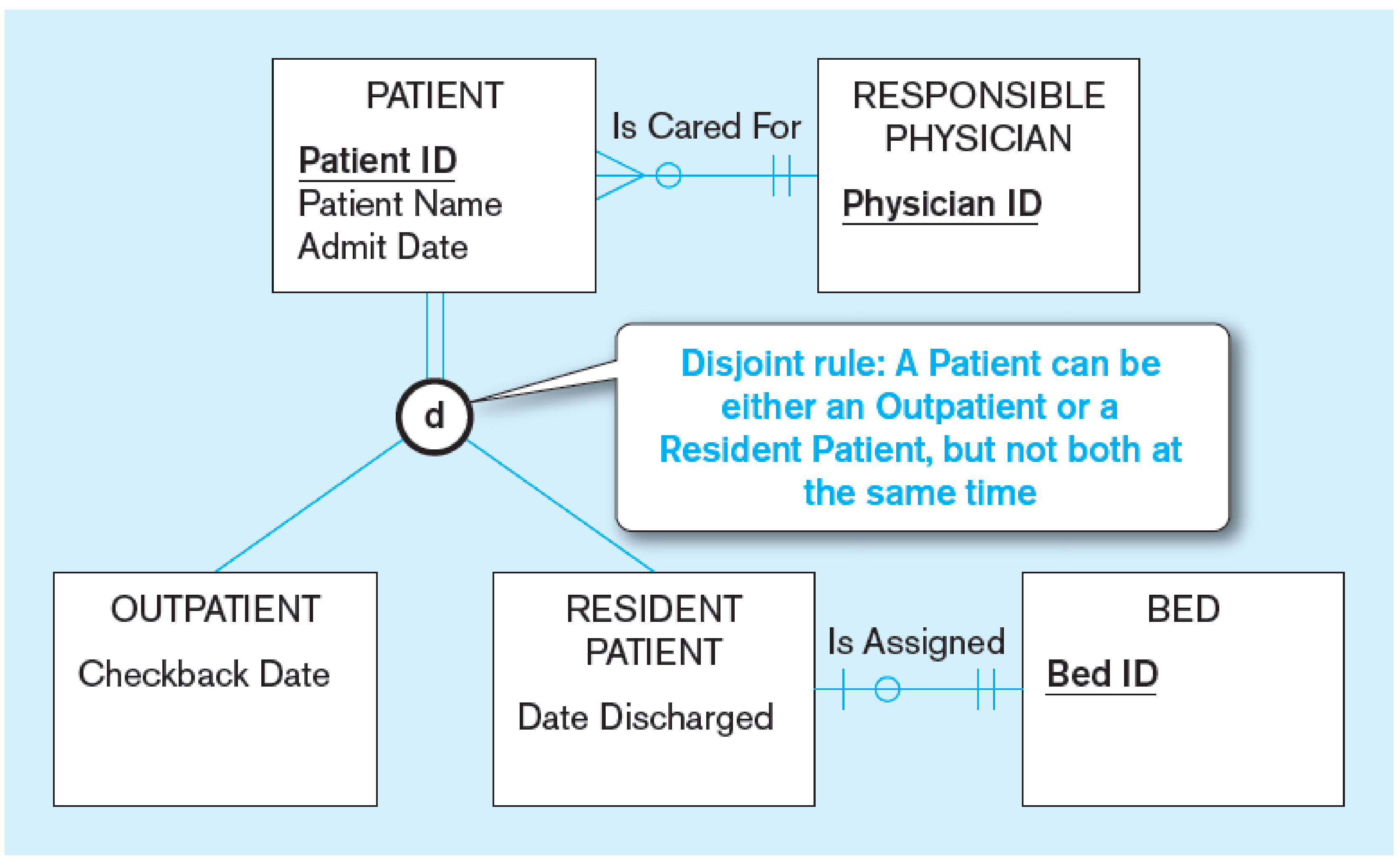
CONSTRAINTS IN SUPERTYPE/SUBTYPE RELATIONSHIPS

- ***Disjointness Constraints***: Whether an instance of a supertype may *simultaneously* be a member of two (or more) subtypes
  - Disjoint Rule: An instance of the supertype can be only ONE of the subtypes
  - Overlap Rule: An instance of the supertype could be more than one of the subtypes

Copyright © 2016 Pearson Education, Inc.

