Database Final Project

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Database Management

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Overview and Business Rules

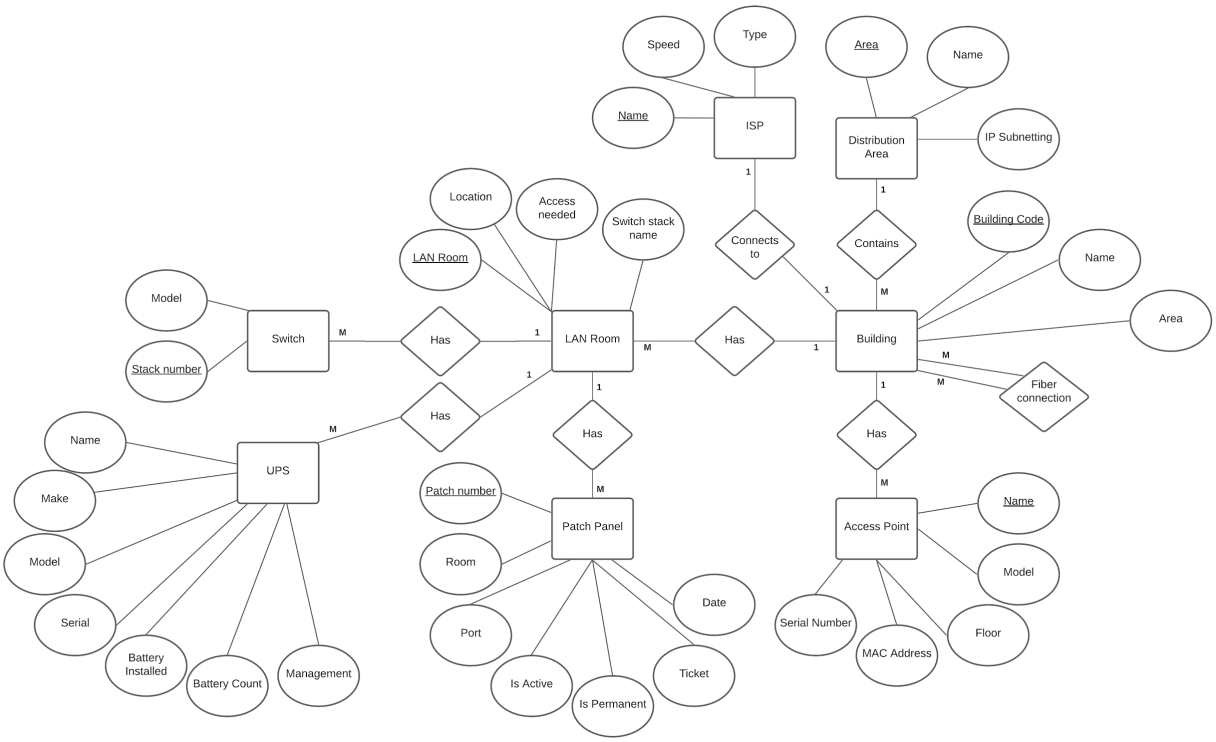
Marist College Networking Department requires a system to document all equipment and connections installed on campus. The database is intended to track everything that the networking department is responsible for, and anything that they install in the future. In addition to tracking, the database can be used by employees to identify which equipment they need to work on to complete tasks. It can also be used for inventory and reporting. By increasing overall levels of documentation, the networking department can become more efficient and provide better service to Marist College.

The system is designed to satisfy the following requirements:

1. The campus has multiple **buildings**. Most buildings have a **LAN room**, some buildings have multiple. If there are multiple, they are often but not always on separate floors. They can be identified either by floor number or cardinal direction.
2. Each LAN room has a single switch stack, which is composed of one or more **switches**. LAN rooms also have a **patch panel**, which has numerous ports. A patch panel port may connect to one switch port. It is important to know which patch panel port has a connection, but not necessary to know which switch port is connected. These connections are either permanent or temporary.
3. Each patch panel port is connected to an ethernet jack somewhere in the building, where a user can plug in a device. It could be a temporary student device in their dorm room, a permanent connection to a faculty/staff computer in an academic building, or a permanent connection to an access point in any building.

