Chapter 5

Database and
Data Center Security

SQL Access Controls

- Two commands for managing access rights:
  - Grant
    - Used to grant one or more access rights or can be used to assign a user to a role
  - Revoke
    - Revokes the access rights
- Typical access rights are:
  - Select
  - Insert
  - Update
  - Delete
  - References

Role-Based Access Control (RBAC)

- Role-based access control eases administrative burden and improves security
- A database RBAC needs to provide the following capabilities:
  - Create and delete roles
  - Define permissions for a role
  - Assign and cancel assignment of users to roles

Application owner	End user	Administrator
• An end user who owns database objects as part of an application	• An end user who operates on database objects via a particular application but does not own any of the database objects	• User who has administrative responsibility for part or all of the database

Table 5.2

Fixed Roles in Microsoft SQL Server

Role	Permissions
Fixed Server Roles	
sysadmin	Can perform any activity in SQL Server and have complete control over all database functions
serveradmin	Can set server-wide configuration options, shut down the server
setupadmin	Can manage linked servers and startup procedures
securityadmin	Can manage logins and CREATE DATABASE permissions, also read error logs and change passwords
processadmin	Can manage processes running in SQL Server
dbcreator	Can create, alter, and drop databases
diskadmin	Can manage disk files
bulkadmin	Can execute BULK INSERT statements
Fixed Database Roles	
db_owner	Has all permissions in the database
db_accessadmin	Can add or remove user IDs
db_datareader	Can select all data from any user table in the database
db_datawriter	Can modify any data in any user table in the database
db_ddladmin	Can issue all Data Definition Language (DDL) statements
db_securityadmin	Can manage all permissions, object ownerships, roles and role memberships
db_backupoperator	Can issue DBCC, CHECKPOINT, and BACKUP statements
db_denydatareader	Can deny permission to select data in the database
db_denydatawriter	Can deny permission to change data in the database

(Table is on page 165 in the textbook)

