Case Study: Autonomic Network Configuration Using Machine Learning

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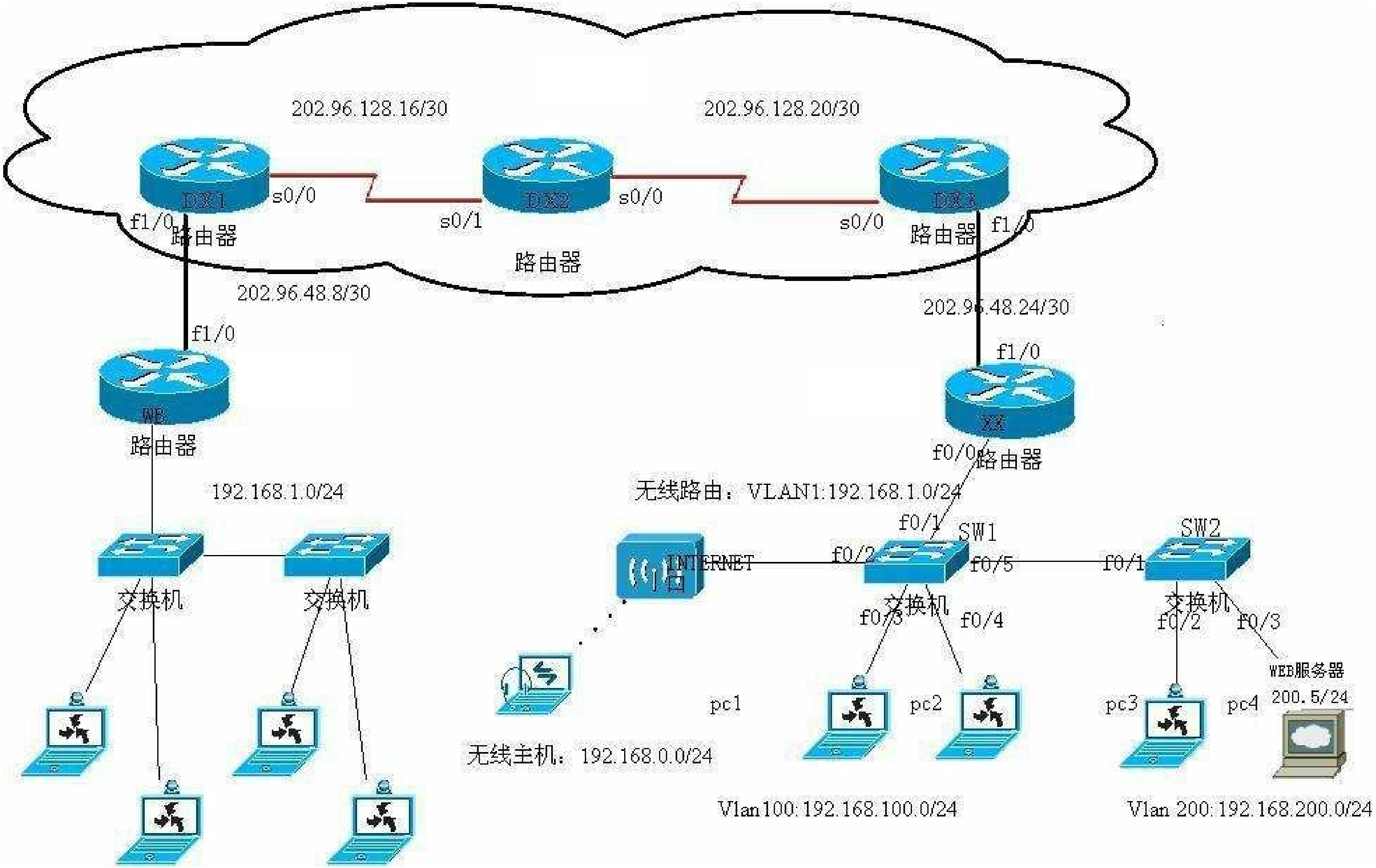
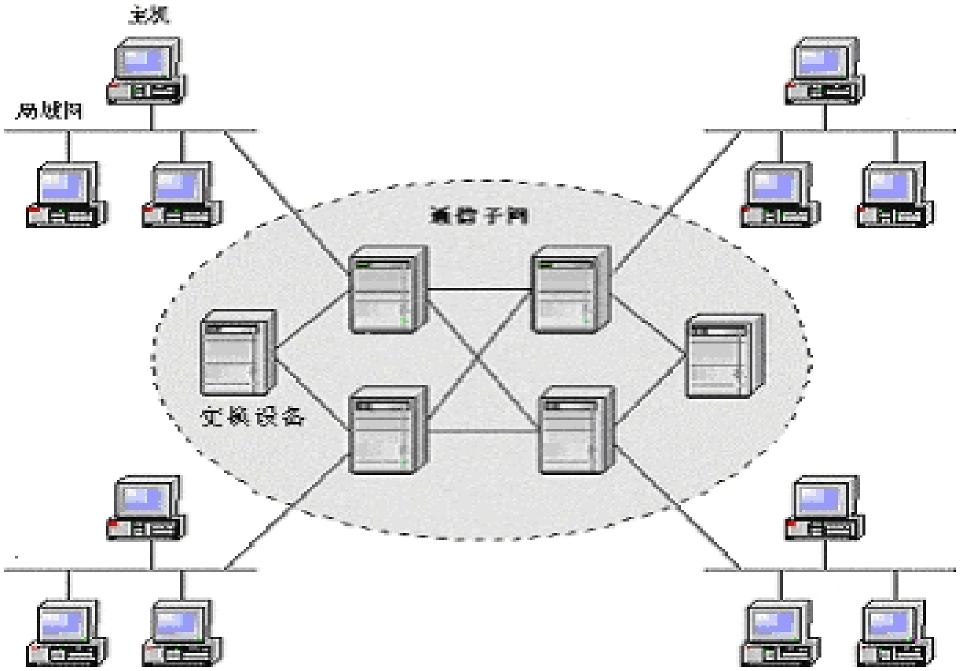
Devices Well Organized in Networks

