Таблица 1 – Node labels

Label	Meaning	Color
LR	Линейный разъединитель (ЛР)	Зеленый
TP	Трансформаторная подстанция (ТП)	Коричневый
PS35	Подстанция номинального напряжения 35/10 кВ (ПС)	Красный

Таблица 2 – Property Keys

Key	Meaning
name	Наименование
number_lr	Номер ЛР, с которым ТП
number_vl	Номер ВЛ (высоковольтной линии), которая соединяет ТП с ЛР или ПС
nominal_voltage	Номинальное напряжение

Таблица 3 – Relationship Types

Type		Meaning
CONNECTION_LR		Соединение ТП с ЛР
CON_BETWEEN_LR		Соединение между ЛР
CONNECTION_PS		Соединение ТП с ПС
CON_PS_LR		Соединение ПС с ЛР

Листинг

```
CREATE (tp092:TP {name:'St.Sverdl.24_ramp'})

CREATE (tp093:TP {name:'St.Green,Budennogo'})

CREATE (lr032:LR {name:'LR_032'})

CREATE

  (tp092)-[:CONNECTION_LR {number_lr:32}]->(lr032),

  (tp093)-[:CONNECTION_LR {number_lr:32}]->(lr032)


CREATE (tp089:TP {name:'Parkovaya'})

CREATE (tp088:TP {name:'St.Lenina,Komsomolskaya,School'})

CREATE (tp090:TP {name:'St.Lenina,Pervomayskaya,Komsomolskaya'})

CREATE (lr030:LR {name:'LR_030'})

CREATE

  (tp089)-[:CONNECTION_LR {number_lr:30, name: ['VL'], nominal_voltage:10,
number_vl:16}]->(lr030),

  (tp088)-[:CONNECTION_LR {number_lr:30, name: ['VL'], nominal_voltage:10,
number_vl:16}]->(lr030),
```

```
    (tp090)-[:CONNECTION_LR {number_lr:30, name: ['VL'], nominal_voltage:10,
number_vl:16}]->(lr030)


MATCH (a:LR), (m:LR)

WHERE a.name = 'LR_032' AND m.name = 'LR_030'

CREATE (a)-[:CON_BETWEEN_LR]->(m)

RETURN a, m


CREATE (tp140:TP {name:'Pumping station, gym'})

CREATE (tp094:TP {name:'St.Oktyabrskaya'})

CREATE (tp091:TP {name:'St.Zarechnaya,Prudki,Bath'})

CREATE (tp095:TP {name:'St.Novikova,Tele2'})

CREATE (ps:PS35 {name:'Semzavod', nominal_voltage:'35/10'})

CREATE

  (tp140)-[:CONNECTION_PS]->(ps),

  (tp094)-[:CONNECTION_PS]->(ps),

  (tp091)-[:CONNECTION_PS]->(ps),

  (tp095)-[:CONNECTION_PS]->(ps)


MATCH (a:LR), (m:PS35)

WHERE a.name = 'LR_030' AND m.name = 'Semzavod'

CREATE (a)-[:CON_PS_LR]->(m)

RETURN a, m


CREATE (tp082:TP {name:'St.Molodezhnaya'})

CREATE (tp081:TP {name:'St.Narodnaya'})

CREATE (tp085:TP {name:'Ozerki(current)'})


MATCH (a:TP), (m:PS35)

WHERE a.name = 'St.Narodnaya' OR a.name = 'Ozerki(current)' or a.name =