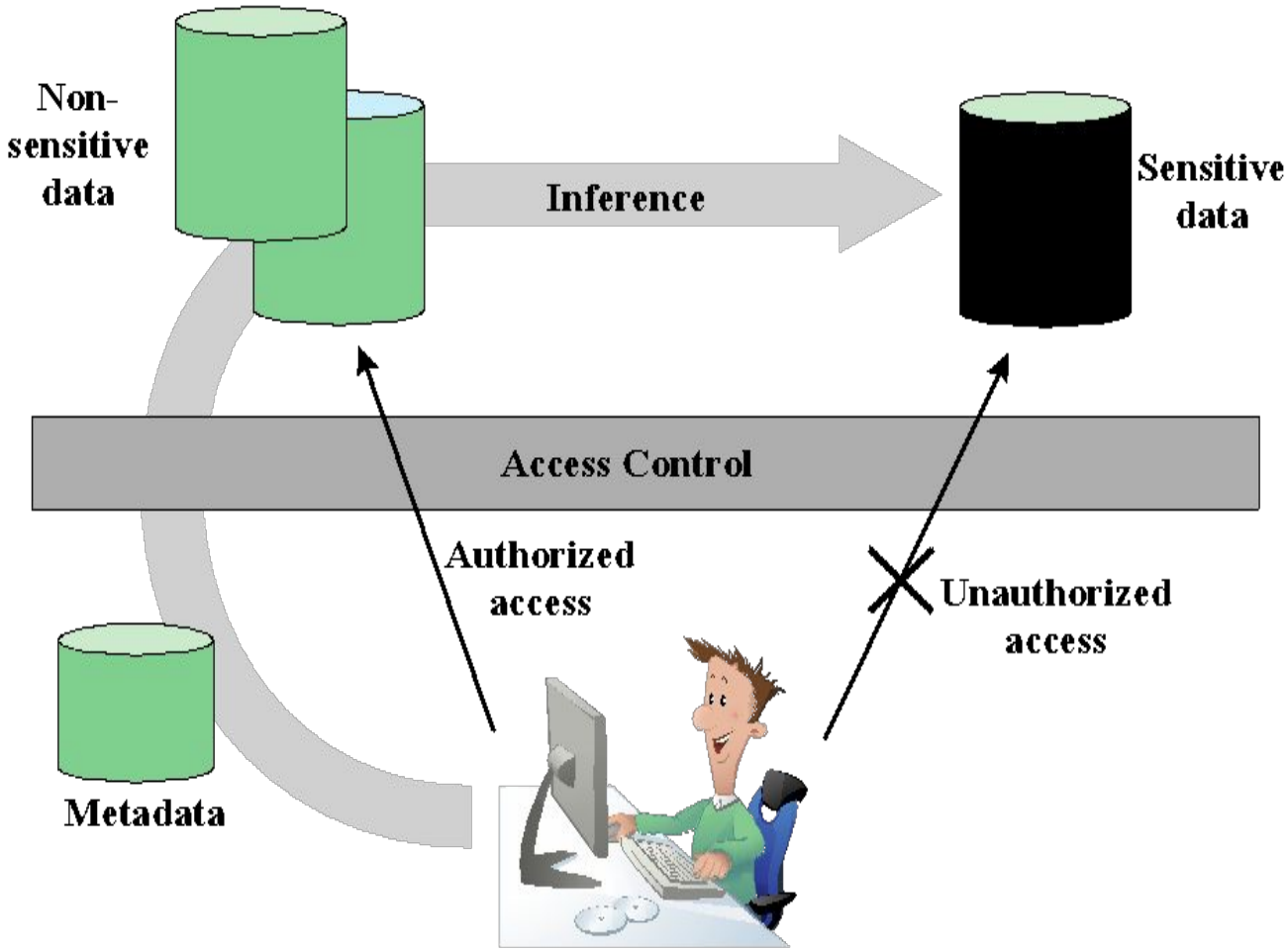
