CHAPTER 3:
THE ENHANCED E-R MODEL

Modern Database Management

12th Edition

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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

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

Figure 3-1 Basic notation for supertype/subtype notation

a) EER notation

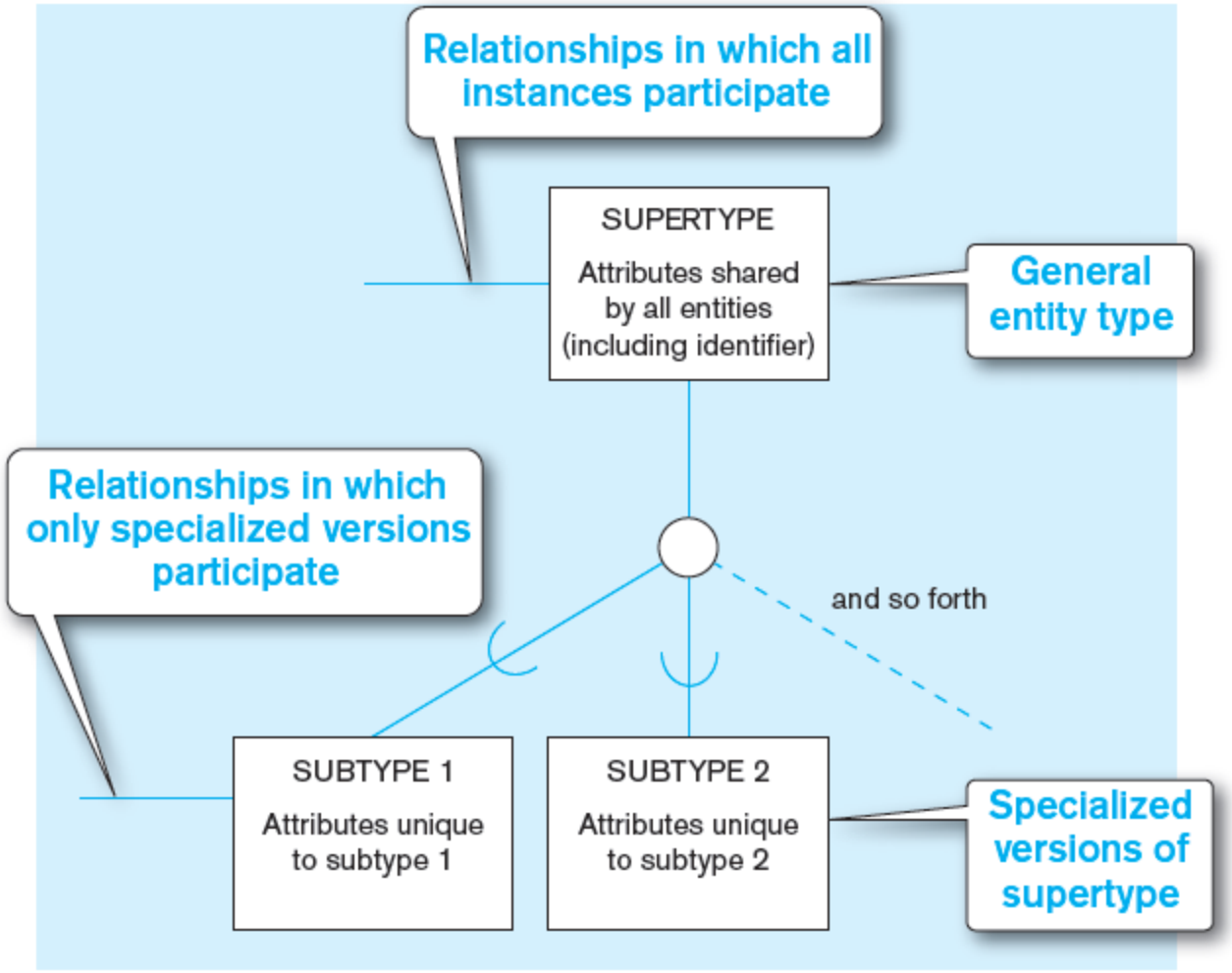
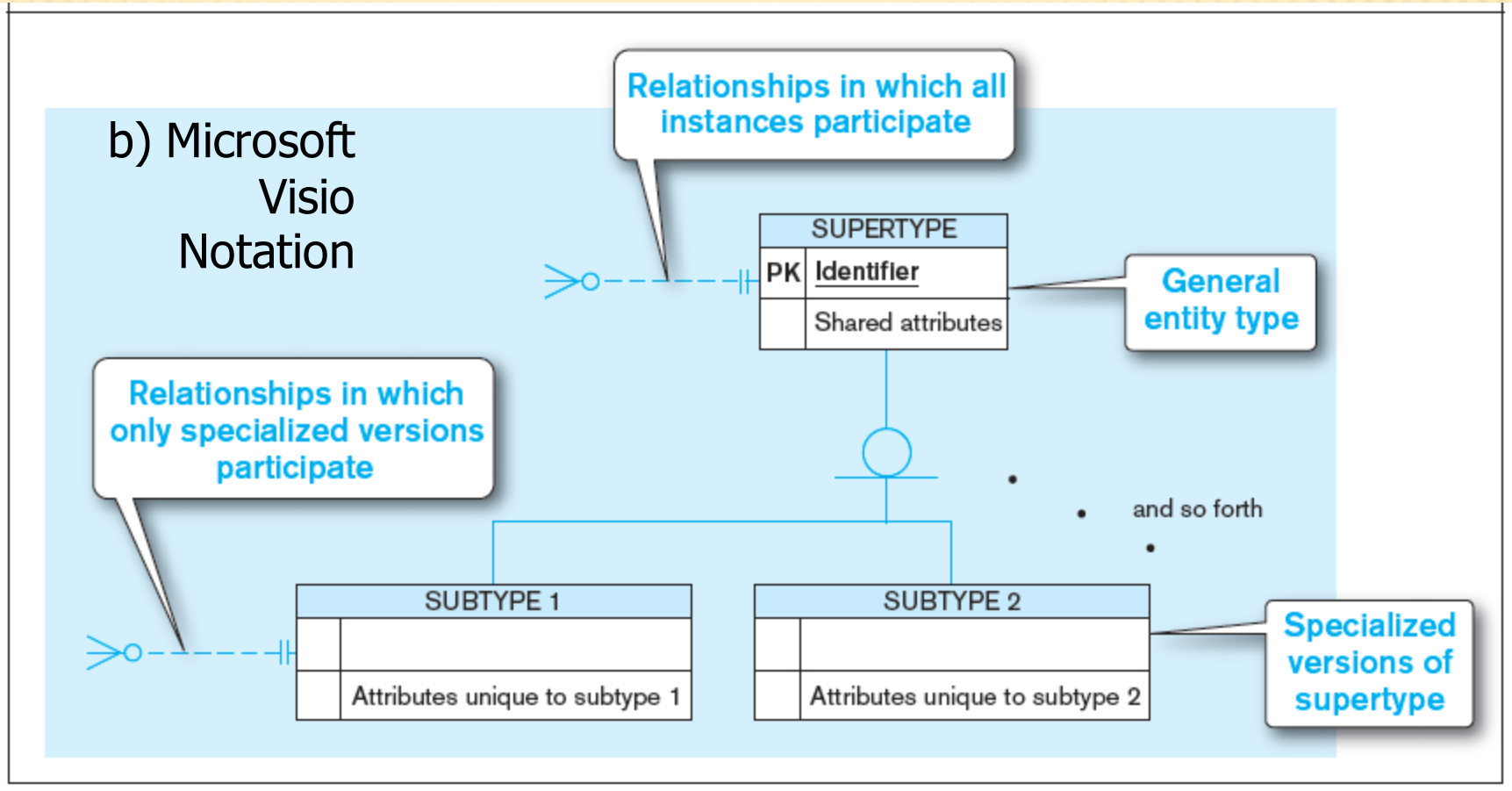
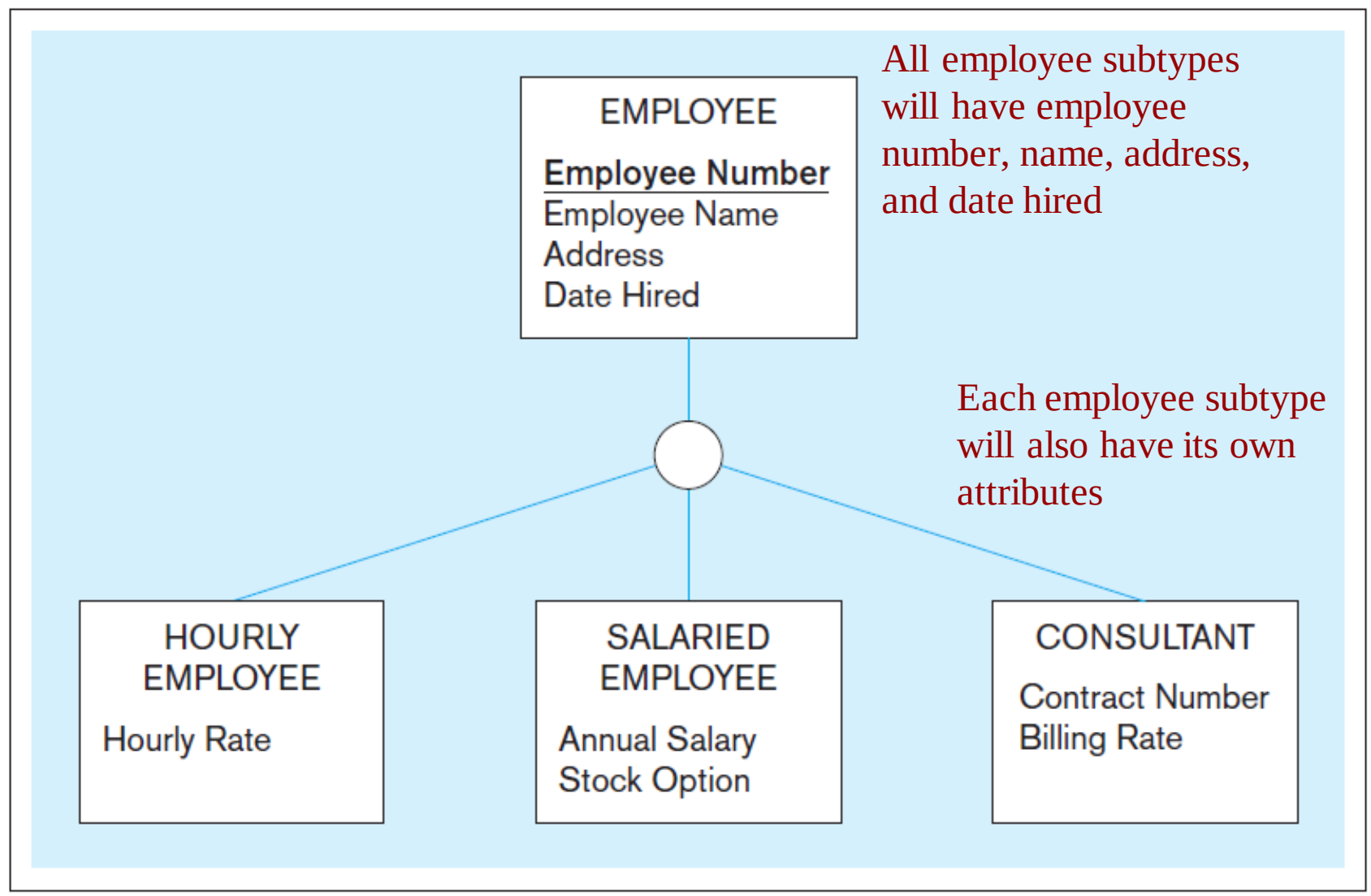