4. Students often open tickets to get a port activated in their dorm room. An employee makes the required connection between switch and patch panel. At the end of an academic year, all these temporary connections get unplugged.
5. **Access points** are installed in every building, but not every room. They serve wifi to multiple clients at the same time. It is not needed to document the individual clients.
6. Each building is within a **distribution area**. One building is a central hub, responsible for distributing internet access to the other buildings within the distribution area.
7. The network of one building connects to other buildings via **fiber connections**. There needs to be one connection for a building to be on the network, but multiple connections usually exist for redundancy.
8. LAN rooms often have a **UPS** which provides power to critical equipment in the event of a power failure.
9. The College contracts the service of several **ISP**'s. One is the primary internet connection, and the others are backups. There is also a CDN. Their connections enter the college in several buildings.

ER Diagram


Speed
Type
Area
Name
Name
ISP
Distribution Area
IP Subnetting
1
1
Location
Access needed
Switch stack name
Connects to
Contains
Building Code
LAN Room
1
M
Name
Model
Switch
M
Has
1
LAN Room
M
Has
1
Building
Area
Stack number
M
M
1
Fiber connection
1
Has
1
Has
Has
Name
M
M
UPS
Patch number
Patch Panel
Access Point
Name
Make
M
Model
Room
Model
Date
Serial
Port
Serial Number
Floor
Battery Installed
Is Active
Ticket
MAC Address
Battery Count
Management
Is Permanent

Tables

Distribution Area

```
CREATE TABLE DISTRIBUTION_AREA (
  AREA NUMBER(38, 0) NOT NULL
, NAME NVARCHAR2(20)
, IP_SUBNETTING NVARCHAR2(20)
, PRIMARY KEY (AREA));
```

This table documents the distribution areas. Each area is numbered, named by the building that is used as the central hub for the area, and lists the subnetting used when assigning IP addresses.

Building

```
CREATE TABLE BUILDING (
  BUILDING_CODE NVARCHAR2(30) NOT NULL
, NAME NVARCHAR2(30)
, AREA NUMBER(38, 0)
, PRIMARY KEY (BUILDING_CODE)
, FOREIGN KEY (AREA) REFERENCES DISTRIBUTION_AREA);
```

This table documents buildings on campus. Each building has a name, a short code that is an abbreviation of the name, and is in an area.

LAN Room

```
CREATE TABLE LAN_ROOM (
  LAN_ROOM NVARCHAR2(26) NOT NULL
, BUILDING NVARCHAR2(26)
, LOCATION NVARCHAR2(26)
, SWITCH_STACK_NAME NVARCHAR2(26)
, ACCESS_NEEDED NVARCHAR2(26)
, PRIMARY KEY (LAN_ROOM)
, FOREIGN KEY(BUILDING) REFERENCES BUILDING (BUILDING_CODE));
```

This table documents the LAN rooms on campus. Each is at some location within a building. The location is usually identified by floor, but can also be cardinal direction. The combination of building and location makes the LAN room code, which uniquely identifies a room. Rooms are secured, and usually require a card or a key to enter, which is the access needed. Each room has a switch stack, and its name is used to SSH into it.

Fiber Connection

```
CREATE TABLE FIBER_CONNECTION (
  OUTGOING_BUILDING NVARCHAR2(20) NOT NULL
, INCOMING_BUILDING NVARCHAR2(20) NOT NULL
, PRIMARY KEY (OUTGOING_BUILDING, INCOMING_BUILDING)
, FOREIGN KEY (OUTGOING_BUILDING) REFERENCES BUILDING
(BUILDING_CODE)
, FOREIGN KEY (INCOMING_BUILDING) REFERENCES BUILDING
(BUILDING_CODE));
```

Buildings are connected to each other and the campus network via fiber connections, and these connections are what this table lists. These connections are bidirectional, so the incoming/outgoing naming may be a bit confusing.