'St.Molodezhnaya' AND m.name = 'Semzavod'

CREATE

  (a)-[:CONNECTION_PS {name: ['VL'], nominal_voltage:10, number_vl:10}]->(m)


CREATE (tp067:TP {name:'8 March street, Lesnaya'})

CREATE (lr027:LR {name:'LR_027'})
```

```
CREATE
  (tp067)-[:CONNECTION_LR {number_lr:27}]->(lr027)


CREATE (tp068:TP {name:'St.Vatutina, politotdelskaya'})
CREATE (tp071:TP {name:'St.Vatutina(current)'})
CREATE (tp069:TP {name:'St.Vatutina,Elbrus'})
CREATE (lr026:LR {name:'LR_026'})
CREATE
  (tp068)-[:CONNECTION_LR {number_lr:26}]->(lr026),
  (tp069)-[:CONNECTION_LR {number_lr:26}]->(lr026),
  (tp071)-[:CONNECTION_LR {number_lr:26}]->(lr026)


MATCH (a:LR), (m:LR)
WHERE a.name = 'LR_027' AND m.name = 'LR_026'
CREATE (a)-[:CON_BETWEEN_LR]->(m)
RETURN a, m


CREATE (tp077:TP {name:'St.Krasnostepovskaya'})
CREATE (tp076:TP {name:'Well'})
CREATE (tp075:TP {name:'St.Gagarina'})
CREATE (tp073:TP {name:'St.Dzerzhinskogo'})
CREATE (tp074:TP {name:'Village council central,Embankment'})
CREATE (tp072:TP {name:'St.Shkolnaya, Vishnev, Hospital'})
CREATE (lr025:LR {name:'LR_025'})
CREATE
  (tp077)-[:CONNECTION_LR {number_lr:25}]->(lr025),
  (tp076)-[:CONNECTION_LR {number_lr:25}]->(lr025),
  (tp075)-[:CONNECTION_LR {number_lr:25}]->(lr025),
  (tp073)-[:CONNECTION_LR {number_lr:25}]->(lr025),
  (tp074)-[:CONNECTION_LR {number_lr:25}]->(lr025),
  (tp072)-[:CONNECTION_LR {number_lr:25}]->(lr025)


CREATE (tp064:TP {name:'Kids camp'})
CREATE (tp065:TP {name:'Club'})
CREATE (lr024:LR {name:'LR_024'})
```

```
CREATE

  (tp064)-[:CONNECTION_LR {number_lr:24}]->(lr024),

  (tp065)-[:CONNECTION_LR {number_lr:24}]->(lr024)


MATCH (a:LR), (m:LR)

WHERE a.name = 'LR_026' AND m.name = 'LR_024'

CREATE (a)-[:CON_BETWEEN_LR]->(m)

RETURN a, m


MATCH (n:TP { name: 'Village council central,Embankment' })

DETACH DELETE n


MATCH (a:LR), (m:PS35)

WHERE a.name = 'LR_024' AND m.name = 'Semzavod'

CREATE (a)-[:CON_PS_LR]->(m)

RETURN a, m


CREATE (tp078:TP {name:'Gas'})

CREATE (tp080:TP {name:'Megaphone'})

CREATE (tp063:TP {name:'Khutor mokrenkiy'})

MATCH (a:TP), (m:PS35)

WHERE a.name = 'Gas' OR a.name = 'Megaphone' or a.name = 'Khutor mokrenkiy' AND
m.name = 'Semzavod'

CREATE
  (a)-[:CONNECTION_PS {name: ['VL'], nominal_voltage:10, number_vl:9}]->(m)
```