Figure 3-1 Basic notation for supertype/subtype notation (cont.)



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

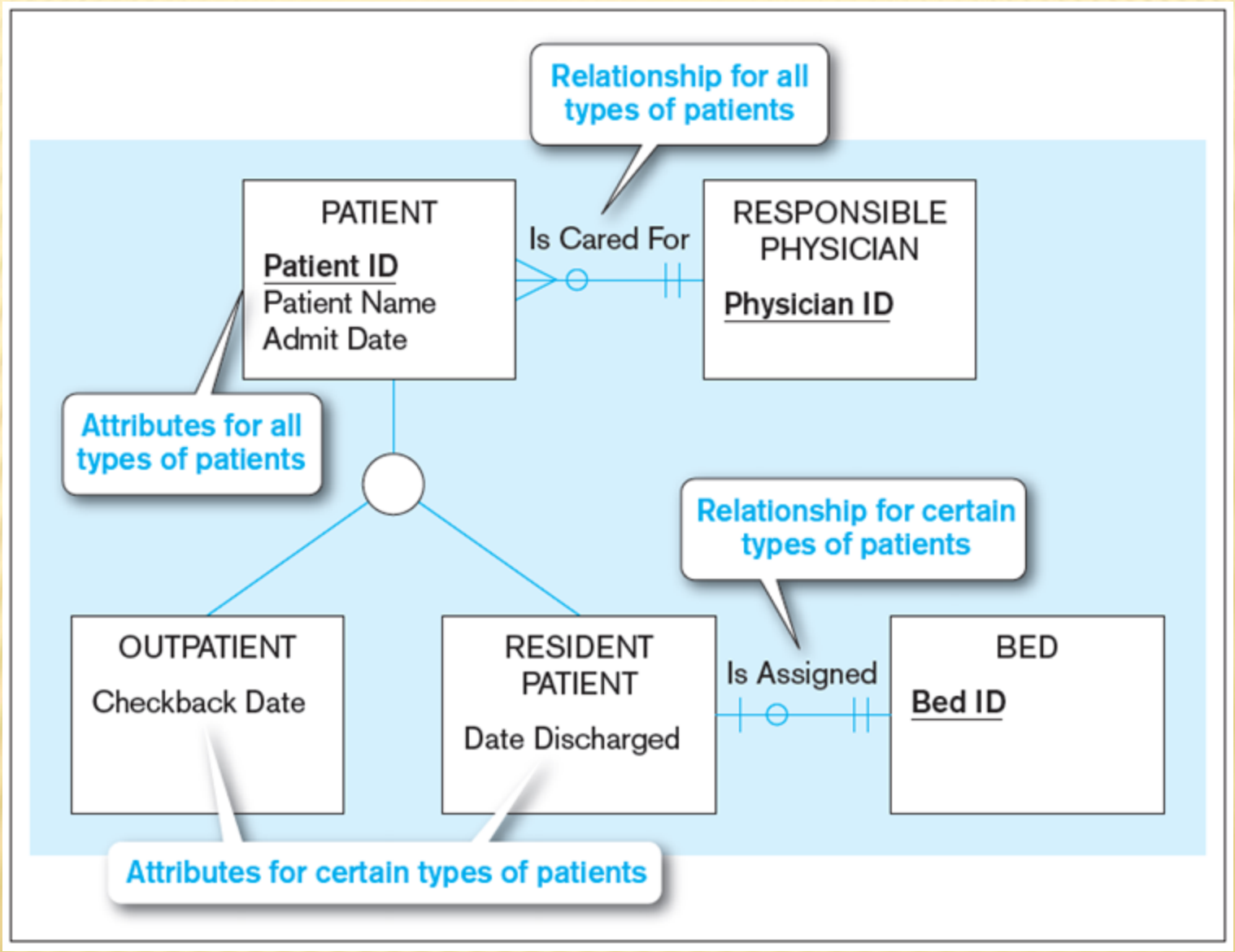
Figure 3-2 Employee supertype with three subtypes