ISP

```
CREATE TABLE ISP (
  NAME NVARCHAR2(30) NOT NULL
, SPEED NUMBER(38, 0)
, BUILDING NVARCHAR2(20)
, TYPE NVARCHAR2(20)
, PRIMARY KEY (NAME)
, FOREIGN KEY (BUILDING) REFERENCES BUILDING (BUILDING_CODE));
```

This table lists the ISPs that the college buys service from. They are named, have a max provided speed in Mbps, have a connection point in a building, and are either the primary connection, a backup, or a CDN.

Patch Panel

```
CREATE TABLE PATCH_PANEL (
  LAN_ROOM NVARCHAR2(26) NOT NULL
, PATCH_NUMBER NVARCHAR2(26) NOT NULL
, ROOM NVARCHAR2(38)
, PORT NVARCHAR2(26)
, IS_ACTIVE NUMBER(38, 0)
, IS_PERMANENT NUMBER(38, 0)
, TICKET NVARCHAR2(26)
, DATE_MODIFIED DATE
, NOTE NVARCHAR2(100)
, PRIMARY KEY (LAN_ROOM, PATCH_NUMBER)
, FOREIGN KEY (LAN_ROOM) REFERENCES LAN_ROOM);
```

This table documents patch panel ports. They can be uniquely identified by the LAN room they are in and their number. Each port connects to another port somewhere elsewhere in the building, and the room and port letter are documented. A patch port can be active (1) or not active (0). It can also be permanent (1). Ports are often activated because of a ticket, and the ticket number is recorded, as well as the date it was last changed, and any relevant notes.

Access Point

```
CREATE TABLE ACCESS_POINT (
  BUILDING NVARCHAR2(26) NOT NULL
, NAME NVARCHAR2(128) NOT NULL
, FLOOR NUMBER(38, 0)
, MAC_ADDRESS NVARCHAR2(26)
, MODEL NVARCHAR2(26)
, SERIAL_NUMBER NVARCHAR2(26)
, PRIMARY KEY (BUILDING, NAME)
, FOREIGN KEY (BUILDING) REFERENCES BUILDING (BUILDING_CODE));
```

This table documents access points that are installed in buildings. Their floor is listed, and you can infer the room/location from the AP's name. AP's also have a MAC address, serial number, and a model number.

Switch

```
CREATE TABLE SWITCH (
  LAN_ROOM NVARCHAR2(26) NOT NULL
, STACK_NUMBER NUMBER(38, 0) NOT NULL
, MODEL NVARCHAR2(26)
, PRIMARY KEY (LAN_ROOM, STACK_NUMBER)
, FOREIGN KEY (LAN_ROOM) REFERENCES LAN_ROOM);
```

A switch stack in a LAN room can be composed of multiple switches, and this table lists those. A single switch can be identified by the LAN room and which position in the stack they are in. Each switch has a model number.

UPS

```
CREATE TABLE UPS (
  LAN_ROOM NVARCHAR2(26) NOT NULL
, NAME NVARCHAR2(26)
, MAKE NVARCHAR2(26)
, MODEL NVARCHAR2(26)
, SERIAL NVARCHAR2(26)
, BATTERY_INSTALLED DATE
, BATTERY_MODEL NVARCHAR2(26)
, BATTERY_COUNT NUMBER(38, 0)
, MANAGEMENT NVARCHAR2(26)
, PRIMARY KEY (LAN_ROOM)
, FOREIGN KEY (LAN_ROOM) REFERENCES LAN_ROOM);
```