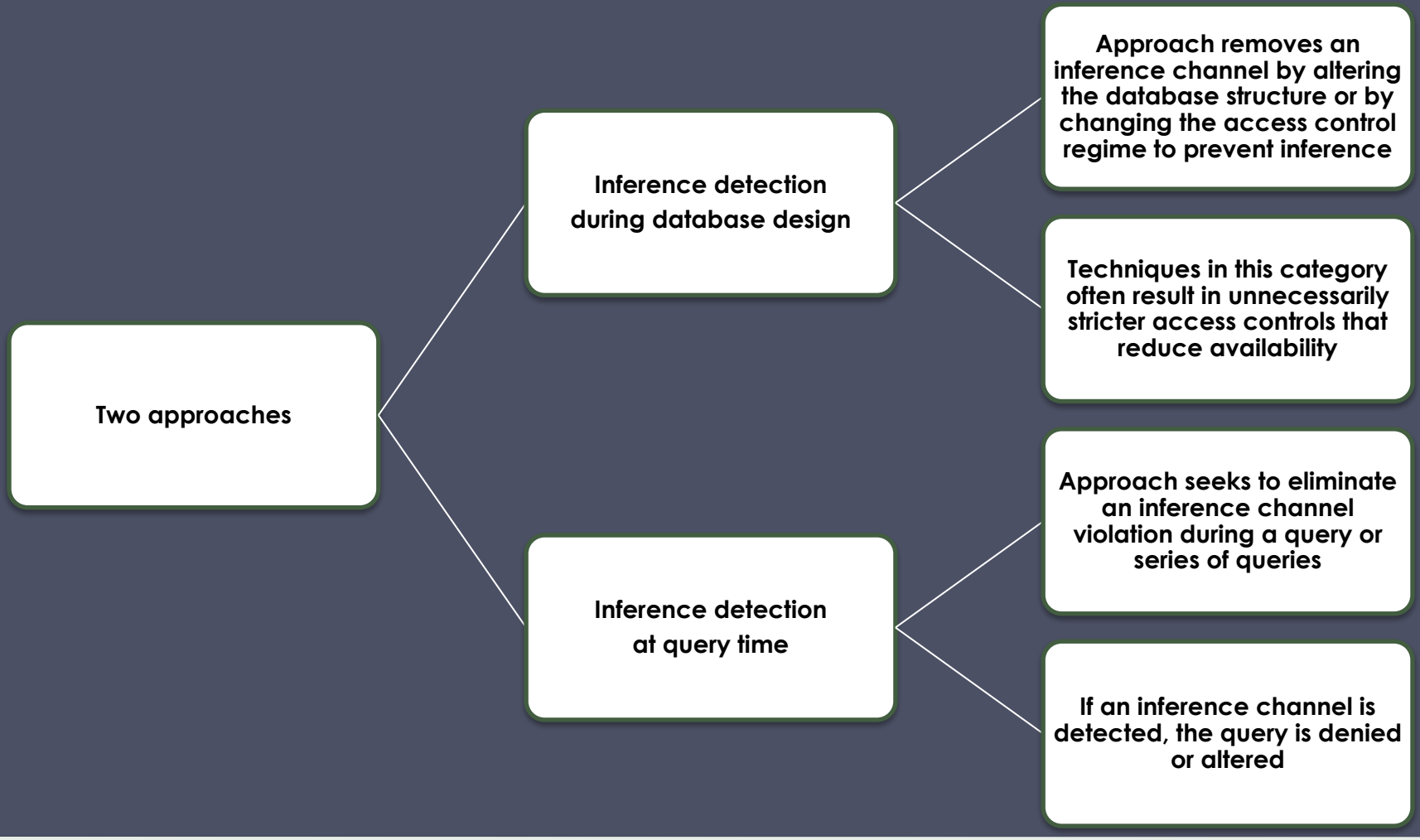