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

Figure 3-3 Supertype/subtype relationships in a hospital

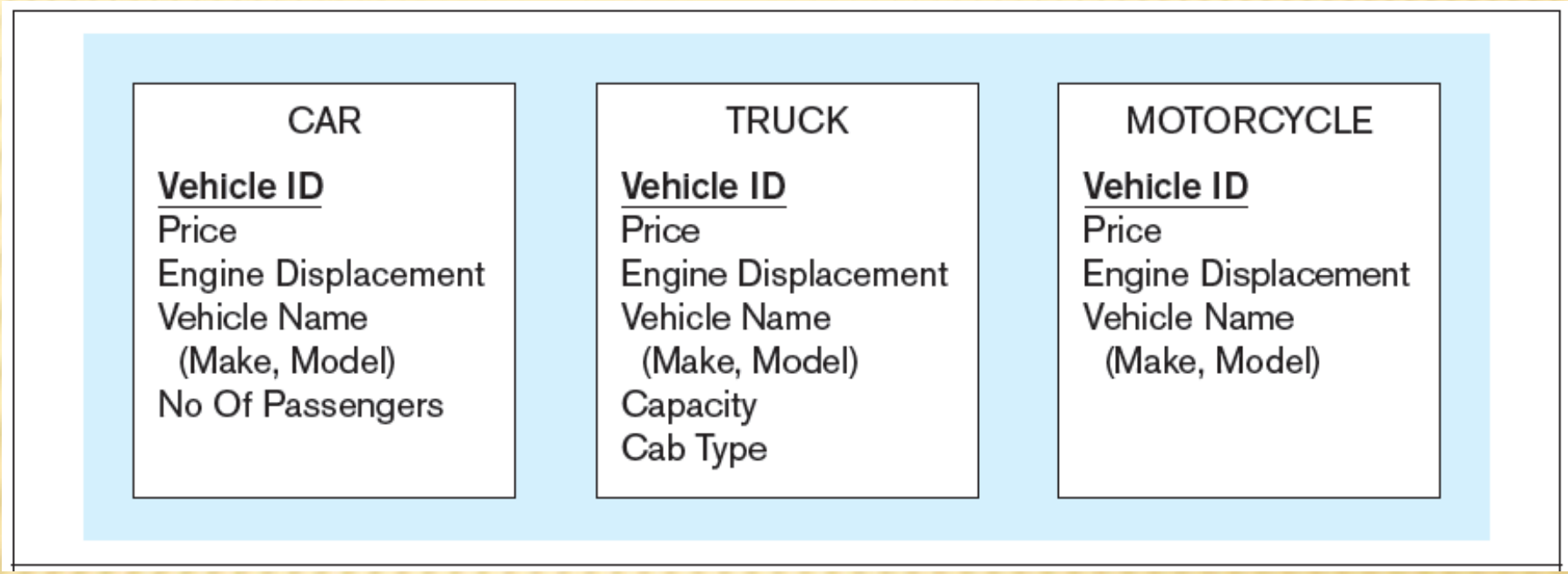


GENERALIZATION AND SPECIALIZATION

- ***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

Figure 3-4 Example of generalization

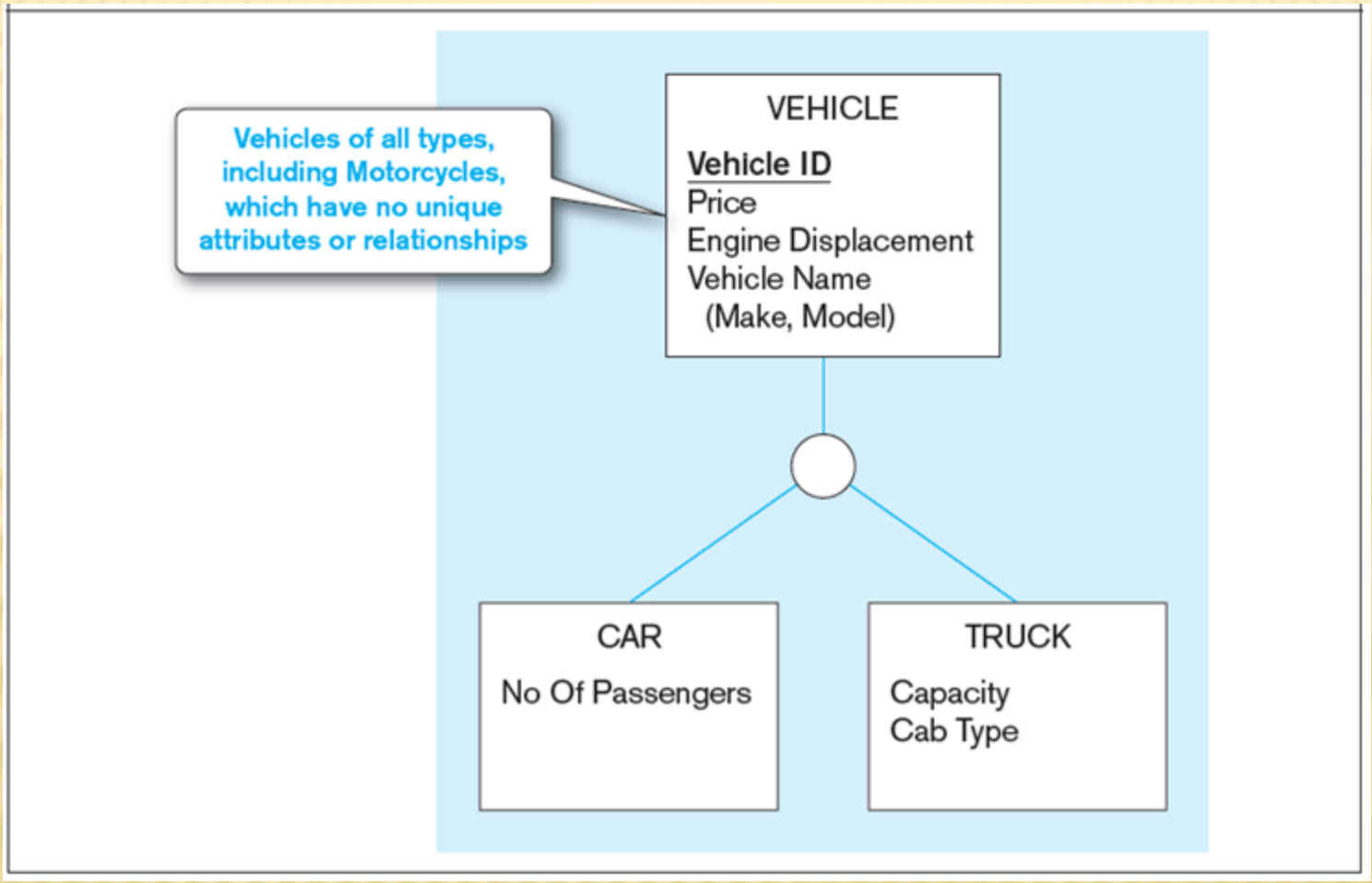
a) Three entity types: CAR, TRUCK, and MOTORCYCLE



All these types of vehicles have common attributes

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

Figure 3-5 Example of specialization

a) Entity type PART

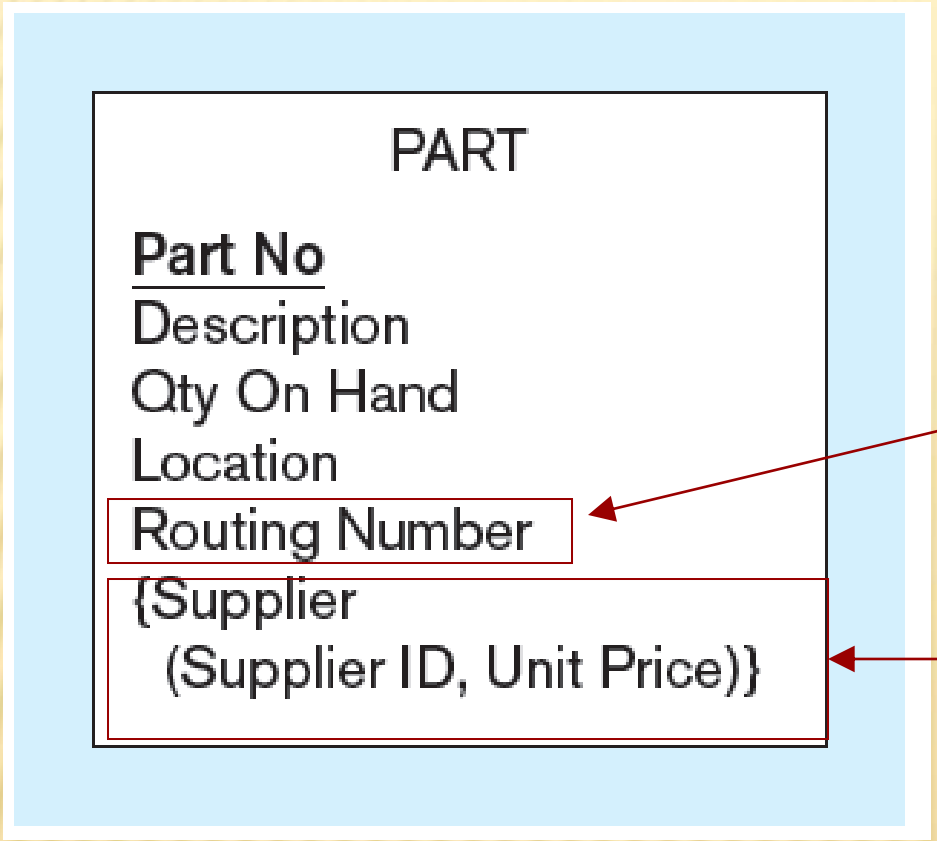
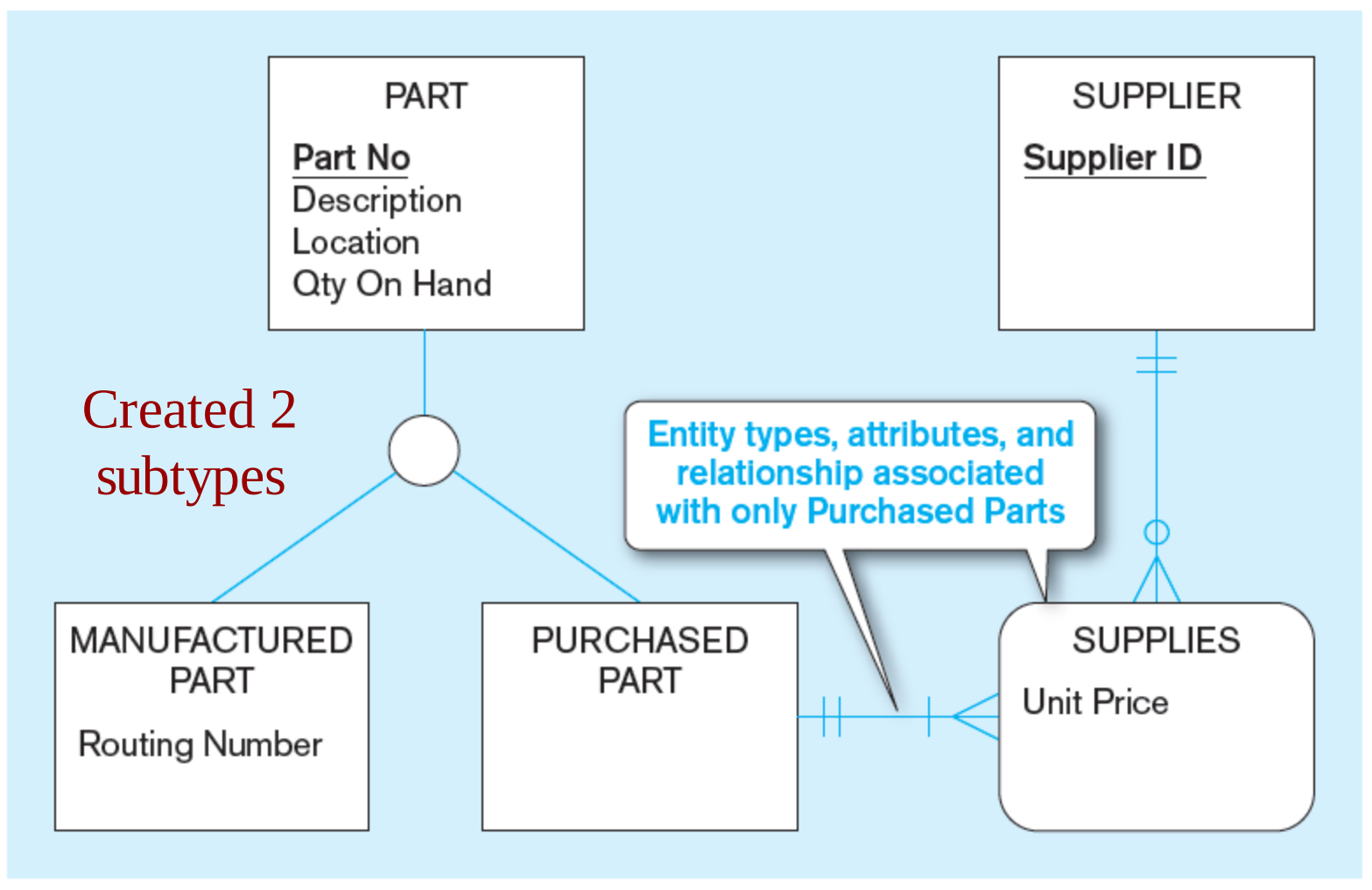