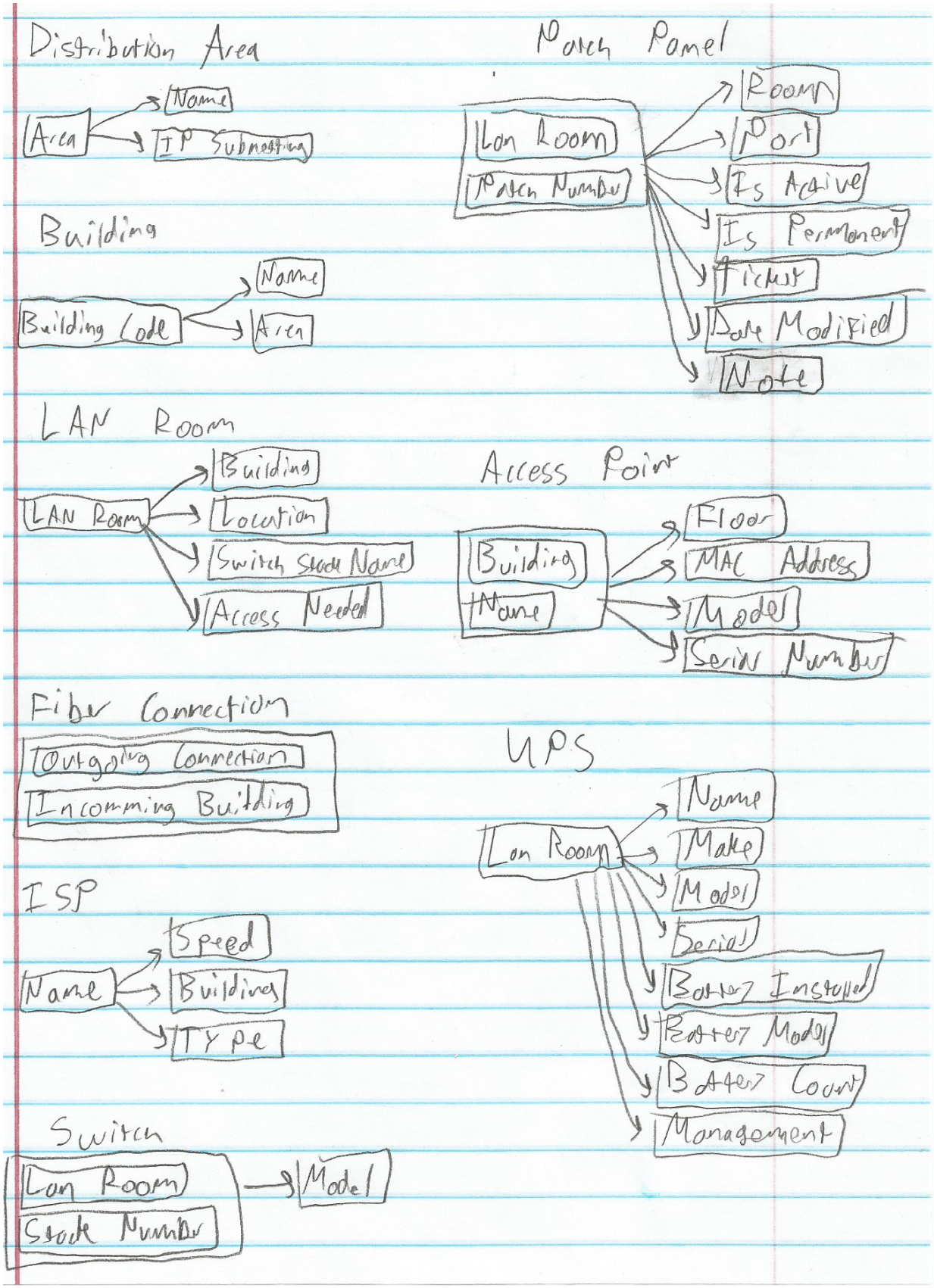
This table documents UPS's that are in LAN rooms. They have a name, make, model, and serial number. This lists the last time a battery was installed, how many batteries are in a UPS, and the battery model numbers. Most UPS's can be managed over the network, but some can't.