Figure 5.7 Indirect Information Access Via Inference Channel

Inference Detection



- Some inference detection algorithm is needed for either of these approaches
- Progress has been made in devising specific inference detection techniques for multilevel secure databases and statistical databases

Database Encryption

- The database is typically the most valuable information resource for any organization
  - Protected by multiple layers of security
    - Firewalls, authentication, general access control systems, DB access control systems, database encryption
    - Encryption becomes the last line of defense in database security
  - Can be applied to the entire database, at the record level, the attribute level, or level of the individual field
- Disadvantages to encryption:
  - Key management
    - Authorized users must have access to the decryption key for the data for which they have access
  - Inflexibility
    - When part or all of the database is encrypted it becomes more difficult to perform record searching

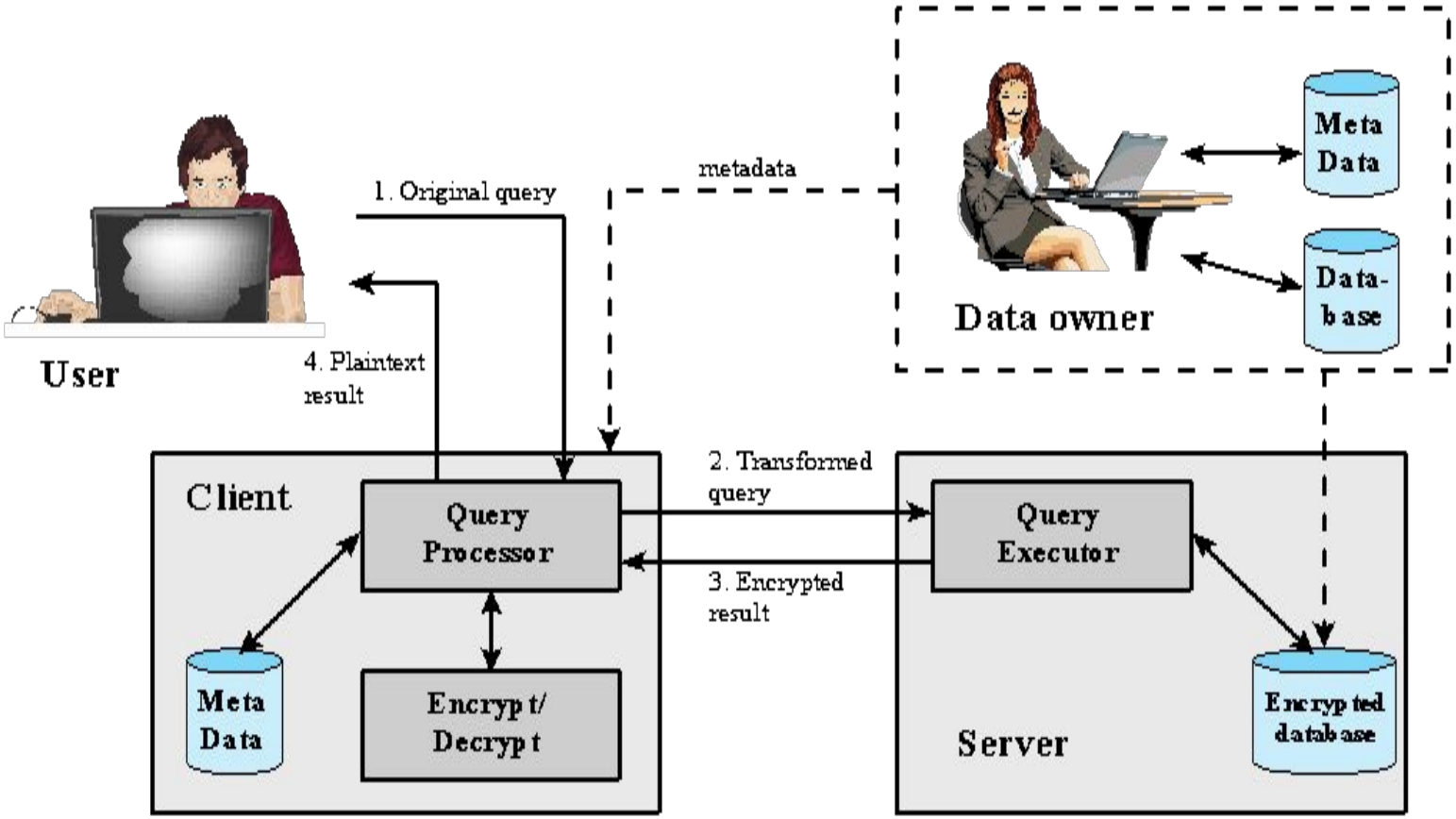


Figure 5.9 A Database Encryption Scheme

Table 5.3 Encrypted Database Example

(a) Employee Table

eid	ename	salary	addr	did
23	Tom	70K	Maple	45
860	Mary	60K	Main	83
320	John	50K	River	50
875	Jerry	55K	Hopewell	92

(b) Encrypted Employee Table with Indexes

E(k, B)	I(eid)	I(ename)	I(salary)	I(addr)	I(did)
1100110011001011…	1	10	3	7	4
0111000111001010…	5	7	2	7	8
1100010010001101…	2	5	1	9	5
0011010011111101…	5	5	2	4	9

Data Center Security

- Data center:
  - An enterprise facility that houses a large number of servers, storage devices, and network switches and equipment
  - The number of servers and storage devices can run into the tens of thousands in one facility
  - Generally includes redundant or backup power supplies, redundant network connections, environmental controls, and various security devices
  - Can occupy one room of a building, one or more floors, or an entire building
- Examples of uses include:
  - Cloud service providers
  - Search engines
  - Large scientific research facilities
  - IT facilities for large enterprises