Figure 3-5 Example of specialization (cont.)

b) Specialization to MANUFACTURED PART and PURCHASED PART



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

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)

Figure 3-6 Examples of completeness constraints

a) Total specialization rule

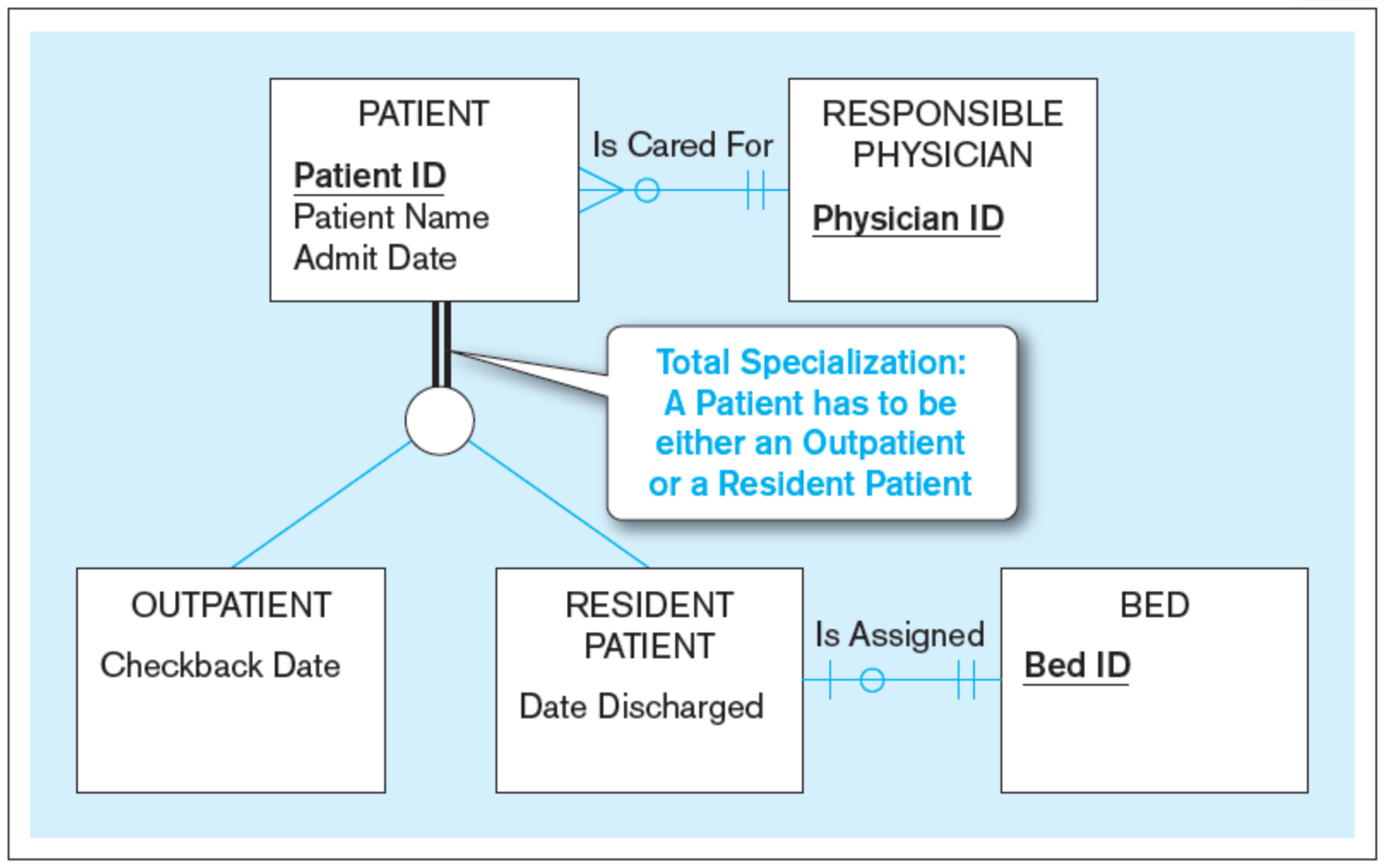
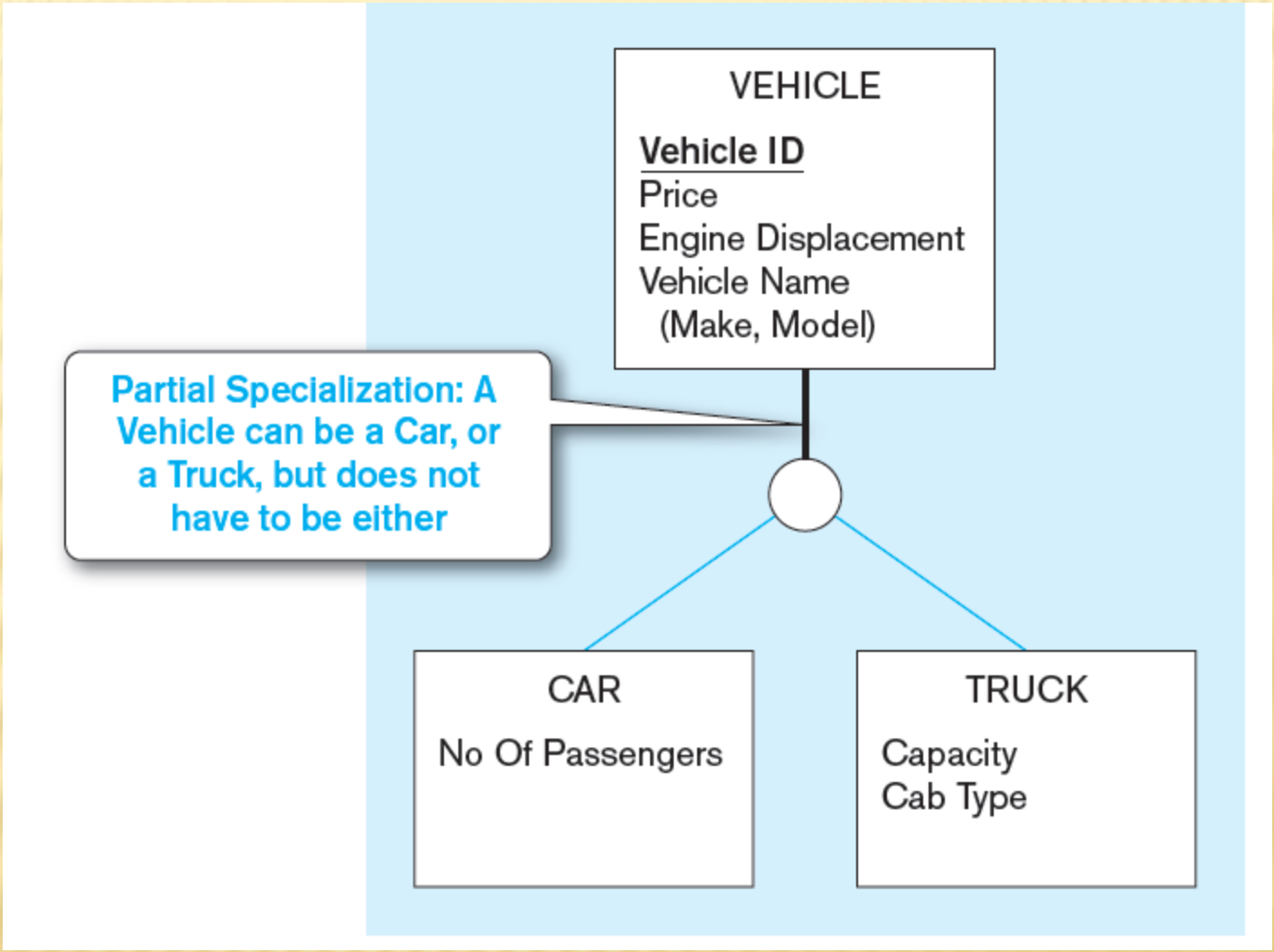


Figure 3-6 Examples of completeness constraints (cont.)