Justifications for Third Normal Form

Short answer: Each table is in third normal form because each of them are in 2nf and have no transitive dependencies.

Longer answer: Each of them have a primary key and no repeating groups, so they are in 1nf. They are in 1nf and have no partial dependencies, so they are in 2nf. They are in 2nf and have no transitive dependencies, so they are in 3nf.

See FD diagrams on the next page.


Distribution Area
Area
Name
IP Subnetting
Building
Building Code
Name
Area
LAN Room
LAN Room
Building
Location
Switch Stack Name
Access Needed
Fiber Connection
Outgoing Connection
Incomming Building
ISP
Name
Speed
Building
Type
Switch
Lan Room
Stock Number
Model
Patch Panel
Lan Room
Patch Number
Room
Port
Is Active
Is Permanent
Ticket
Date Modified
Note
Access Point
Building
Name
Floor
MAC Address
Model
Serial Number
UPS
Lan Room
Name
Make
Model
Serial
Battery Installed
Battery Model
Battery Count
Management

SQL Queries

Universal Quantifier

Get buildings that have a direct fiber connection to every other building in the same distribution area. (In other words, get buildings for which there isn't another building in their distribution area that they don't have a fiber connection with.)

```
SELECT *
FROM building b1
WHERE NOT EXISTS
   (SELECT *
   FROM building b2
   WHERE b1.area=b2.area
   AND b1.building_code != b2.building_code
   AND NOT EXISTS
      (SELECT*
      FROM fiber_connection
      WHERE b2.building_code = fiber_connection.incoming_building
      AND b1.building_code  = fiber_connection.outgoing_building
      OR b1.building_code = fiber_connection.incoming_building
      AND b2.building_code  = fiber_connection.outgoing_building));
```

BUILDING_CODE	NAME	AREA
DN	Donnelly	2

Cardinality: 1

Only

Get buildings where the lan room(s) can only be accessed by card.

```
SELECT DISTINCT building_code, building.name, building.area
FROM building, lan_room lr0
WHERE building.building_code = lr0.building
AND building.building_code NOT IN
   (SELECT lr1.building
   FROM lan_room lr1
   WHERE lr1.lan_room NOT IN
      (SELECT lr2.lan_room
      FROM lan_room lr2
      WHERE lr2.access_needed = 'Card'));
```

BUILDING_CODE	NAME	AREA
MC	McCann	2
ST	Steel Plant	5
CH	Champagnat	1
GAD	Building D	3
LWCS	Lower West Cedar S	5
UWCV	Upper West Cedar V	5
AH	Allied Health	5
GAA	Building A	3
GAC	Building C	3
LB	Library	4
GAB	Building B	3
LWCP	Lower West Cedar P	5
MR	Midrise	1

Cardinality: 13

None

Find buildings in area 3 where the lan room(s) use none of the model C9300-48P switches.

```
SELECT DISTINCT building_code, building.name, building.area
FROM building, lan_room lr0
WHERE building.building_code = lr0.building
AND building.area = 3
AND building.building_code NOT IN
   (SELECT lr1.building
   FROM lan_room lr1
   WHERE lr1.lan_room IN
      (SELECT switch.lan_room
      FROM switch
      WHERE switch.model = 'C9300-48P'));
```

BUILDING_CODE	NAME	AREA
FN	Fontaine	3
GAD	Building D	3
GAA	Building A	3
GAC	Building C	3
THA	Town House A	3
THM	Town House M	3
DY	Dyson	3
GAB	Building B	3
SA	Saint Annes Hermitage	3
THB	Town House B	3
THI	Town House I	3

Cardinality: 11

Outer Joins

Left Outer Join

Get all ISP's, as well as the buildings they are connected to, if any.