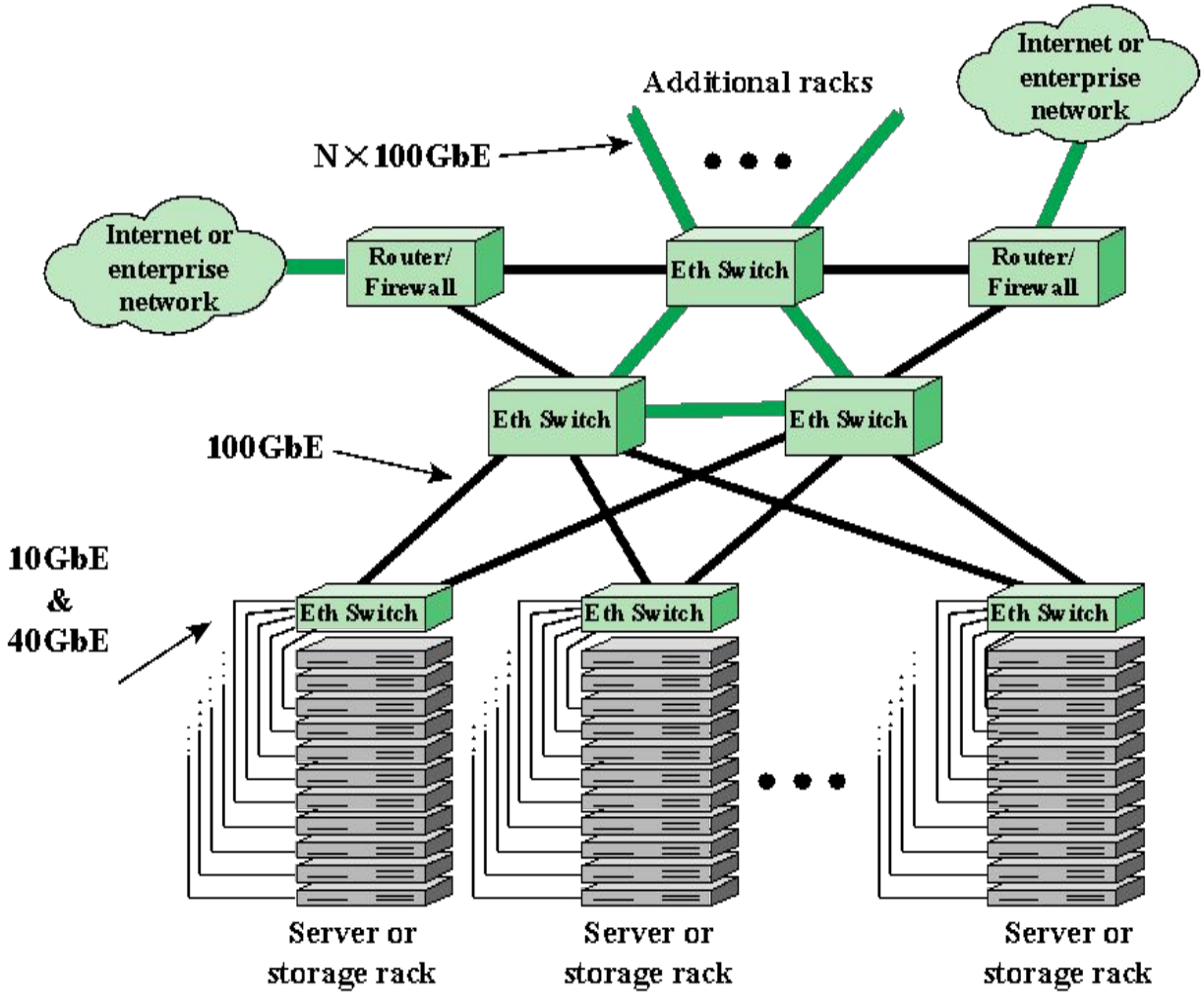


Figure 5.11 Key Data Center Elements

Data Security	Encryption, Password policiy, secure IDs, Data Protection (ISO 27002), Data masking, Data retention, etc.
Network Security	Firewalls, Anti-virus, Intrusion detection/prevention, authentication, etc.
Physical Security	Surveillance, Mantraps, Two/three factor authentication, Security zones, ISO 27001/27002, etc.
Site Security	Setbacks, Redundant utilities Landscaping, Buffer zones, Crash barriers, Entry points, etc.

Figure 5.12 Data Center Security Model

TIA-492

- The Telecommunications Industry Association (TIA)
- TIA-492 (*Telecommunications Infrastructure Standard for Data Centers*) specifies the minimum requirements for telecommunications infrastructure of data centers
- Includes topics such as:
  - Network architecture
  - Electrical design
  - File storage, backup, and archiving
  - System redundancy
  - Network access control and security
  - Database management
  - Web hosting
  - Application hosting
  - Content distribution
  - Environmental control
  - Protection against physical hazards
  - Power management