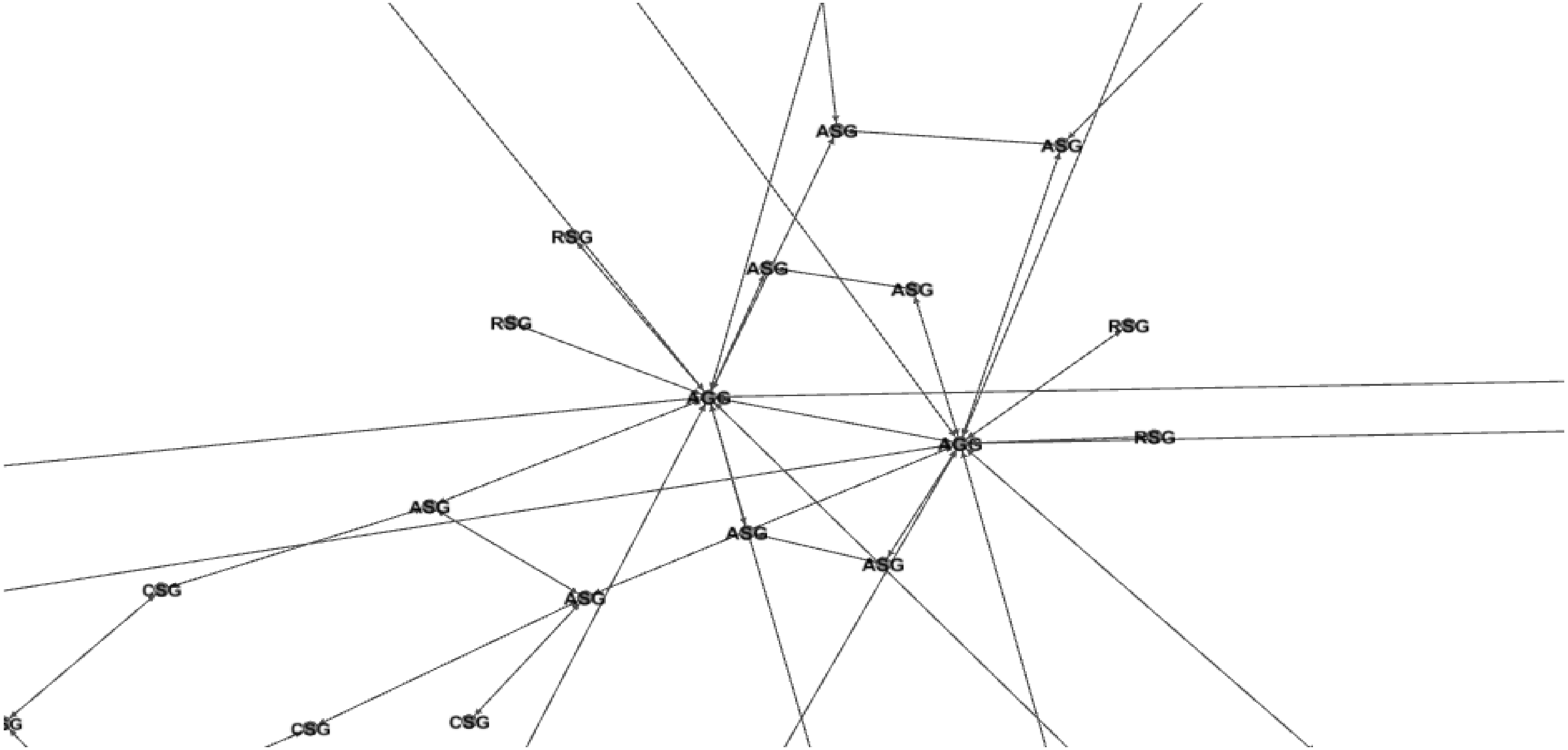


Setup New Networks & Add/Remove Devices



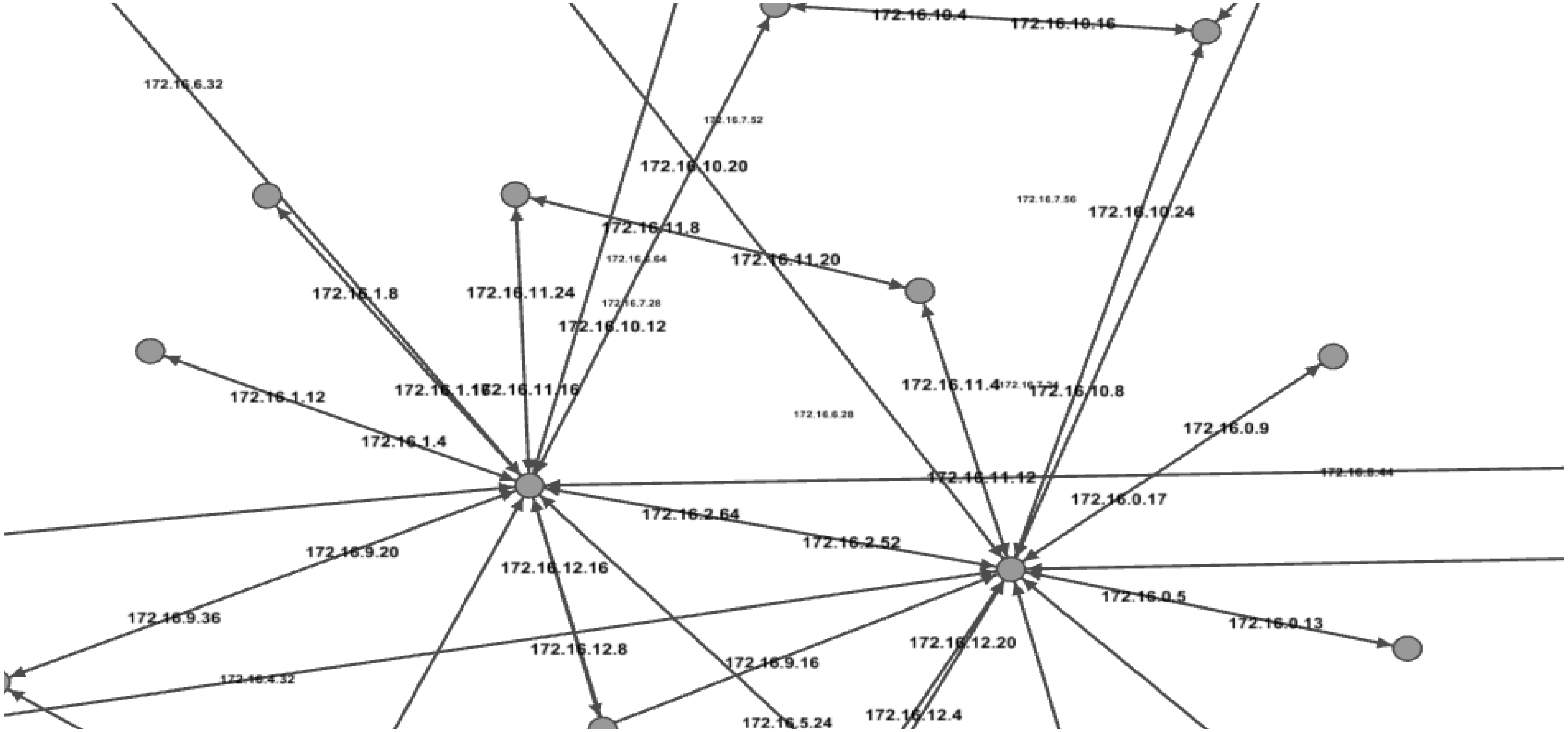
Device Parameter Configuration

Input → Network Topology, Device Vendor, Type, etc.



Device Parameter Configuration

Output → Parameters: IP addresses, IGP Area ID, IGP Cost, etc.

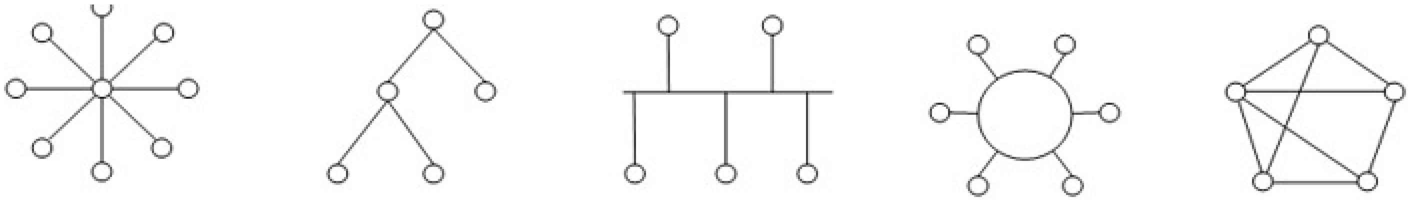


Why Machine Learning?

- Traditional: Program Aided Artificial Configuration
  - Strictly Pre-defined Programs: inflexible adaption to new networks
  - Long Artificial Processing Time: inefficient & huge cost
- Machine Learning: Automatic Configuration
  - Flexible & Universal: learning from exiting networks rather than strict pre-rules
  - Incremental Learning: self-adaptive to new networks
  - Quick Automatic Processing : efficient & low cost