Figure 3-7 Examples of disjointness constraints

a) Disjoint rule

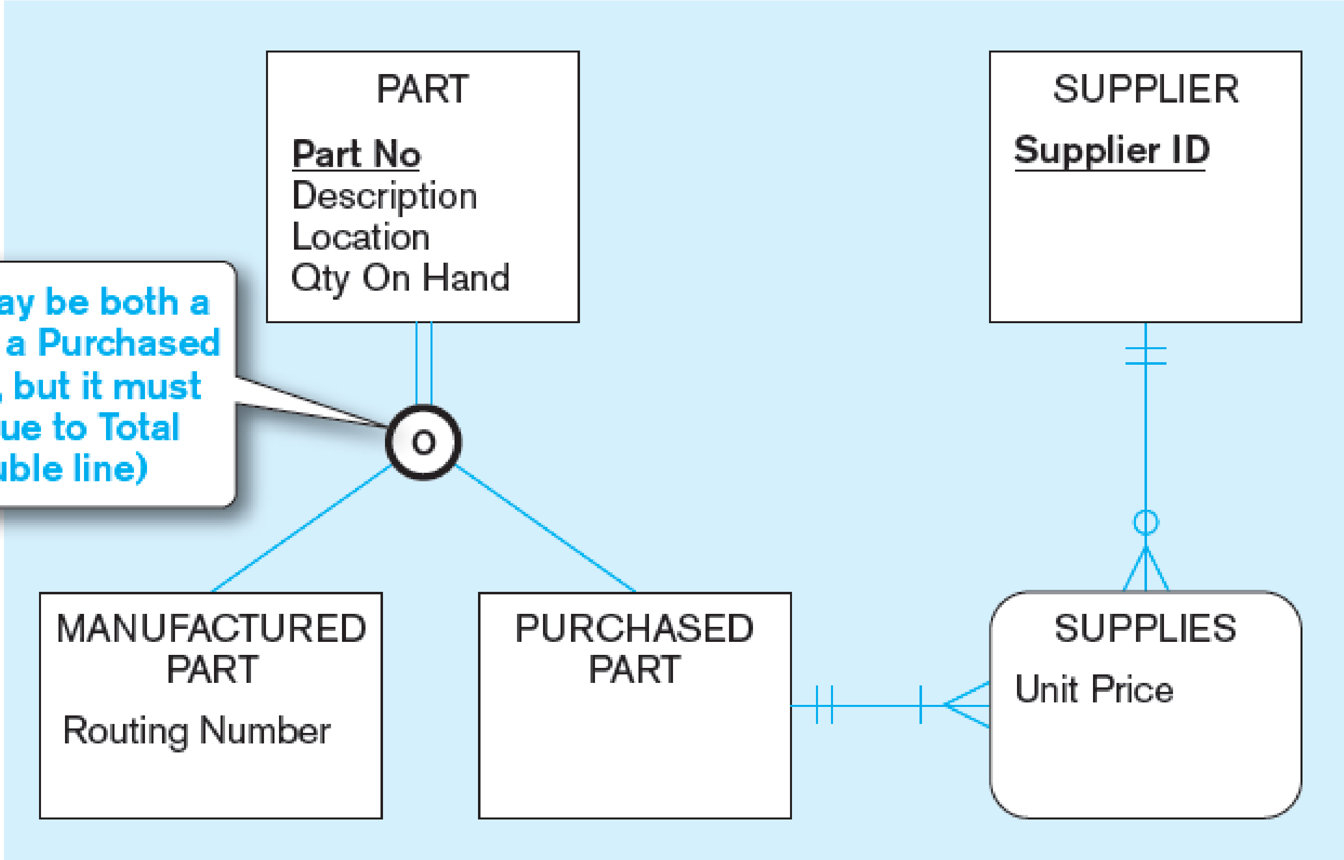


Disjoint rule: A Patient can be either an Outpatient or a Resident Patient, but not both at the same time

Copyright © 2016 Pearson Education, Inc.

Figure 3-7 Examples of disjointness constraints (cont.)

b) Overlap rule



Overlap rule: A Part may be both a Manufactured Part and a Purchased Part at the same time, but it must be one or the other due to Total Specialization (double line)

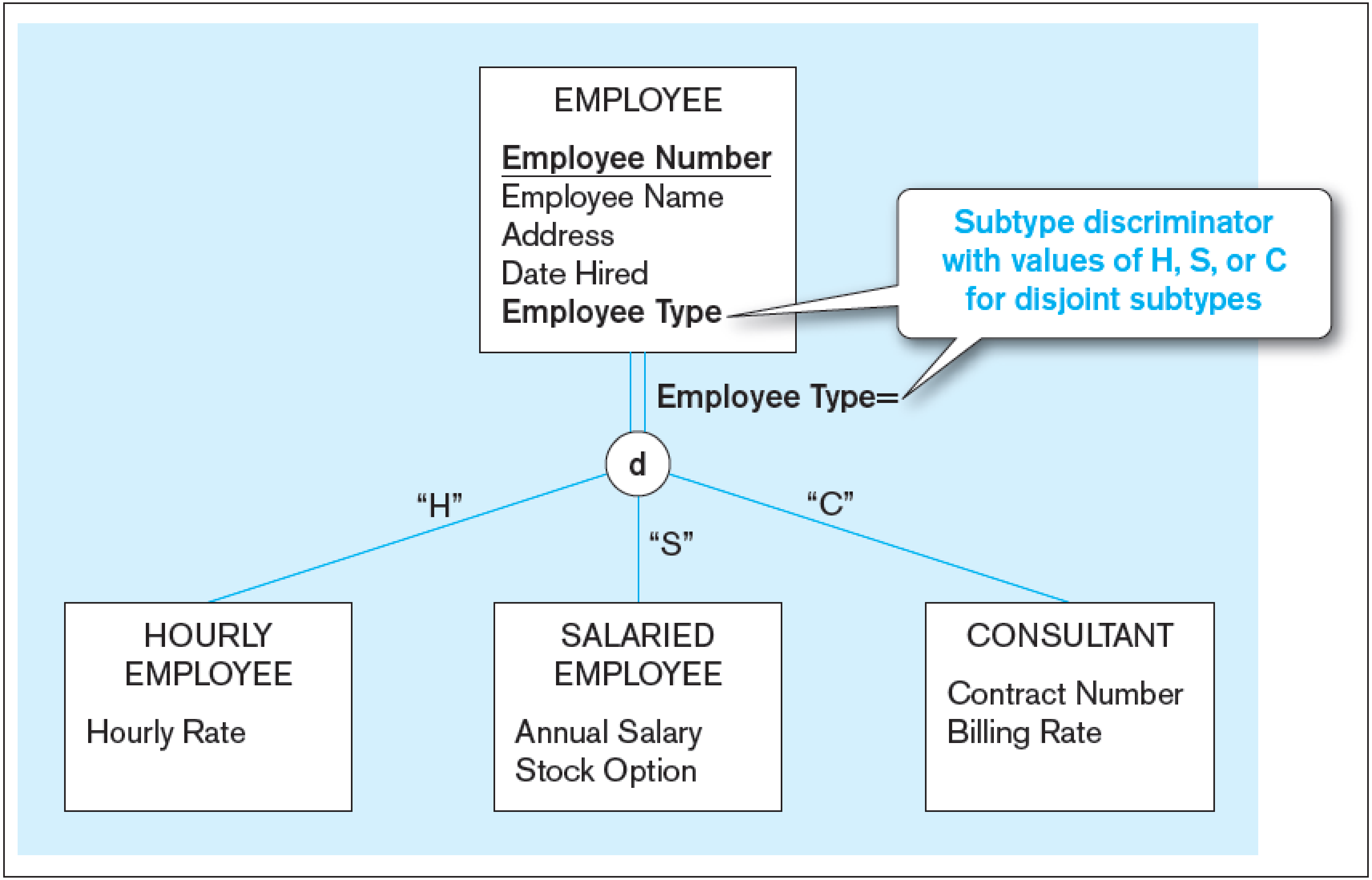
Copyright © 2016 Pearson Education, Inc.