JSON file with nodes

```
[
  {
    "n": {
"identity": 0,
"labels": [
        "TP"
    ],
"properties": {
"name": "St.Sverdl.24_ramp"
    }
   }
  },
  {
    "n": {
"identity": 1,
"labels": [
```

```json
        "TP"
    ],
    "properties": {
    "name": "St.Green,Budennogo"
        }
    }
  },
  {
    "n": {
    "identity": 2,
    "labels": [
        "LR"
    ],
    "properties": {
    "name": "LR_032"
        }
    }
  },
  {
    "n": {
    "identity": 3,
    "labels": [
        "TP"
    ],
    "properties": {
    "name": "Parkovaya"
        }
    }
  },
  {
    "n": {
    "identity": 4,
    "labels": [
        "TP"
    ],
    "properties": {
    "name": "St.Lenina,Komsomolskaya,School"
        }
    }
  },
  {
    "n": {
    "identity": 5,
    "labels": [
        "TP"
    ],
    "properties": {
    "name": "St.Lenina,Pervomayskaya,Komsomolskaya"
        }
    }
  },
  {
    "n": {
    "identity": 6,
    "labels": [
        "LR"
    ],
    "properties": {
    "name": "LR_030"
        }
    }
  },
  {
    "n": {
    "identity": 7,
```

```json
        "labels": [
                "TP"
        ],
"properties": {
"name": "Pumping station, gym"
        }
    }
},
{
    "n": {
"identity": 8,
"labels": [
        "TP"
    ],
"properties": {
"name": "St.Oktyabrskaya"
    }
    }
},
{
    "n": {
"identity": 9,
"labels": [
        "TP"
    ],
"properties": {
"name": "St.Zarechnaya,Prudki,Bath"
    }
    }
},
{
    "n": {
"identity": 10,
"labels": [
        "TP"
    ],
"properties": {
"name": "St.Novikova,Tele2"
    }
    }
},
{
    "n": {
"identity": 11,
"labels": [
        "PS35"
    ],
"properties": {
"name": "Semzavod",
"nominal_voltage": "35/10"
    }
    }
},
{
    "n": {
"identity": 12,
"labels": [
        "TP"
    ],
"properties": {
"name": "St.Molodezhnaya"
    }
    }
},
{
```

```json
      "n": {
"identity": 13,
"labels": [
          "TP"
      ],
"properties": {
"name": "St.Narodnaya"
      }
    }
  },
  {
      "n": {
"identity": 14,
"labels": [
          "TP"
      ],
"properties": {
"name": "Ozerki(current)"
      }
    }
  },
  {
      "n": {
"identity": 15,
"labels": [
          "TP"
      ],
"properties": {
"name": "8 March street, Lesnaya"
      }
    }
  },
  {
      "n": {
"identity": 16,
"labels": [
          "LR"
      ],
"properties": {
"name": "LR_027"
      }
    }
  },
  {
      "n": {
"identity": 17,
"labels": [
          "TP"
      ],
"properties": {
"name": "St.Vatutina, politotdelskaya"
      }
    }
  },
  {
      "n": {
"identity": 18,
"labels": [
          "TP"
      ],
"properties": {
"name": "St.Vatutina(current)"
      }
    }
  },
```

```json
  {
    "n": {
"identity": 19,
"labels": [
        "TP"
      ],
"properties": {
"name": "St.Vatutina,Elbrus"
      }
    }
  },
  {
    "n": {
"identity": 20,
"labels": [
        "LR"
      ],
"properties": {
"name": "LR_026"
      }
    }
  },
  {
    "n": {
"identity": 21,
"labels": [
        "TP"
      ],
"properties": {
"name": "St.Krasnostepovskaya"
      }
    }
  },
  {
    "n": {
"identity": 22,
"labels": [
        "TP"
      ],
"properties": {
"name": "Well"
      }
    }
  },
  {
    "n": {
"identity": 23,
"labels": [
        "TP"
      ],
"properties": {
"name": "St.Gagarina"
      }
    }
  },
  {
    "n": {
"identity": 24,
"labels": [
        "TP"
      ],
"properties": {
"name": "St.Dzerzhinskogo"
      }
    }
  }
```

```json
    },
    {
        "n": {
"identity": 25,
"labels": [
            "TP"
        ],
"properties": {
"name": "Village council central,Embankment"
        }
    }
    },
    {
        "n": {
"identity": 26,
"labels": [
            "TP"
        ],
"properties": {
"name": "St.Shkolnaya, Vishnev, Hospital"
        }
    }
    },
    {
        "n": {
"identity": 27,
"labels": [
            "LR"
        ],
"properties": {
"name": "LR_025"
        }
    }
    },
    {
        "n": {
"identity": 28,
"labels": [
            "TP"
        ],
"properties": {
"name": "Kids camp"
        }
    }
    },
    {
        "n": {
"identity": 29,
"labels": [
            "TP"
        ],
"properties": {
"name": "Club"
        }
    }
    },
    {
        "n": {
"identity": 30,
"labels": [
            "LR"
        ],
"properties": {
"name": "LR_024"
        }
```

```json
        }
    },
    {
        "n": {
            "identity": 31,
            "labels": [
                "TP"
            ],
            "properties": {
                "name": "Gas"
            }
        }
    },
    {
        "n": {
            "identity": 32,
            "labels": [
                "TP"
            ],
            "properties": {
                "name": "Megaphone"
            }
        }
    },
    {
        "n": {
            "identity": 33,
            "labels": [
                "TP"
            ],
            "properties": {
                "name": "Khutor mokrenkiy"
            }
        }
    }
]
```