b) Partial specialization rule



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

Figure 3-7 Examples of disjointness constraints

a) Disjoint rule

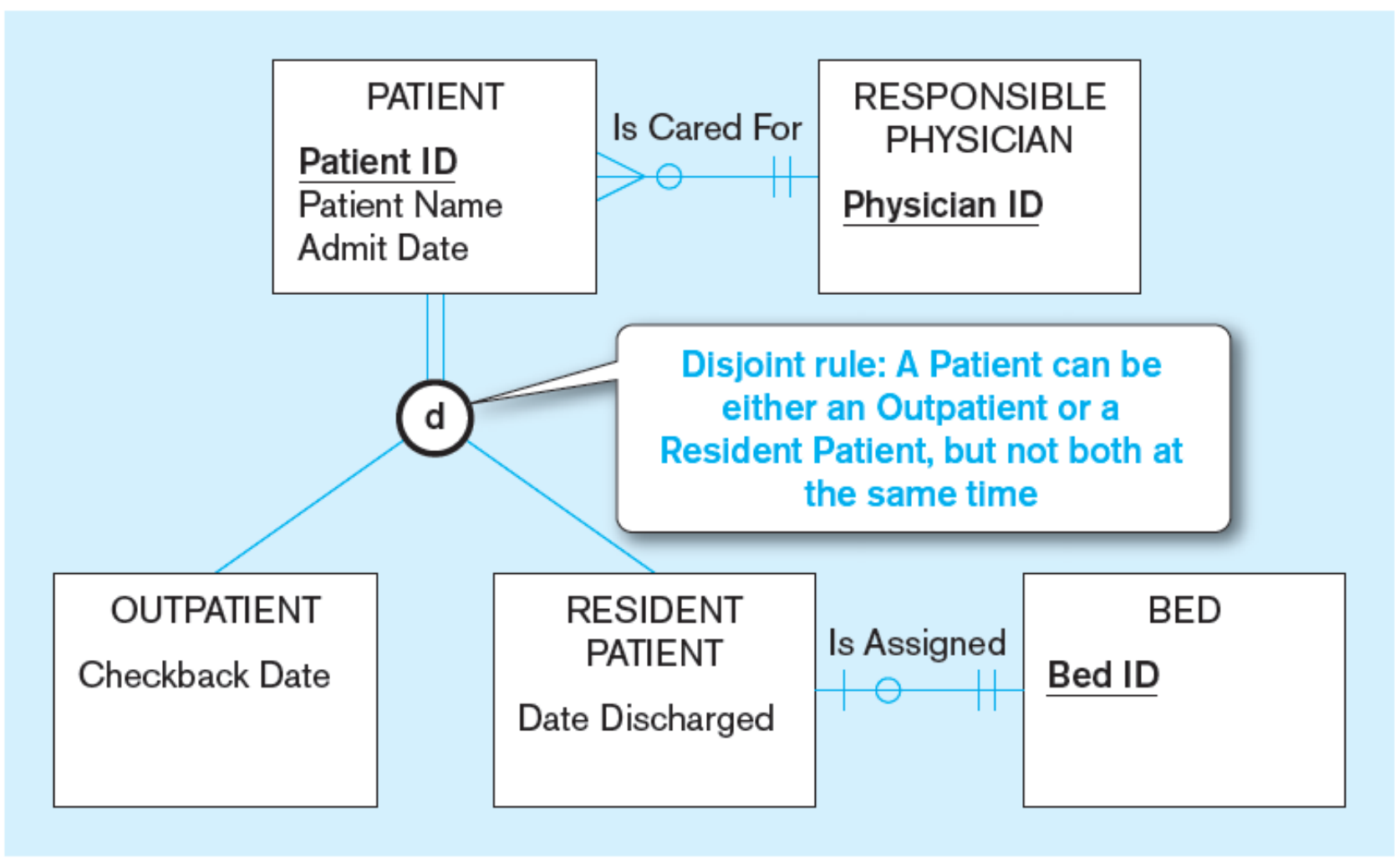
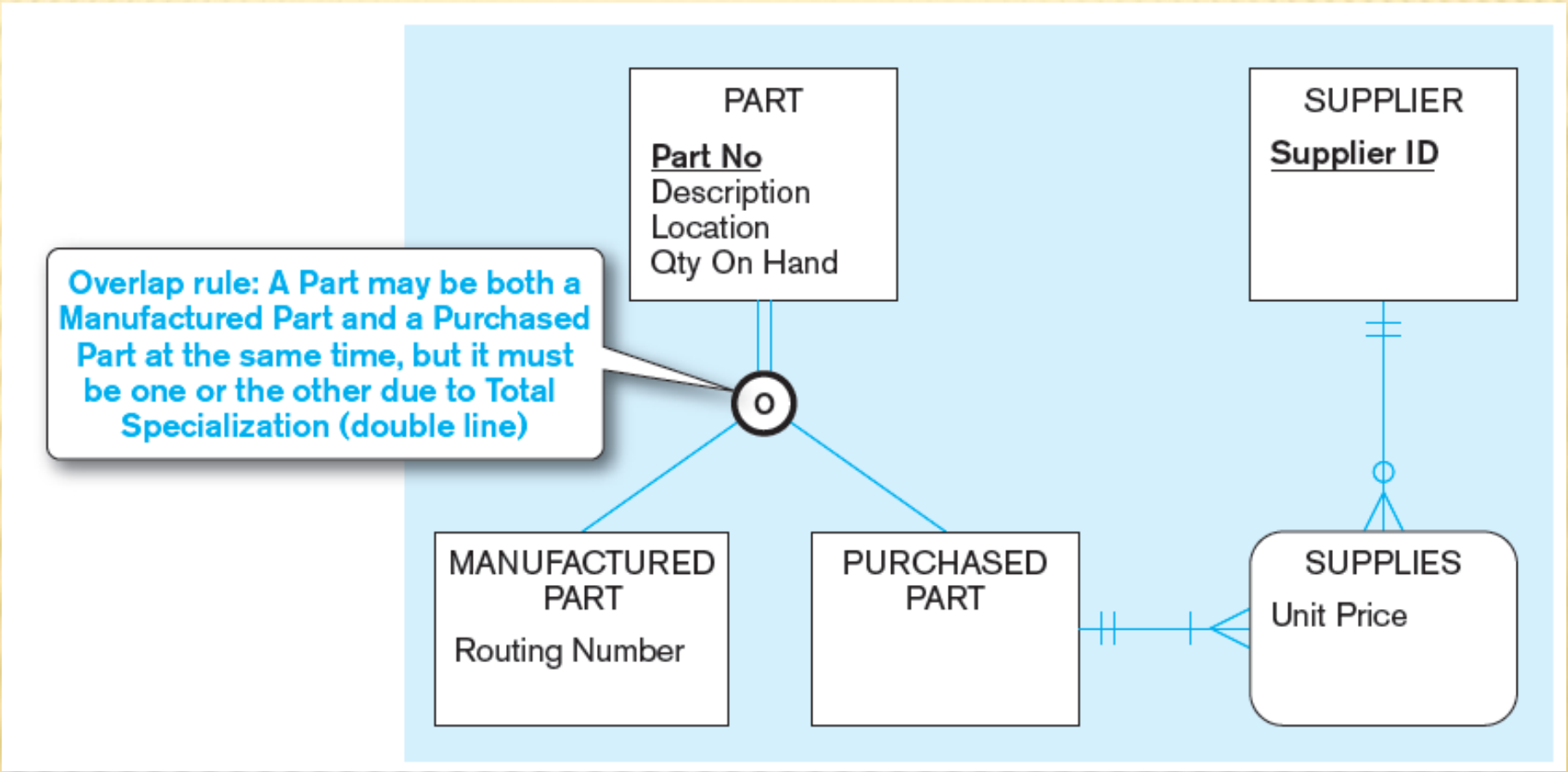


Figure 3-7 Examples of disjointness constraints (cont.)
b) Overlap rule



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

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

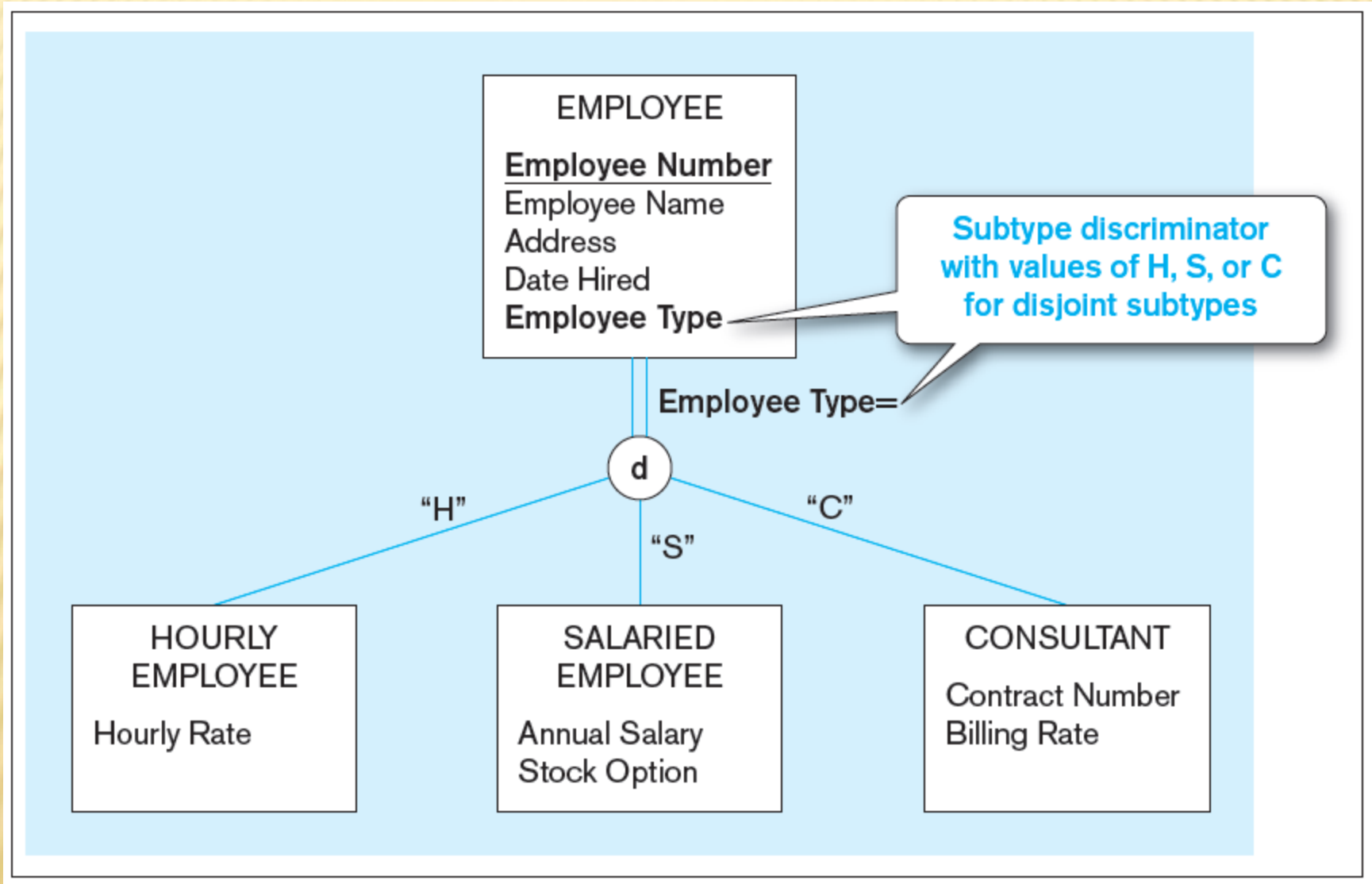


Figure 3-9 Subtype discriminator (***overlap*** rule)