CONSTRAINTS IN SUPERTYPE/SUBTYPE RELATIONSHIPS

- ***Subtype Discriminator***: An attribute of the supertype whose values determine the target subtype(s)
  - **Disjoint** – a *simple* attribute with alternative values to indicate the possible subtypes
  - **Overlapping** – a *composite* attribute whose subparts pertain to different subtypes. Each subpart contains a Boolean value to indicate whether or not the instance belongs to the associated subtype

Copyright © 2016 Pearson Education, Inc.

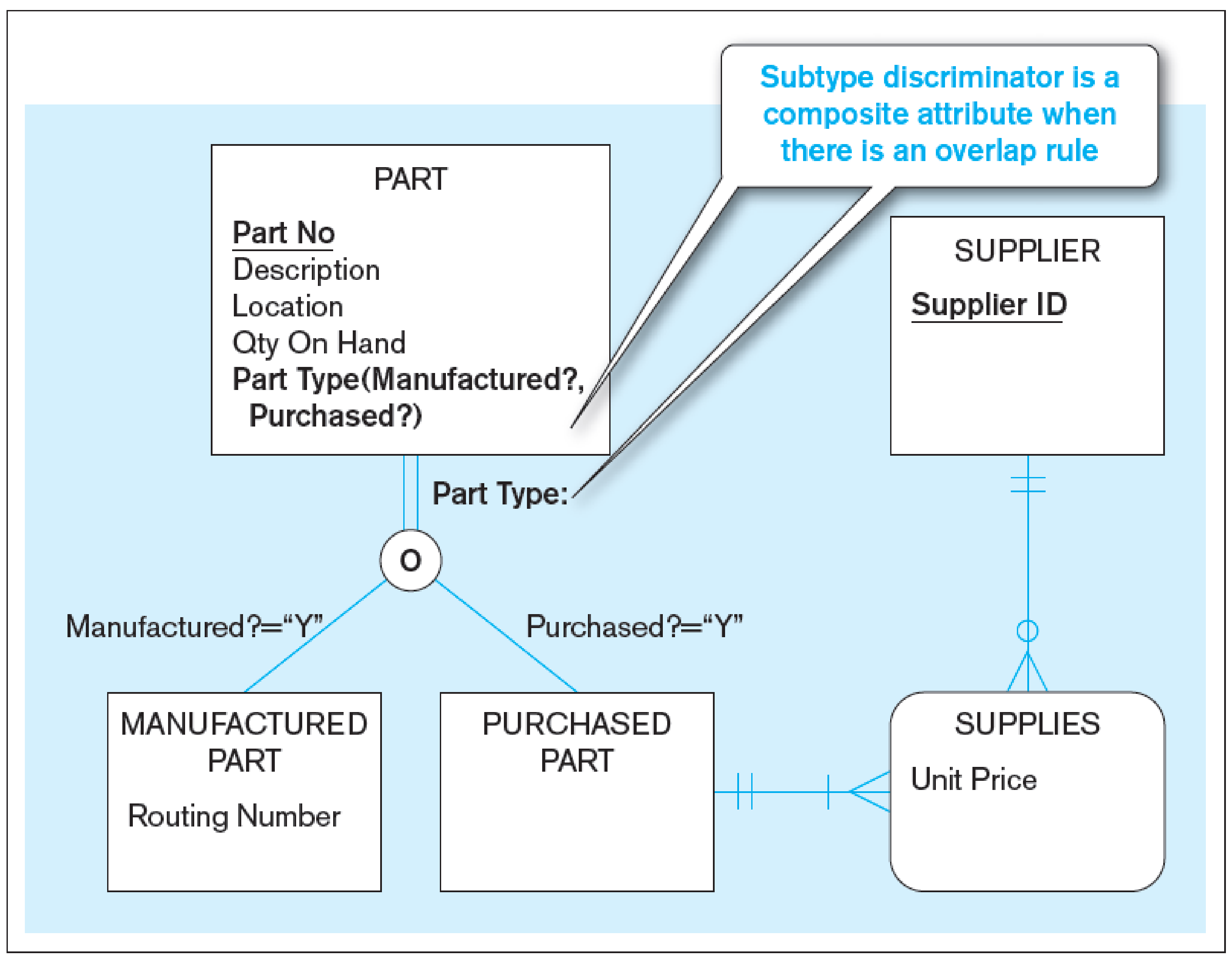
Figure 3-8 Introducing a subtype discriminator (***disjoint*** rule)