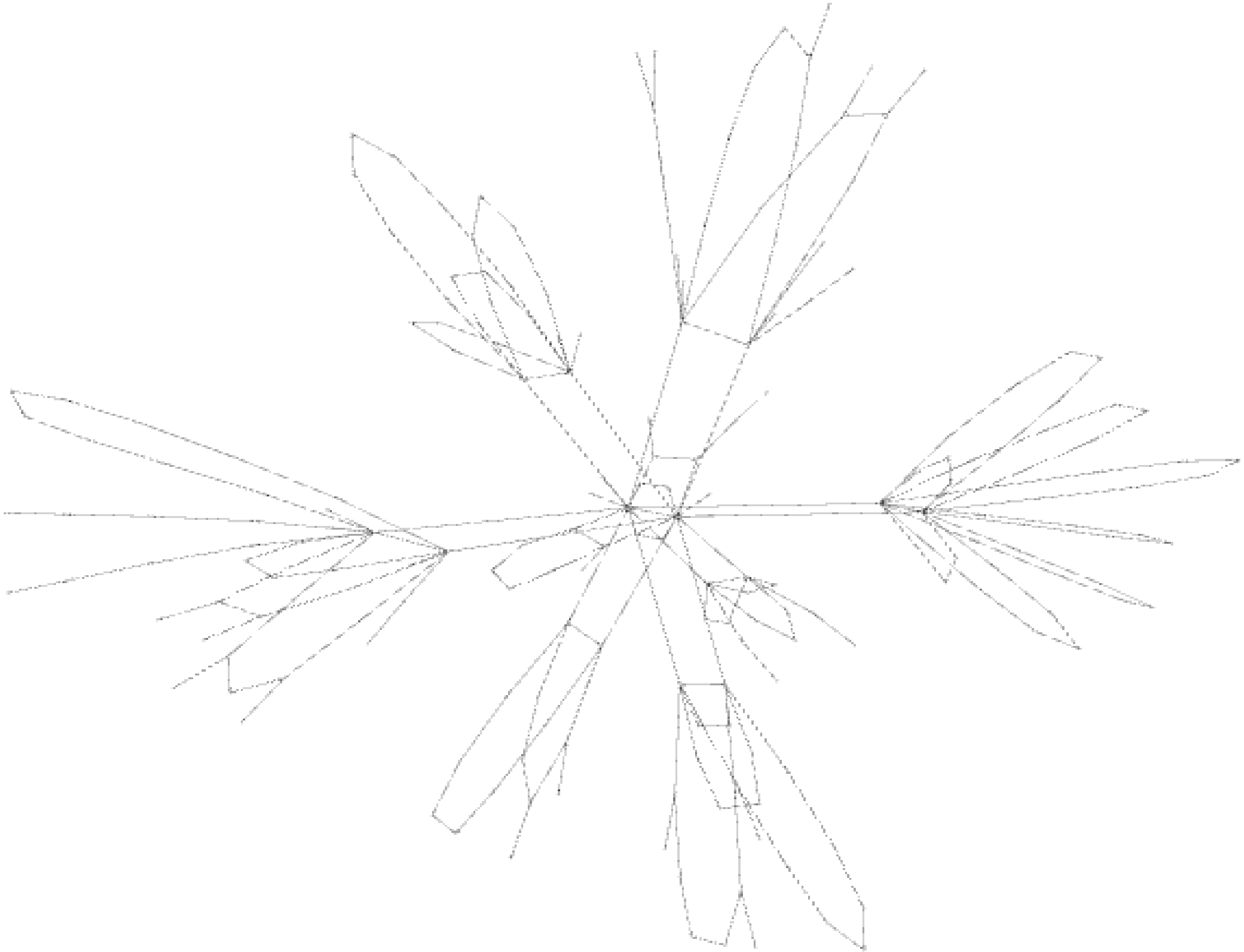
Case Study: Automatic Device Configuration
(A project collaborated with Huawei)

- Adapt to Hierarchical Layers: Core Layer, Convergence Layer, Access Layer.
- Adapt to Diverse Topology: star, tree, bus, ring, mesh etc.