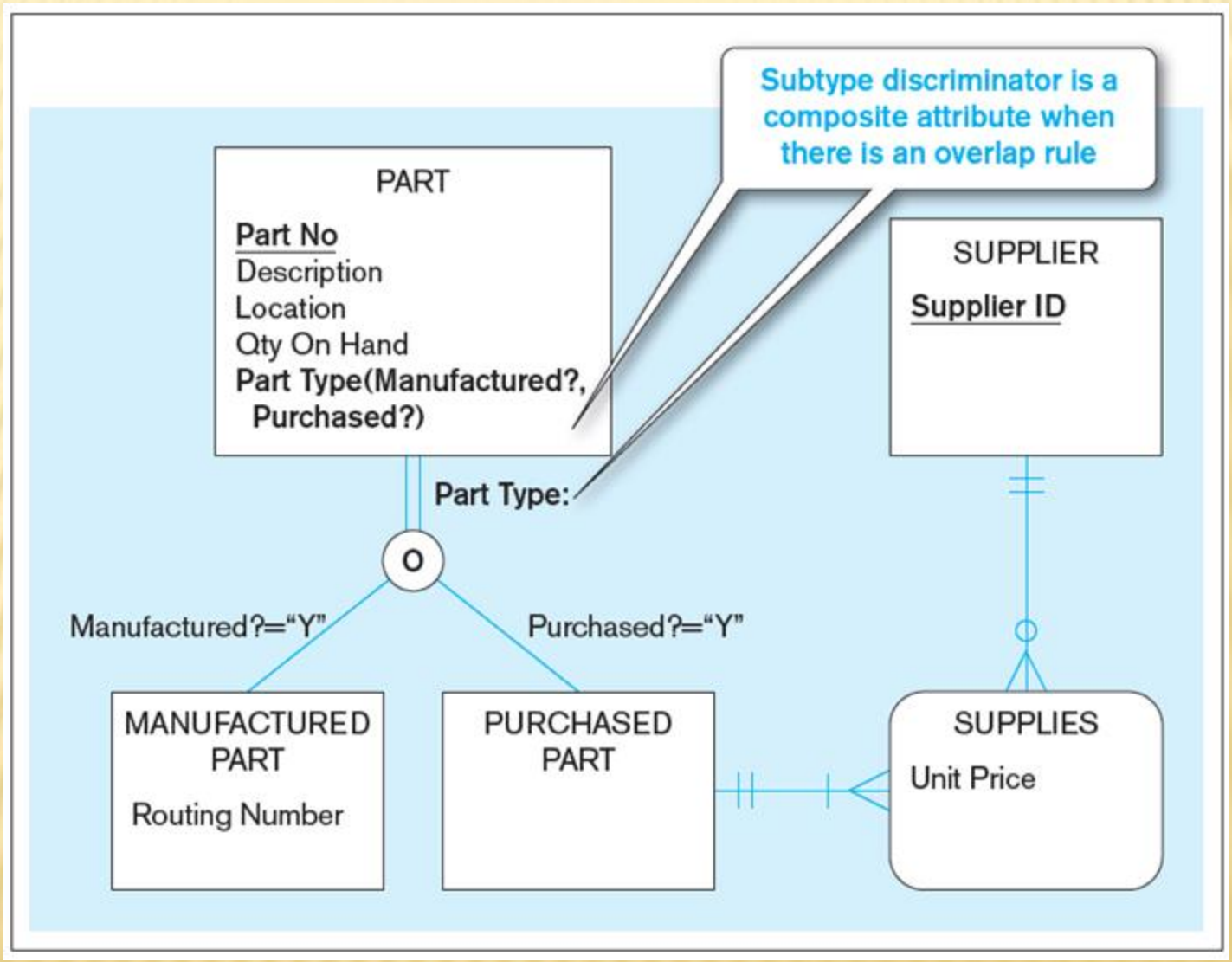
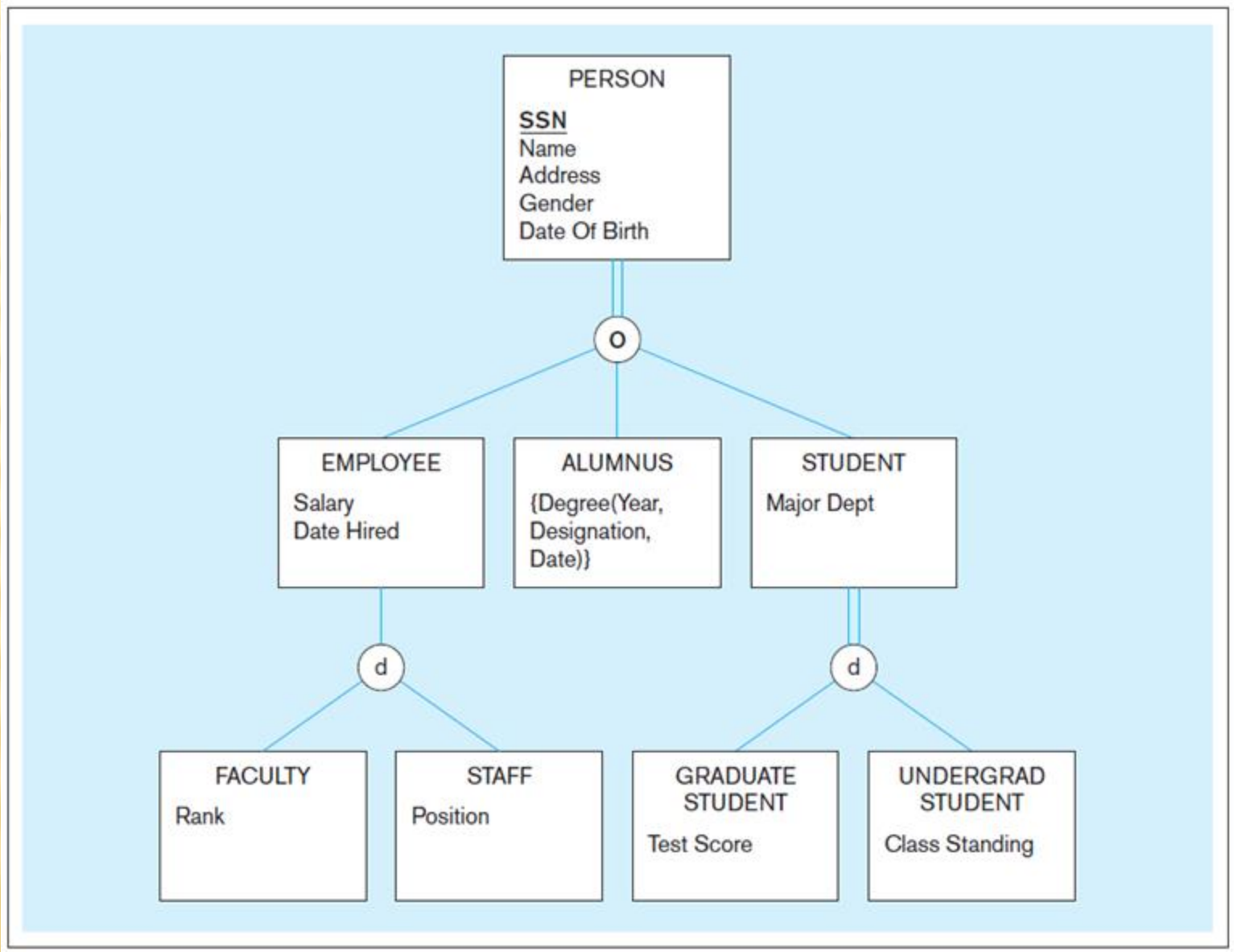