Subtype discriminator with values of H, S, or C for disjoint subtypes

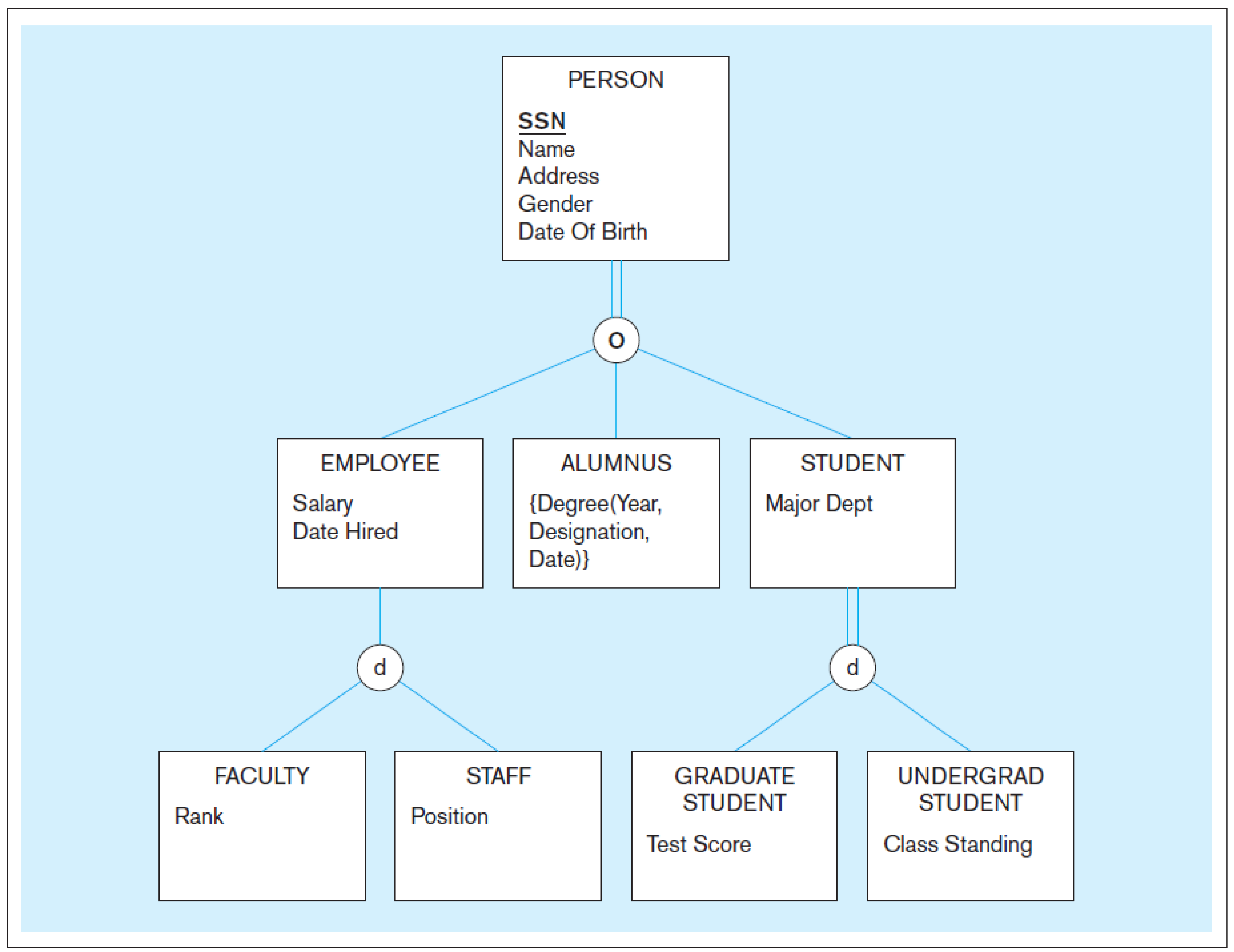
Copyright © 2016 Pearson Education, Inc.

Figure 3-9 Subtype discriminator (***overlap*** rule)



Copyright © 2016 Pearson Education, Inc.

Figure 3-10 Example of supertype/subtype hierarchy



Copyright © 2016 Pearson Education, Inc.