Relationship properties

[{"name":"St.Green,Budennogo"},{"number_lr":32},{"name":"LR_032"}]

[{"name":"St.Sverdl.24_ramp"},{"number_lr":32},{"name":"LR_032"}]

[{"name":"LR_032"},{},{"name":"LR_030"}]

[{"name":"St.Lenina,Pervomayskaya,Komsomolskaya"},{"name":["VL"],"nominal_voltage":10,"number_lr":30,"number_vl":16},{"name":"LR_030"}]

[{"name":"St.Lenina,Komsomolskaya,School"},{"name":["VL"],"nominal_voltage":10,"number_lr":30,"number_vl":16},{"name":"LR_030"}]

[{"name":"Parkovaya"},{"name":["VL"],"nominal_voltage":10,"number_lr":30,"number_vl":16},{"name":"LR_030"}]

[{"name":"Khutor mokrenkiy"},{"name":["VL"],"nominal_voltage":10,"number_vl":9},{"name":"Semzavod","nominal_voltage":"35/10"}]

[{"name":"Megaphone"},{"name":["VL"],"nominal_voltage":10,"number_vl":9},{"name":"Semzavod","nominal_voltage":"35/10"}]

[{"name":"Gas"},{"name":["VL"],"nominal_voltage":10,"number_vl":9},{"name":"Semzavod","nominal_voltage":"35/10"}]

[{"name":"LR_024"},{},{"name":"Semzavod","nominal_voltage":"35/10"}]

[{"name":"Ozerki(current)"},{"name":["VL"],"nominal_voltage":10,"number_vl":10},{"name":"Semzavod","nominal_voltage":"35/10"}]

[{"name":"St.Narodnaya"},{"name":["VL"],"nominal_voltage":10,"number_vl":10},{"name":"Semzavod","nominal_voltage":"35/10"}]

[{"name":"St.Molodezhnaya"},{"name":["VL"],"nominal_voltage":10,"number_vl":10},{"name":"Semzavod","nominal_voltage":"35/10"}]

[{"name":"LR_030"},{},{"name":"Semzavod","nominal_voltage":"35/10"}]

[{"name":"St.Novikova,Tele2"},{},{"name":"Semzavod","nominal_voltage":"35/10"}]

[{"name":"St.Zarechnaya,Prudki,Bath"},{},{"name":"Semzavod","nominal_voltage":"35/10"}]

[{"name":"St.Oktyabrskaya"},{},{"name":"Semzavod","nominal_voltage":"35/10"}]

[{"name":"Pumping station, gym"},{},{"name":"Semzavod","nominal_voltage":"35/10"}]

[{"name":"8 March street, Lesnaya"},{"number_lr":27},{"name":"LR_027"}]

[{"name":"LR_027"},{},{"name":"LR_026"}]

[{"name":"St.Vatutina(current)"},{"number_lr":26},{"name":"LR_026"}]

[{"name":"St.Vatutina,Elbrus"},{"number_lr":26},{"name":"LR_026"}]

[{"name":"St.Vatutina, politotdelskaya"},{"number_lr":26},{"name":"LR_026"}]

[{"name":"St.Shkolnaya, Vishnev, Hospital"},{"number_lr":25},{"name":"LR_025"}]

[{"name":"Village council central,Embankment"},{"number_lr":25},{"name":"LR_025"}]

[{"name":"St.Dzerzhinskogo"},{"number_lr":25},{"name":"LR_025"}]

[{"name":"St.Gagarina"},{"number_lr":25},{"name":"LR_025"}]

[{"name":"Well"},{"number_lr":25},{"name":"LR_025"}]

[{"name":"St.Krasnostepovskaya"},{"number_lr":25},{"name":"LR_025"}]

[{"name":"LR_026"},{},{"name":"LR_024"}]

[{"name":"LR_025"},{},{"name":"LR_024"}]

[{"name":"Club"},{"number_lr":24},{"name":"LR_024"}]

[{"name":"Kids camp"},{"number_lr":24},{"name":"LR_024"}]