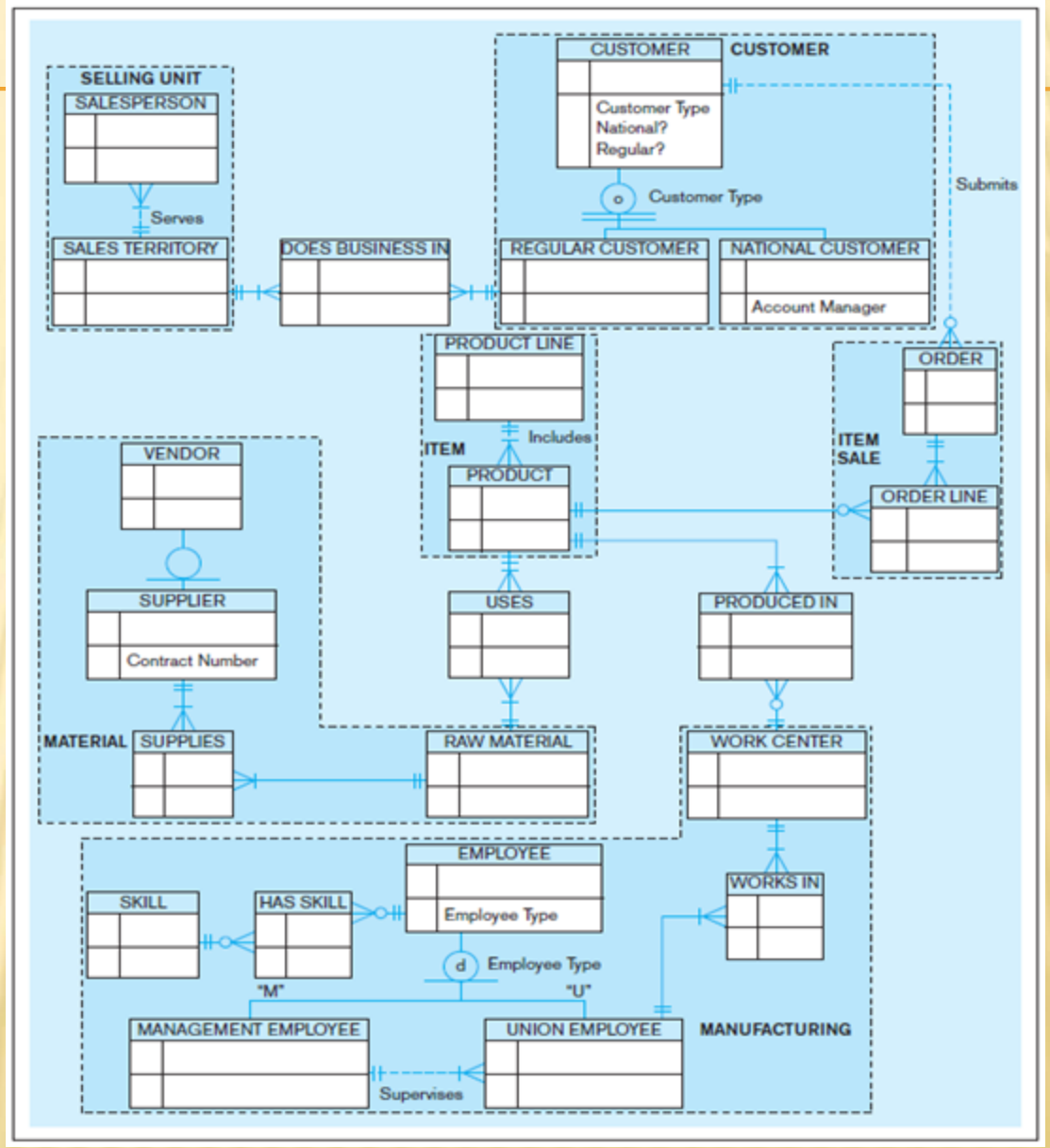
Figure 3-10 Example of supertype/subtype hierarchy



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

Figure 3-13a
Possible entity clusters for Pine Valley Furniture in Microsoft Visio



Related groups of entities could become clusters

Figure 3-13b EER diagram of PVF entity clusters

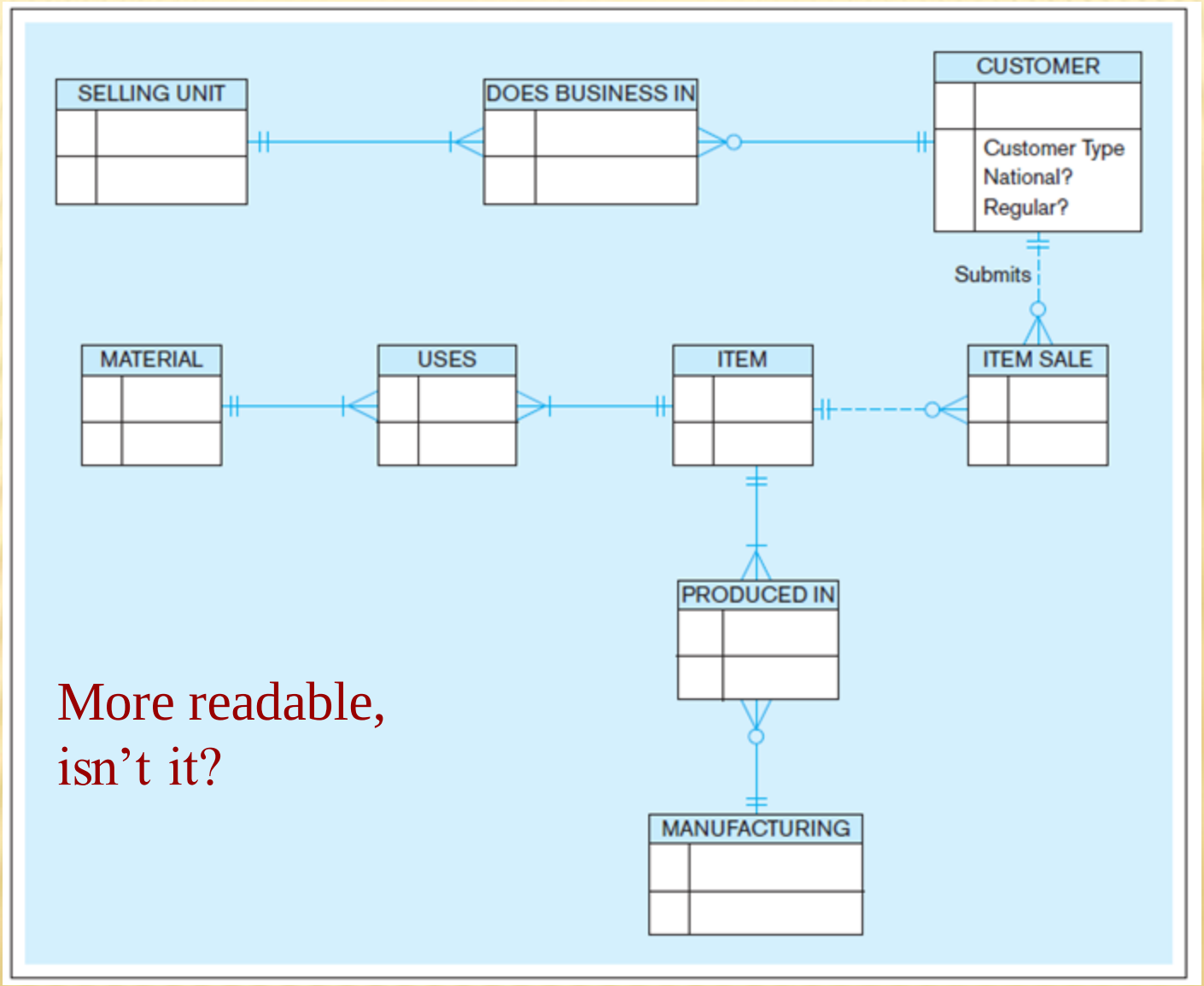
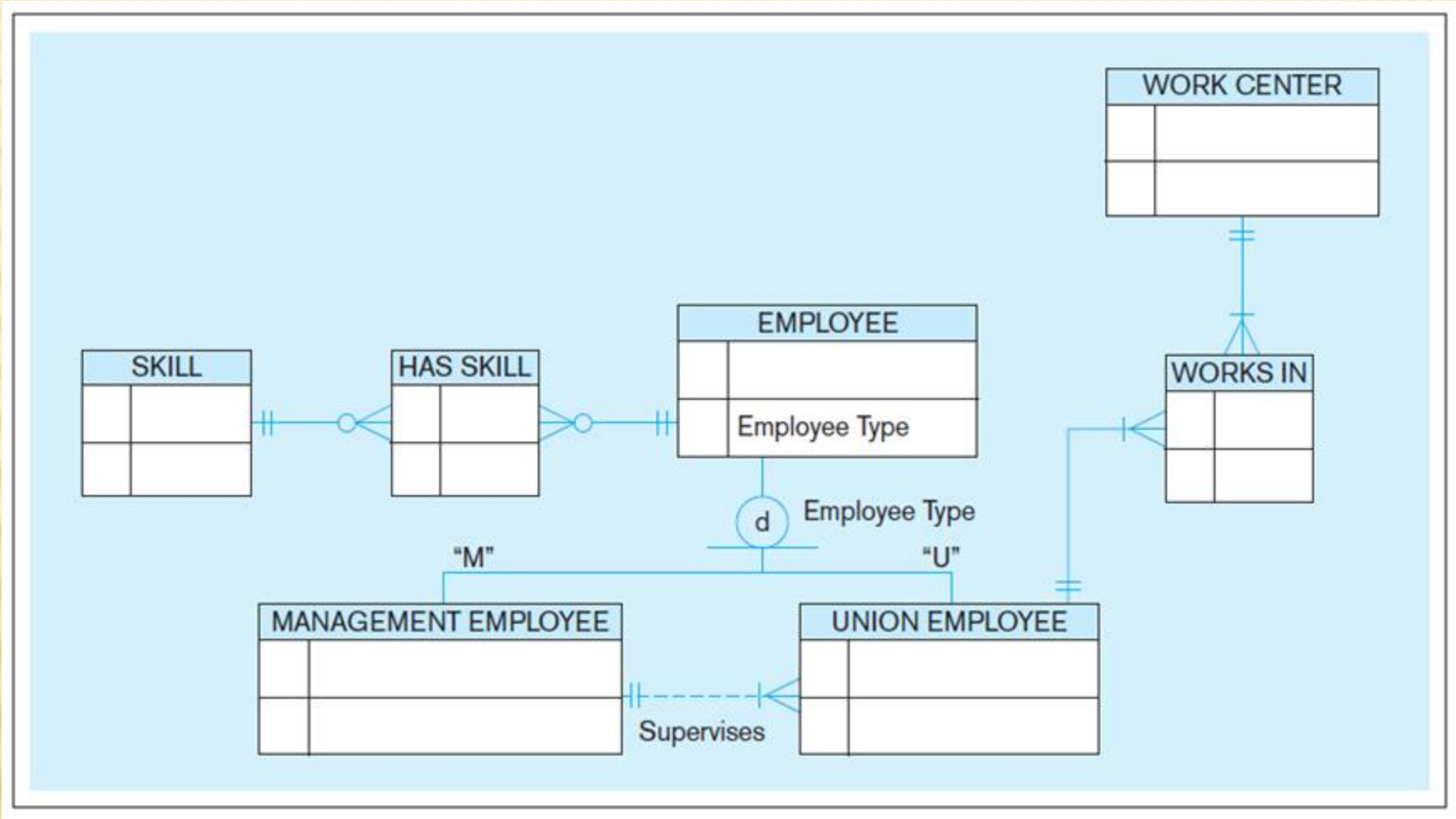