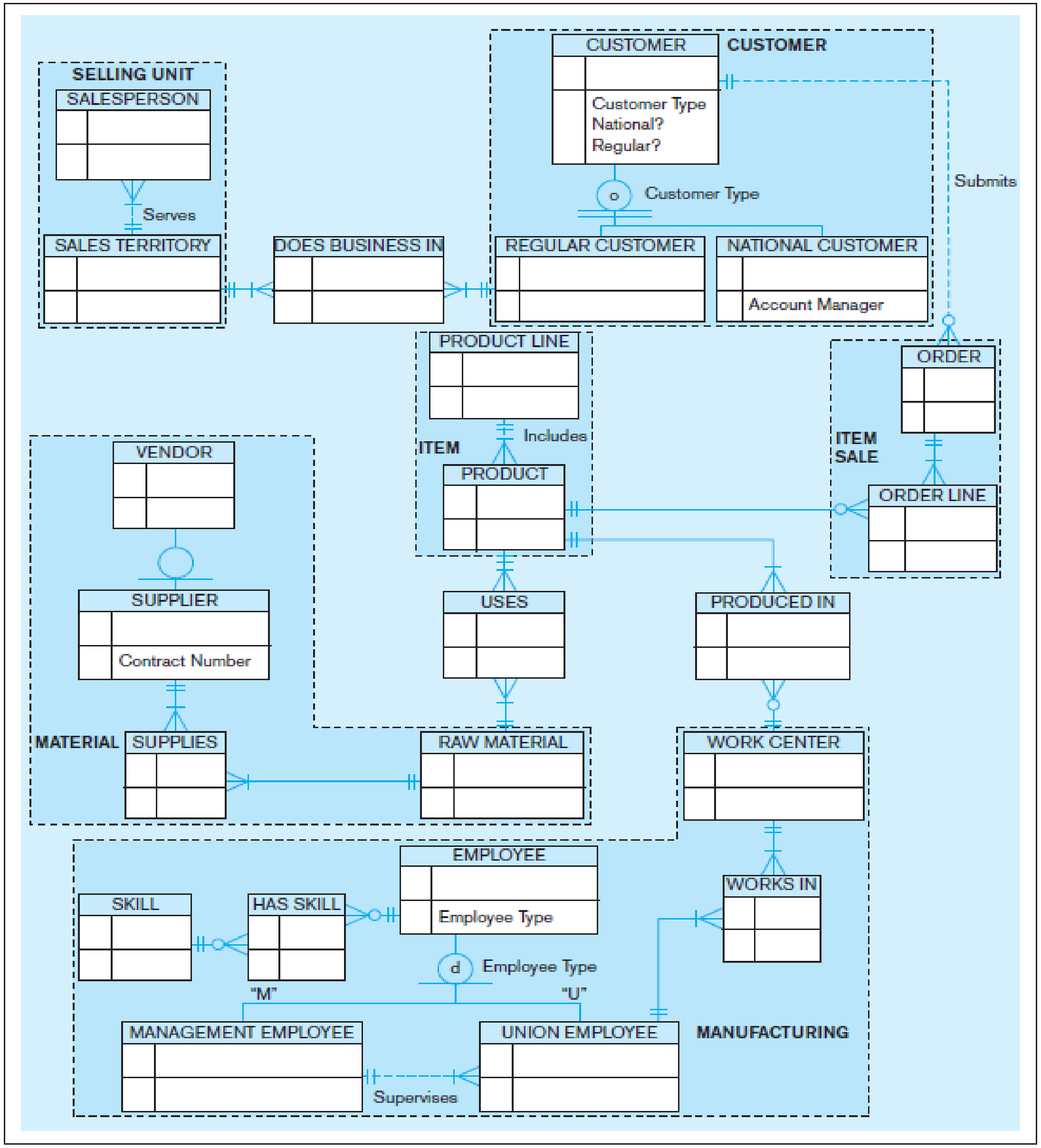
ENTITY CLUSTERS

- EER diagrams are difficult to read when there are too many entities and relationships.
- Solution: Group entities and relationships into ***entity clusters.***
- **Entity cluster**: Set of one or more entity types and associated relationships grouped into a single abstract entity type

Copyright © 2016 Pearson Education, Inc.

Figure 3-13a

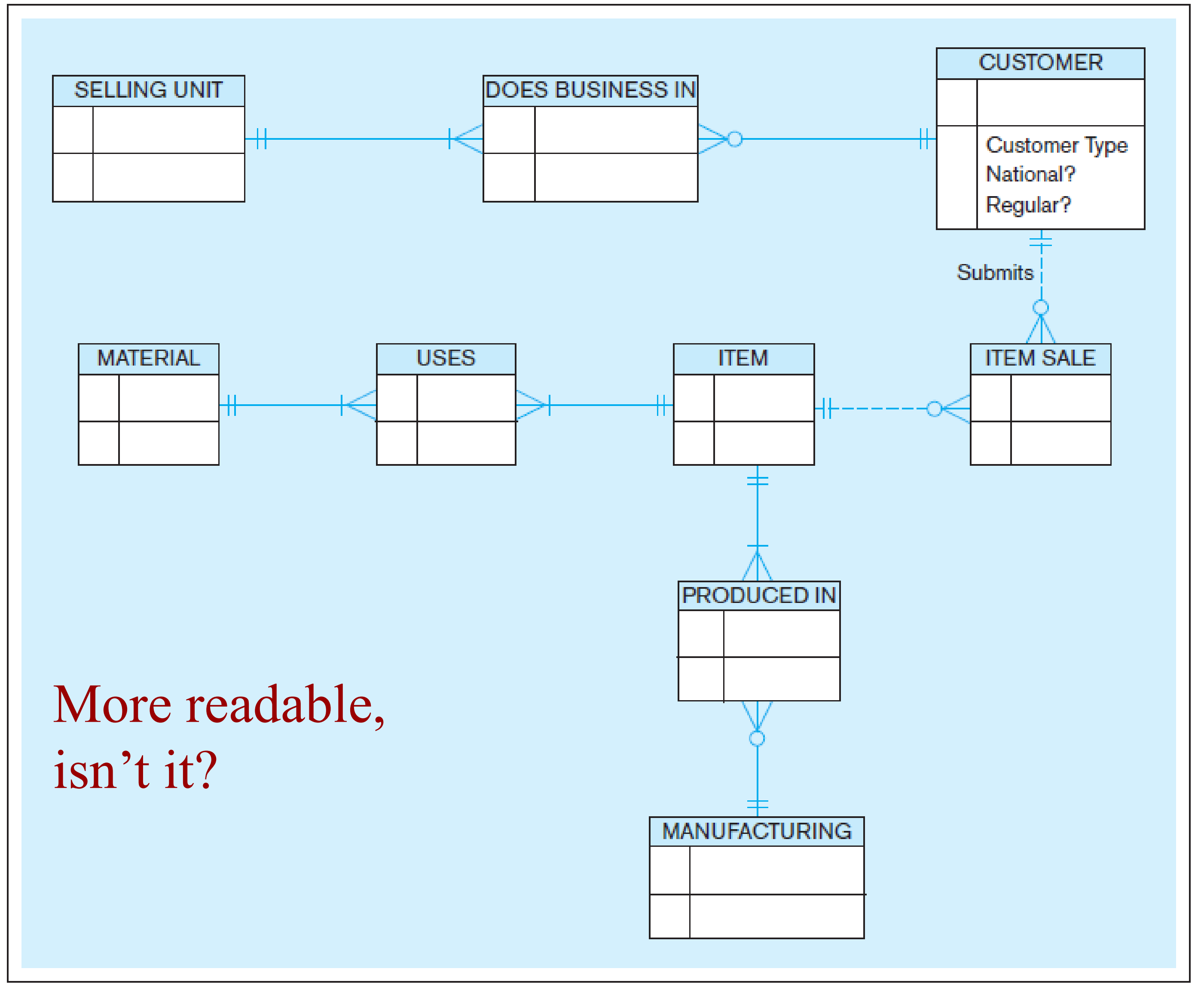
Possible entity clusters for Pine Valley Furniture in Microsoft Visio