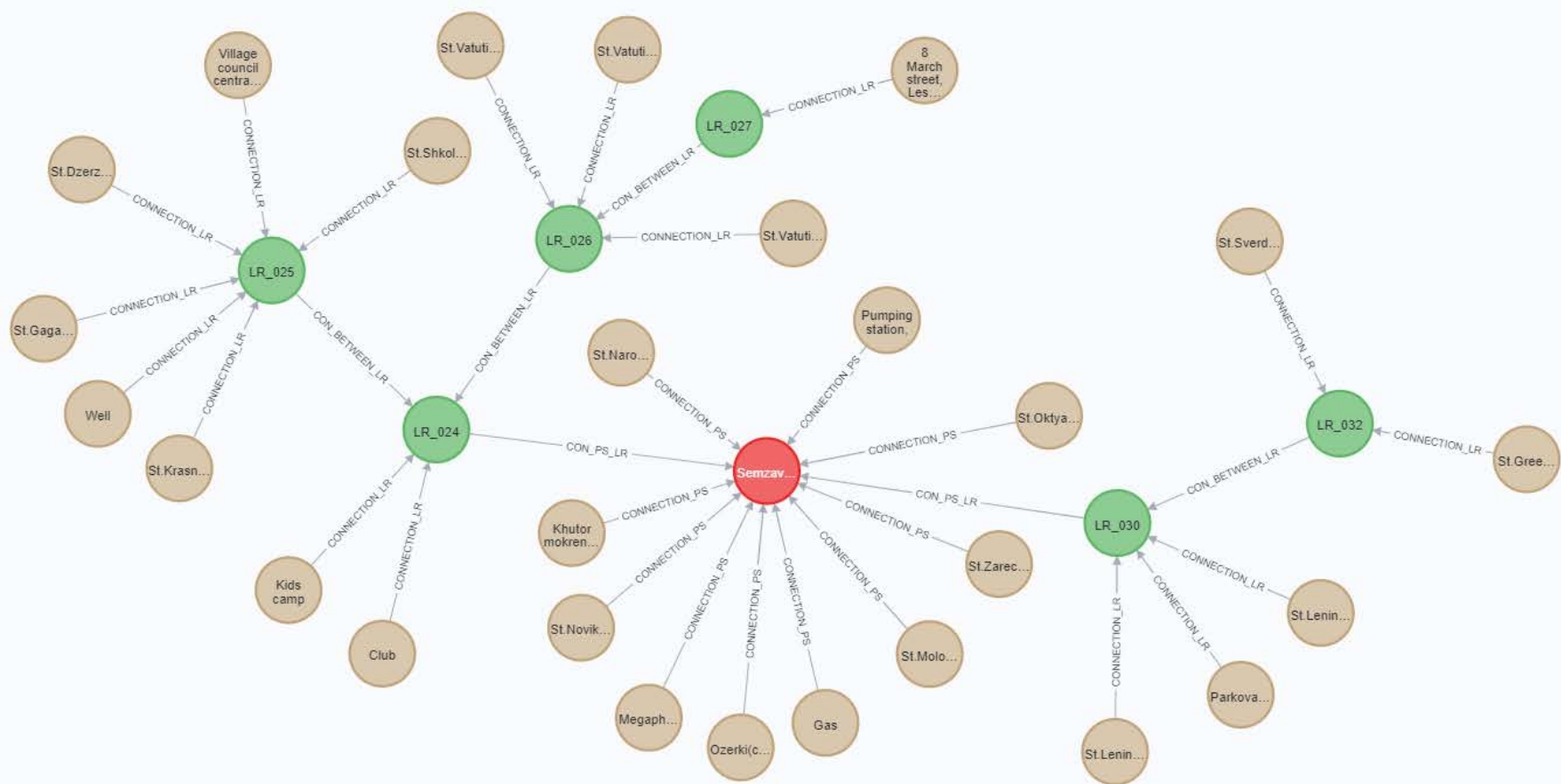Рисунок 1 – БД в виде графа

Запросы

1. Найти имена всех ТП, которые принадлежат заданному ЛР.

Листинг

```
MATCH (t:TP)-[:CONNECTION_LR]->(l:LR {name:'LR_025'})
RETURN t.name AS name
```

"name"
"St.Shkolnaya, Vishnev, Hospital"
"Village council central,Embankment"
"St.Dzerzhinskogo"
"St.Gagarina"
"Well"
"St.Krasnostepovskaya"

Рисунок 2 – Результат реализации запроса 1

2. Вывести списком все ТП и ЛР, с которым они соединяются с сортировкой по имени ЛР.