Figure 3-14 Manufacturing entity cluster



Detail for a single cluster

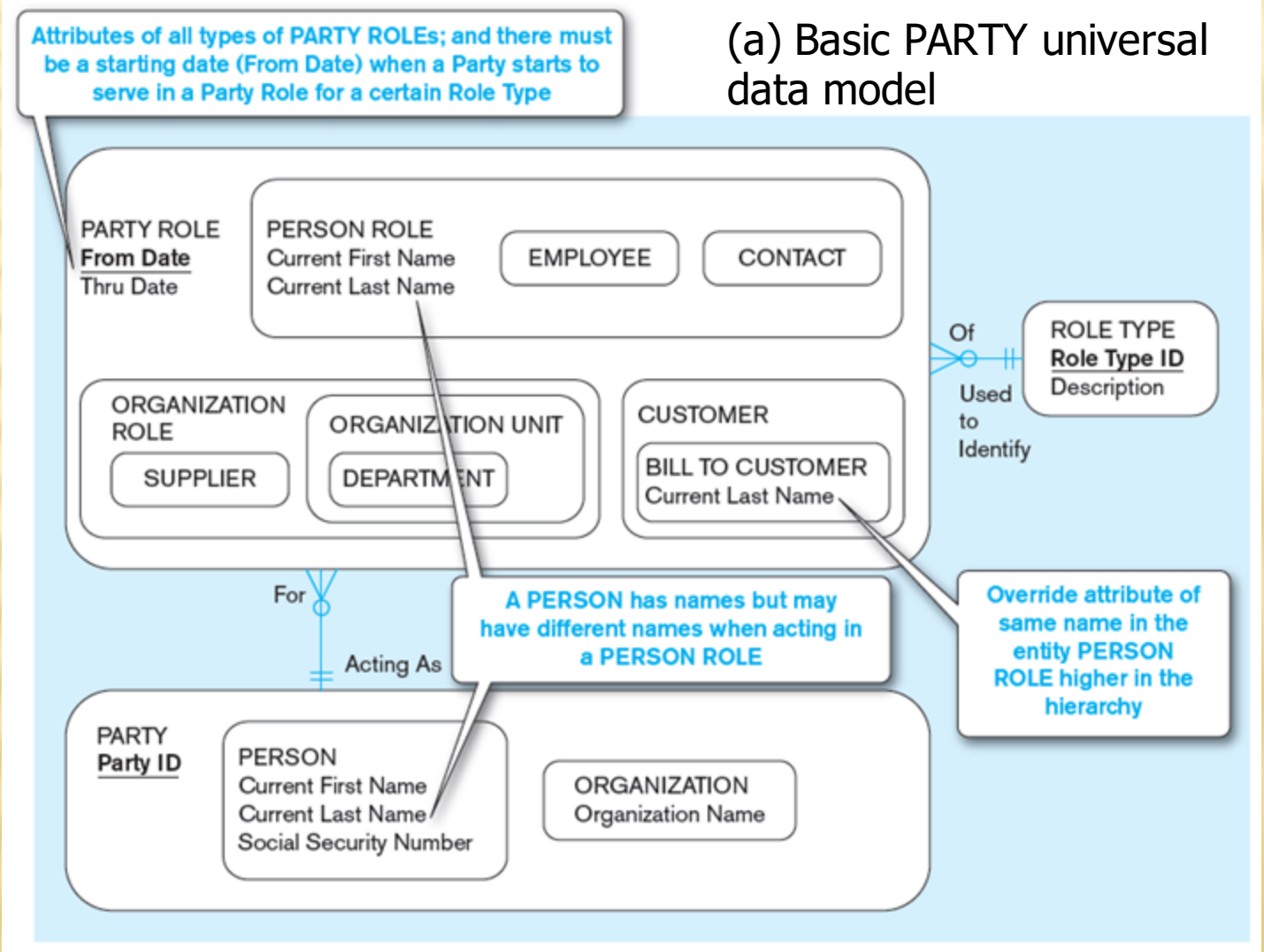
PACKAGED DATA MODELS

- 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")

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

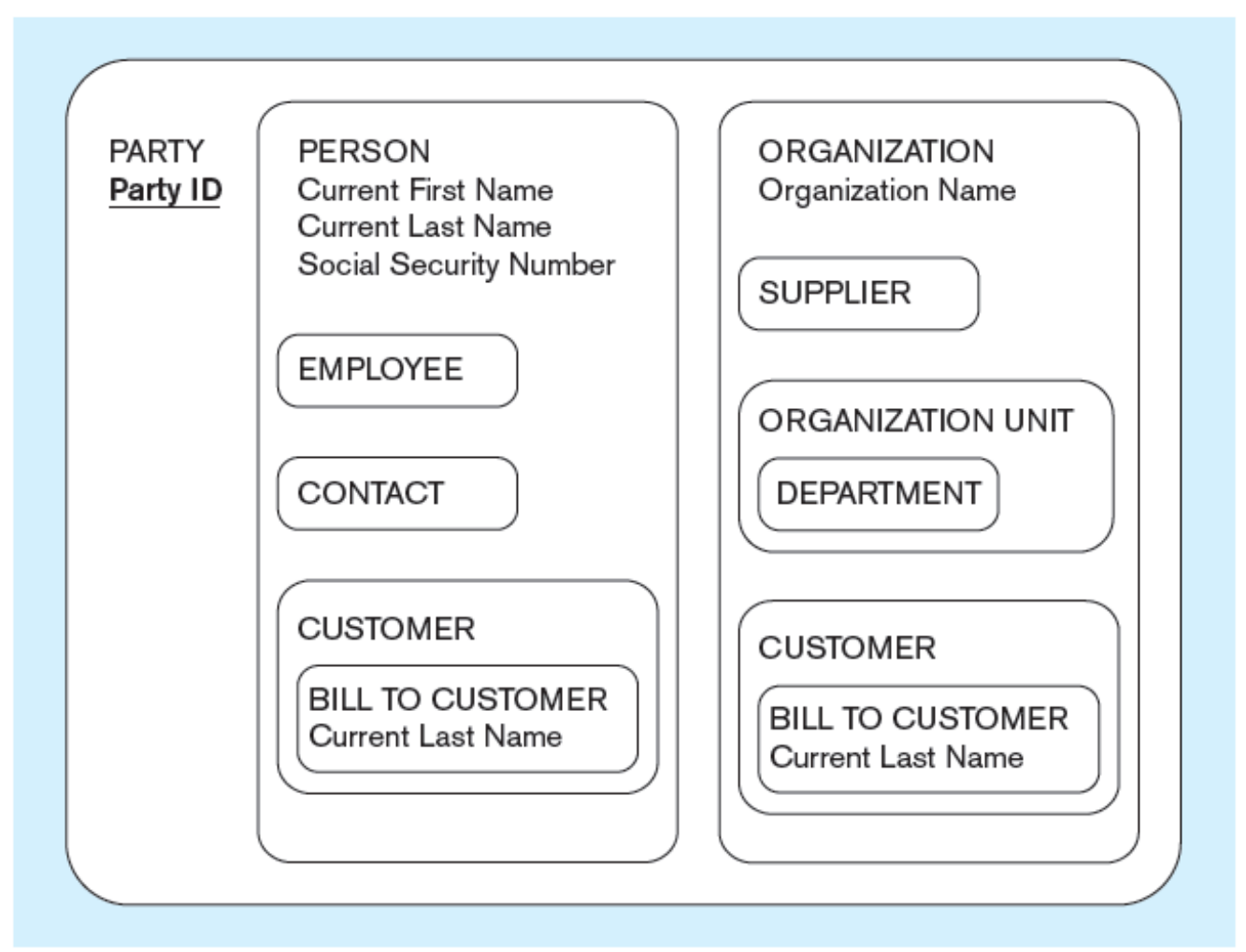
Figure 3-15 PARTY, PARTY ROLE, and ROLE TYPE in a universal data model



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

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

(b) PARTY supertype/subtype hierarchy



EXCERCISES

- A rental car agency classifies the vehicles it rents into four categories: compact, midsize, full-size, and sport utility.
- The agency wants to record the following data for all vehicles: Vehicle ID, Make, Model, Year, and Color.
- There are no unique attributes for any of the four classes of vehicle. The entity type vehicle has a relationship (named Rents) with a customer entity type. None of the four vehicle classes has a unique relationship with an entity type. Would you consider creating a supertype/subtype relationship for this problem? Why or why not?

EXCERCISES

- At a weekend retreat, the entity type PERSON has three subtypes: CAMPER, BIKER, and RUNNER. Draw a separate EER diagram segment for each of the following situations:

- a. At a given time, a person must be exactly one of these subtypes.
- b. A person may or may not be one of these subtypes. However, a person who is one of these subtypes cannot at the same time be one of the other subtypes.
- c. A person may or may not be one of these subtypes. On the other hand, a person may be any two (or even three) of these subtypes at the same time.
- d. At a given time, a person must be at least one of these subtypes