Related groups of entities could become clusters

Copyright © 2016 Pearson Education, Inc.

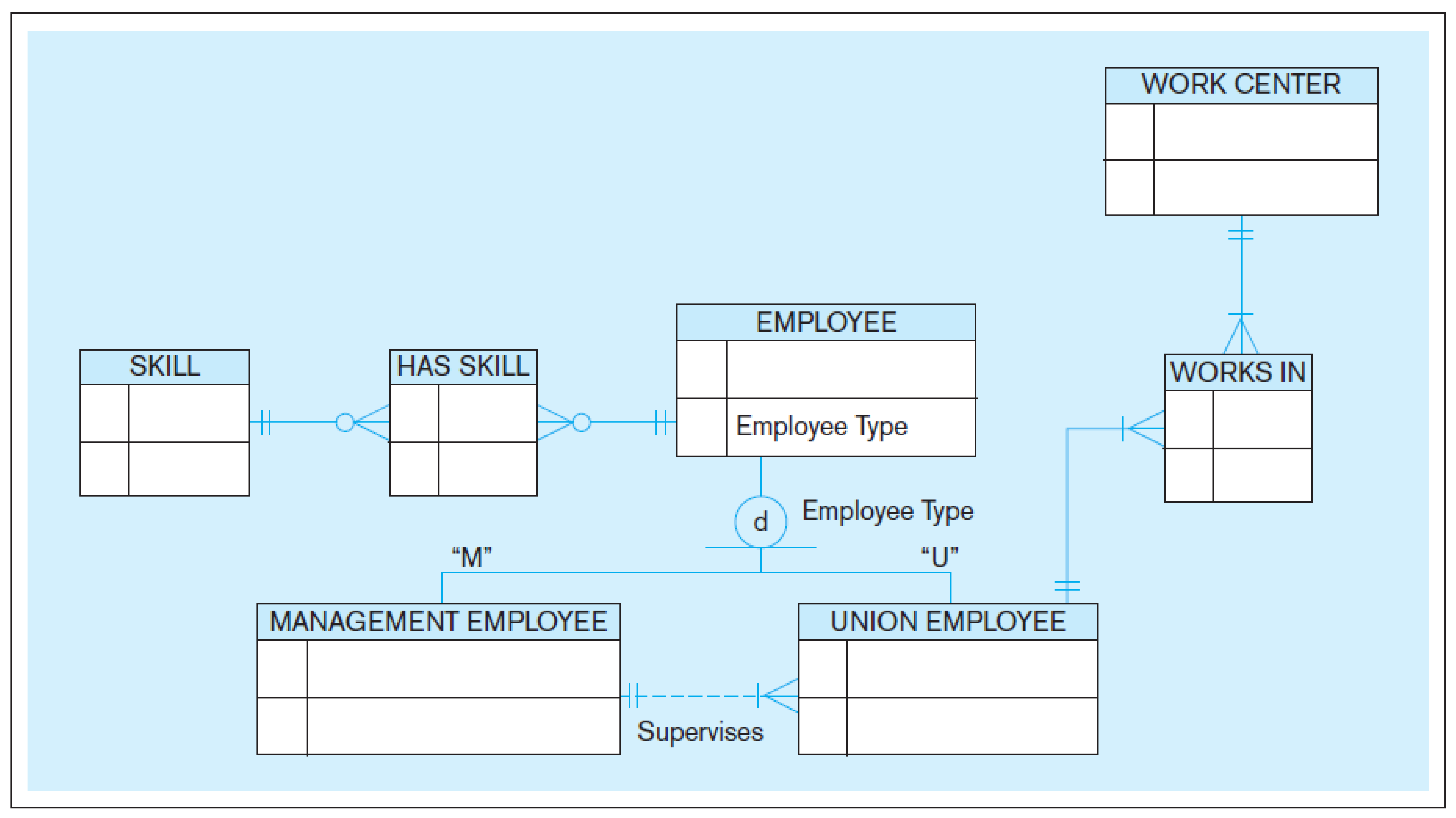
Figure 3-13b EER diagram of PVF entity clusters



More readable, isn’t it?

Copyright © 2016 Pearson Education, Inc.

Figure 3-14 Manufacturing entity cluster



Detail for a single cluster

Copyright © 2016 Pearson Education, Inc.