Листинг

```
MATCH (t:TP)-[:CONNECTION_LR]->(l:LR)
RETURN l.name AS name_LR, t.name AS name_TP
ORDER BY l.name
```

"name_LR"	"name_TP"
"LR_024"	"Club"
"LR_024"	"Kids camp"
"LR_025"	"St.Shkolnaya, Vishnev, Hospital"
"LR_025"	"Village council central,Embankment"
"LR_025"	"St.Dzerzhinskogo"
"LR_025"	"St.Gagarina"
"LR_025"	"Well"
"LR_025"	"St.Krasnostepovskaya"
"LR_026"	"St.Vatutina(current)"
"LR_026"	"St.Vatutina,Elbrus"
"LR_026"	"St.Vatutina, politotdelskaya"

Рисунок 3 – Результат реализации запроса 2

3. Найти все типы связей между объектом ПС «Семзавод» и объектами, с которыми ПС соединяется напрямую.

Листинг

```
MATCH (p)-[rel]->(:PS35 {name:'Semzavod'})
RETURN p.name, type(rel)
```

"p.name"	"type(rel)"
"Khutor mokrenkiy"	"CONNECTION_PS"
"Megaphone"	"CONNECTION_PS"
"Gas"	"CONNECTION_PS"
"LR_024"	"CON_PS_LR"
"Ozerki(current)"	"CONNECTION_PS"
"St.Narodnaya"	"CONNECTION_PS"
"St.Molodezhnaya"	"CONNECTION_PS"
"LR_030"	"CON_PS_LR"
"St.Novikova,Tele2"	"CONNECTION_PS"
"St.Zarechnaya,Prudki,Bath"	"CONNECTION_PS"
"St.Oktyabrskaya"	"CONNECTION_PS"

Рисунок 4 – Результат реализации запроса 3

4. Вернуть список всех ЛР, которые запитываются от ПС «Семзавод» посредством соединения через другие ЛР (т.е. запитываются не напрямую).

Листинг

```
MATCH(:PS35)<-[:CON_PS_LR]-(:LR)<-[:CON_BETWEEN_LR*]-(l:LR)
RETURN l.name
```

	l.name
1	"LR_032"
2	"LR_026"
3	"LR_027"
4	"LR_025"

Рисунок 5 – Результат реализации запроса 4

5. Вернуть все ТП, которые запитываются от ПС «Семзавод» как напрямую, так и не напрямую.

Листинг

```
MATCH  (:PS35)<-[:CONNECTION_PS]-(a:TP)
RETURN a.name AS name
UNION
MATCH  (:PS35)<-[:CON_PS_LR]-(:LR)<-[:CONNECTION_LR]-(t:TP)
RETURN t.name AS name
UNION
MATCH (:PS35)<-[:CON_PS_LR]-(:LR)<-[:CON_BETWEEN_LR*]-(:LR)<-
[:CONNECTION_LR]-(p:TP)
RETURN p.name AS name
```

Или

```
MATCH  (:PS35)<-
[:CONNECTION_PS|CON_PS_LR|CONNECTION_LR|CON_BETWEEN_LR*]-
(a:TP)
RETURN a.name
```


	name
22	"St.Shkolnaya, Vishnev, Hospital"
23	"Village council central,Embankment"
24	"St.Dzerzhinskogo"
25	"St.Gagarina"
26	"Well"
27	"St.Krasnostepovskaya"

rted streaming 27 records in less than 1 ms and completed in less than 1 ms.

Рисунок 6 – Результат реализации запроса 5

6. Посмотреть список ТП, которые запитываются посредством ВЛ 10 кВ.

Листинг

```
MATCH (t:TP)-[rel:CONNECTION_PS|CONNECTION_LR {name: ['VL'],
nominal_voltage:10}]->()
RETURN t.name
```

t.name
1 "Parkovaya"
2 "St.Lenina,Komsomolskaya,School"
3 "St.Lenina,Pervomayskaya,Komsomolskaya"
4 "St.Molodezhnaya"
5 "St.Narodnaya"
6 "Ozerki(current)"
7 "Gas"

ted streaming 9 records after 2 ms and completed after 8 ms.