SELECT isp.name, isp.building, building.name AS buildingName

FROM ISP LEFT JOIN building on building.building_code = isp.building;

NAME	BUILDING	BUILDINGNAME
Crown Castle (Poughkeepsie)	DN	Donnelly
Crown Castle (Kingston)	LWCP	Lower West Cedar P
CDN link	(null)	(null)
NYSERNet Internet2	(null)	(null)
Syracuse PtP link	(null)	(null)

Cardinality: 5

Right Outer Join

Get all buildings, as well as their LAN rooms, if any.

```
SELECT lan_room.lan_room, building.building_code, building.name
FROM lan_room RIGHT JOIN building ON lan_room.building = building.building_code;
```

Cardinality: 90

Full Outer Join

Get all UPS's and the switches that are in the same room, if any, as well as any switches that don't have a UPS.

SELECT UPS.name, switch.lan_room, switch.stack_number, switch.model

FROM UPS FULL JOIN switch on switch.lan_room = UPS.lan_room;

Cardinality: 86

Use of at least 6 tables in a single query

Get the LAN room, patch number, and building rooms for permanent, active patch panel connections which are located in a LAN room which has a UPS with more than 1 battery, uses switch model C9407R, and the building is located within the Champ distribution area.

```
SELECT patch_panel.lan_room, patch_panel.patch_number, patch_panel.room
FROM patch_panel, lan_room, ups, switch, building, distribution_area
WHERE patch_panel.is_permanent = 1
AND patch_panel.is_active = 1
AND patch_panel.lan_room = lan_room.lan_room
AND ups.lan_room = lan_room.lan_room
AND switch.lan_room = lan_room.lan_room
AND ups.battery_count > 1
AND switch.model = 'C9407R'
AND lan_room.building = building.building_code
AND building.area = distribution_area.area
AND distribution_area.name = 'Champ';
```

LAN_ROOM	PATCH_NUMBER	ROOM
CH-1	101	623
CH-1	124	323
CH-1	143	902
CH-1	161	502
CH-1	214	509
CH-1	224	222
CH-1	24	625
CH-1	272	807
CH-1	316	822
CH-1	340	504
CH-1	351	419
CH-1	360	920
CH-1	380	615
CH-1	385	715
CH-1	393	916
CH-1	424	215
CH-1	474	612
CH-1	50	327
CH-1	500	913
CH-1	505	211
CH-1	52	828
CH-1	534	610
CH-1	558	413
CH-1	56	923
CH-1	606	228
CH-1	84	606

Cardinality: 26

A collection of three additional queries

Extra query #1

Get LAN room codes that have a model ‘Smart-UPS 1500’ UPS or model ‘C9407R’ switch.

```
SELECT ups.lan_room

FROM ups

WHERE ups.model = 'Smart-UPS 1500'


UNION


SELECT switch.lan_room

FROM switch

WHERE switch.model = 'C9407R';
```

LAN_ROOM
AS-1
BH-2
BY-0
CH-1
FN-0
FU1-1
FU2-1
FU3-1
FU4-1
FU5-1
FU6-1
FU7-1
FU8-1
GS-0
LB-2
LB-3
SC-0
SU-0
THA-1
UWCV-1
WH-1

Cardinality: 21

Extra query #2

Count the number of access points on each floor in each building, but only if that building has a LAN room which is accessible by card.

```
SELECT access_point.building, access_point.floor, count(access_point.name) AS apCount
FROM access_point, lan_room
WHERE lan_room.building = access_point.building
AND lan_room.access_needed = 'Card'
GROUP BY access_point.building, access_point.floor;
```

Cardinality: 55

Extra query #3

Get all buildings that are in the same area as a building which is connected to an ISP.

```
SELECT *
FROM building b1
WHERE b1.area IN
   (SELECT b2.area
   FROM building b2
   WHERE b2.building_code IN
      (SELECT isp.building
      FROM isp));
```

Cardinality: 41