PACKAGED DATA MODELS

- Predefined data models
- Could be universal or industry-specific
- Universal data model = a generic or template data model that can be reused as a starting point for a data modeling project (also called a "pattern")

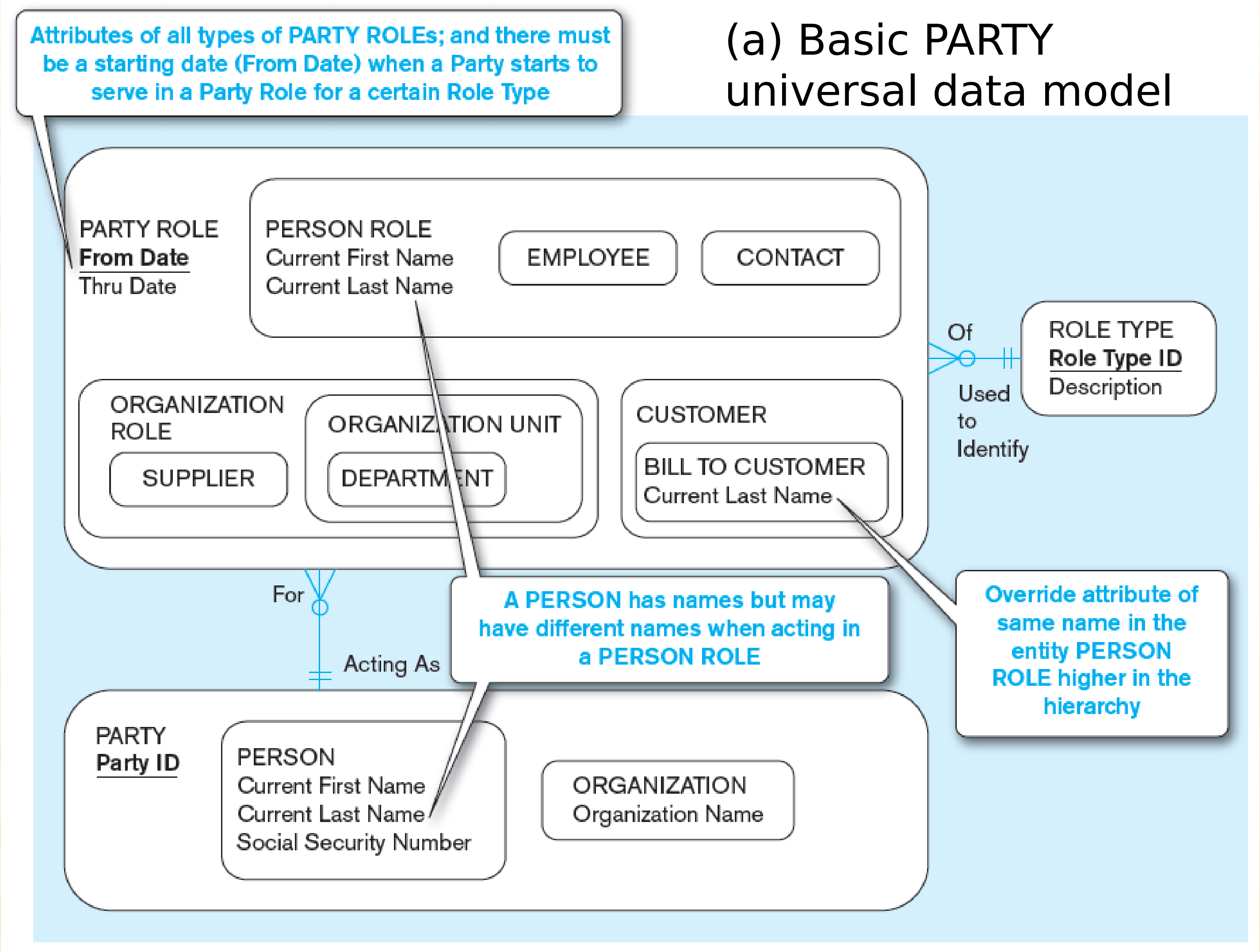
Copyright © 2016 Pearson Education, Inc.

ADVANTAGES OF PACKAGED DATA MODELS

- Use proven model components
- Save time and cost
- Less likelihood of data model errors
- Easier to evolve and modify over time
- Aid in requirements determination
- Easier to read
- Supertype/subtype hierarchies promote reuse
- Many-to-many relationships enhance model flexibility
- Vendor-supplied data model fosters integration with vendor's applications
- Universal models support inter-organizational systems

Copyright © 2016 Pearson Education, Inc.