Рисунок 7 – Результат реализации запроса 6

7. Посмотреть список всех объектов, которые связаны с заданной ЛР, как напрямую, так и нет

Листинг
```
MATCH (:LR {name:'LR_024'})-[:CONNECTION_LR|CON_BETWEEN_LR*]-
(t)
RETURN t.name
```


t.name
10 "St.Dzerzhinskogo"
11 "St.Gagarina"
12 "Well"
13 "St.Krasnostepovskaya"
14 "Club"
15 "Kids camp"

arted streaming 15 records after 2 ms and completed after 4 ms.

Рисунок 8 – Результат реализации запроса 7

8. Найти кратчайший путь между заданными объектами (например, ТП)

Листинг

```
MATCH (a:TP {name:'8 March street, Lesnaya'}),(b:TP
{name:'Parkovaya'}), p=shortestPath((a)-[*..15]-(b))
RETURN p
```
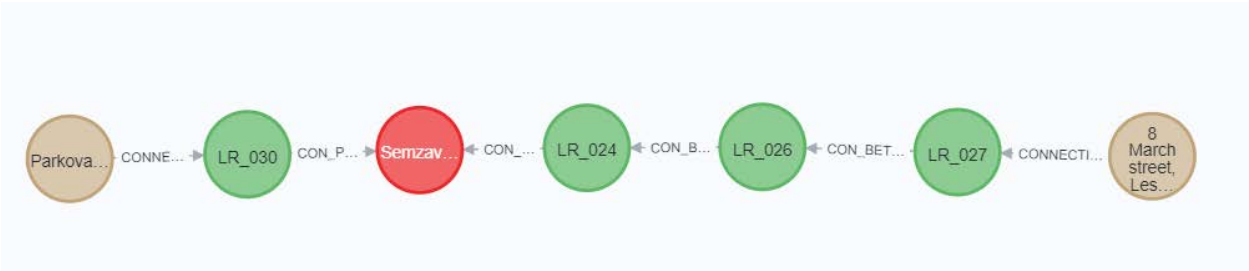

Рисунок 9 – Результат реализации запроса 8

9. Значения можно также объединить в списки. Поэтому запрос 1 можно реализовать с помощью списков, а также с помощью функции size узнать количество элементов в списке.

Листинг

```
MATCH (t:TP)-[:CONNECTION_LR]->(l:LR {name:'LR_025'})
RETURN collect (t.name) AS name_TP, size(collect(t.name)) as
size_TP
```

name_TP	size_TP
["St.Shkolnaya, Vishnev, Hospital", "Village council central,Embankment", "St.Dzerzhinskogo", "St.Gagarina", "Well", "St.Krasnostepovskaya"]	6

Рисунок 10 – Результат реализации запроса 9

10. Возвращать данные об узлах можно также с использованием картографической проекции. Например, если мы хотим найти ТП, которые в своем названии содержит улицу Ленина, то с использованием картографиечкой проекции это можно реализовать следующим образом.

Листинг

```
MATCH (t:TP)
WHERE t.name CONTAINS 'Lenina'
RETURN t { .name} AS name_TP
```

Рисунок 11 – Результат реализации запроса 10

11. Найти ЛР, у которых количество подсоединенных ТП от 2 до 3. Вернуть наименование ЛР, количество ТП и наименование ТП.

Листинг

```
MATCH (l:LR)-[:CONNECTION_LR]-(t:TP)
WITH  l, count(t) AS numTP, collect(t.name) as name_TP
WHERE 1 < numTP < 4
RETURN l.name, numTP, name_TP
ORDER BY l.name
```


Рисунок 12 – Реализация запроса 11

12. Найти объекты, связанные с ЛР, которые напрямую связаны с ПС. Данный запрос можно реализовать с использованием подзапроса с WITH.

Листинг

```
MATCH (:PS35)<-[:CON_PS_LR]-(l:LR)
WITH l
MATCH (l)<-[r:CONNECTION_LR|CON_BETWEEN_LR]-(t)
RETURN l.name, collect(t.name)
```

Рисунок 13 – Реализация запроса 12

13. Также можно выполнить подзапрос с использованием CALL. Например, найти ТП, которое начинается с «P*». Вернуть имя ТП и ЛР, с которым ТП соединяется.

Листинг

```
CALL
{MATCH (t:TP)-[:CONNECTION_LR|CONNECTION_PS]->(l)
RETURN t,l}
MATCH (t) WHERE t.name =~ 'P.*'
RETURN l.name, t.name
```


Рисунок 14 – Реализация запроса 13