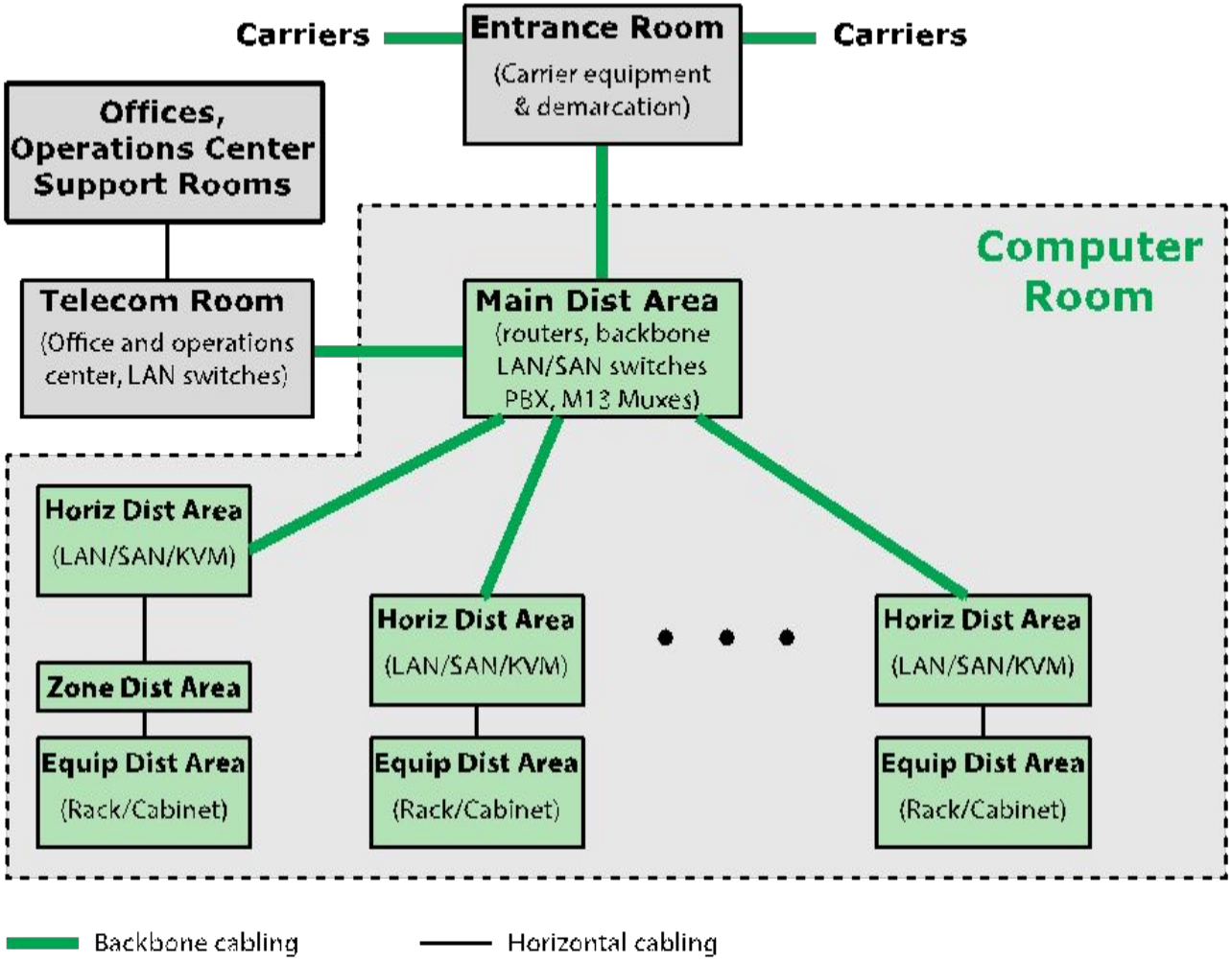


Figure 5.13 TIA-942 Compliant Data Center Showing Key Functional Areas

Tier	System design	Availability /Annual Downtime
1	•Susceptible to disruptions from both planned and unplanned activity •Single path for power and cooling distribution, no redundant components •May or may not have raised floor, UPS, or generator •Takes 3 months to implement •Must be shut down completely to perform preventive maintenance	99.671%/ 28.8 hours
2	•Less susceptible to disruptions from both planned and unplanned activity •Single path for power and cooling distribution, includes redundant components •Includes raised floor, UPS, and generator •Takes 3 to 6 months to implement •Maintenance of power path and other parts of the infrastructure require a processing shutdown	99.741%/ 22.0 hours
3	•Enables planned activity without disrupting computer hardware operation but unplanned events will still cause disruption •Multiple power and cooling distribution paths but with only one path active, includes redundant components •Takes 15 to 20 months to implement •Includes raised floor and sufficient capacity and distribution to carry load on one path while performing maintenance on the other	99.982%/ 1.6 hours
4	•Planned activity does not disrupt critical load and data center can sustain at least one worst-case unplanned event with no critical load impact • Multiple active power and cooling distribution paths, includes redundant components •Takes 15 to 20 months to implement	99.995%/ 0.4 hours

Table 5.4

Data Center Tiers Defined in TIA-942

(Table is on page 177 in textbook)