Figure 3-15 PARTY, PARTY ROLE, and ROLE TYPE in a universal data model



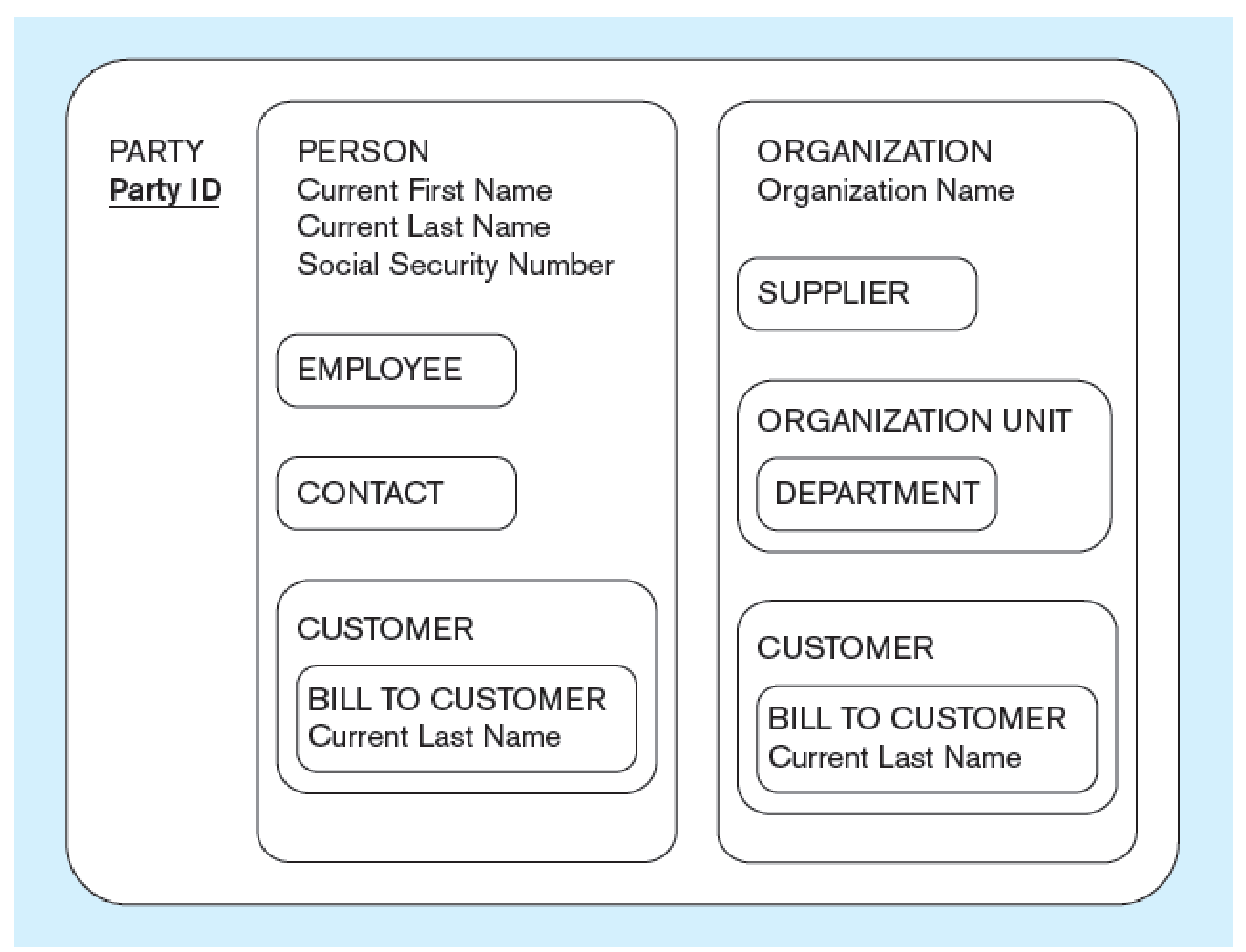
(a) Basic PARTY universal data model

Packaged data models are generic models that can be customized for a particular organization's business rules.

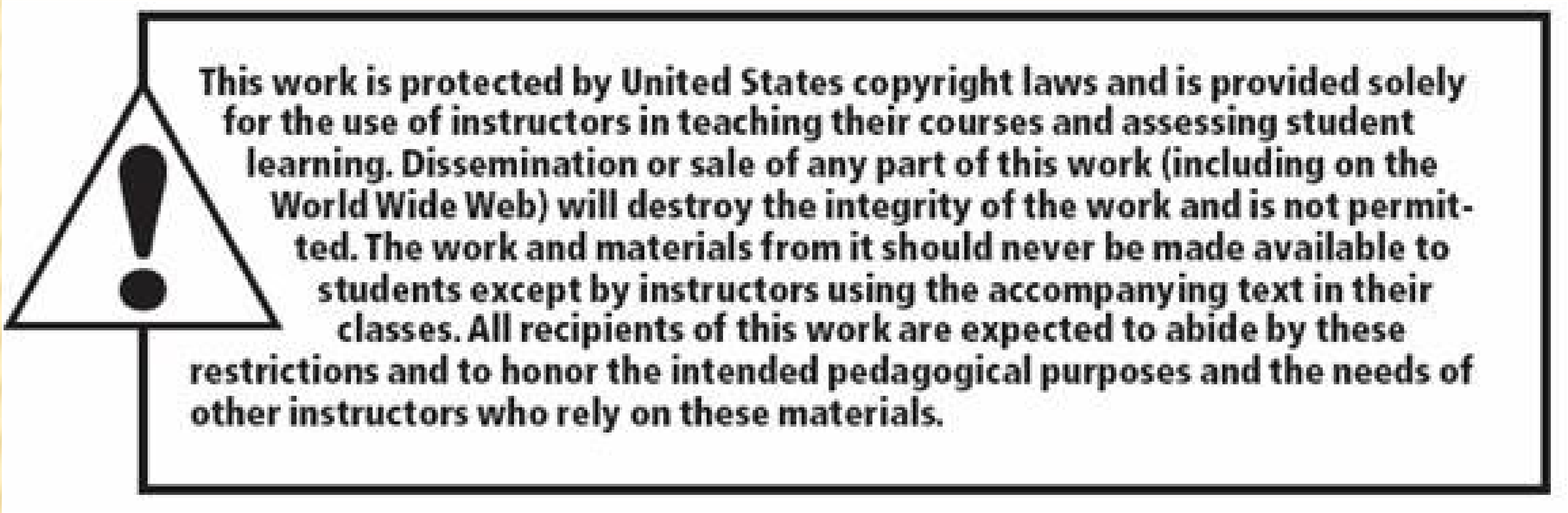
Copyright © 2016 Pearson Education, Inc.

Figure 3-15 PARTY, PARTY ROLE, and ROLE TYPE in a universal data model

(b) PARTY supertype/subtype hierarchy



Copyright © 2016 Pearson Education, Inc.



This work is protected by United States copyright laws and is provided solely for the use of instructors in teaching their courses and assessing student learning. Dissemination or sale of any part of this work (including on the World Wide Web) will destroy the integrity of the work and is not permitted. The work and materials from it should never be made available to students except by instructors using the accompanying text in their classes. All recipients of this work are expected to abide by these restrictions and to honor the intended pedagogical purposes and the needs of other instructors who rely on these materials.