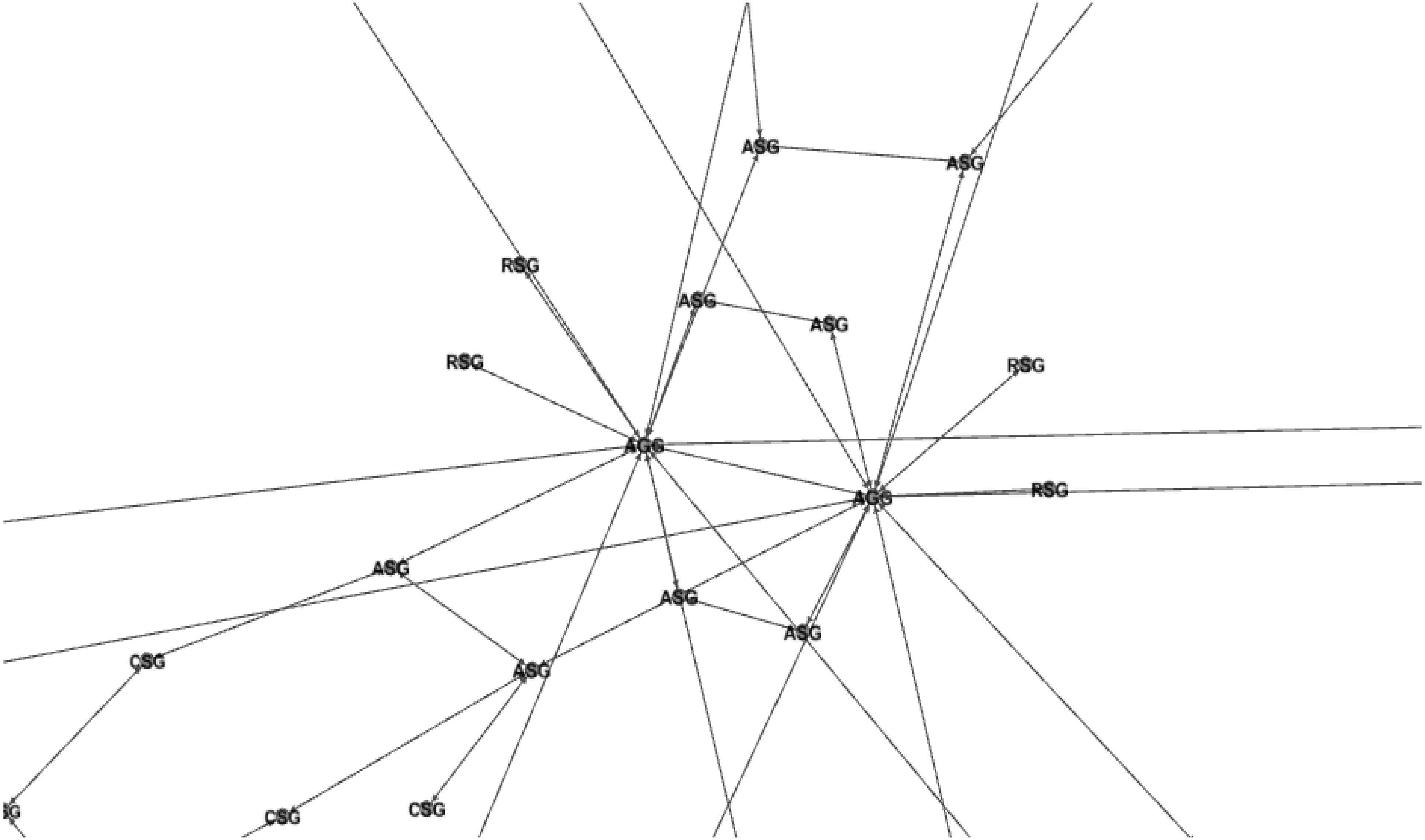


- Handle Global & Local Parameters: IP, IGP Area ID, IGP Cost
- Make Global Configuration: setup new networks
- Make Local Configuration: add & remove devices

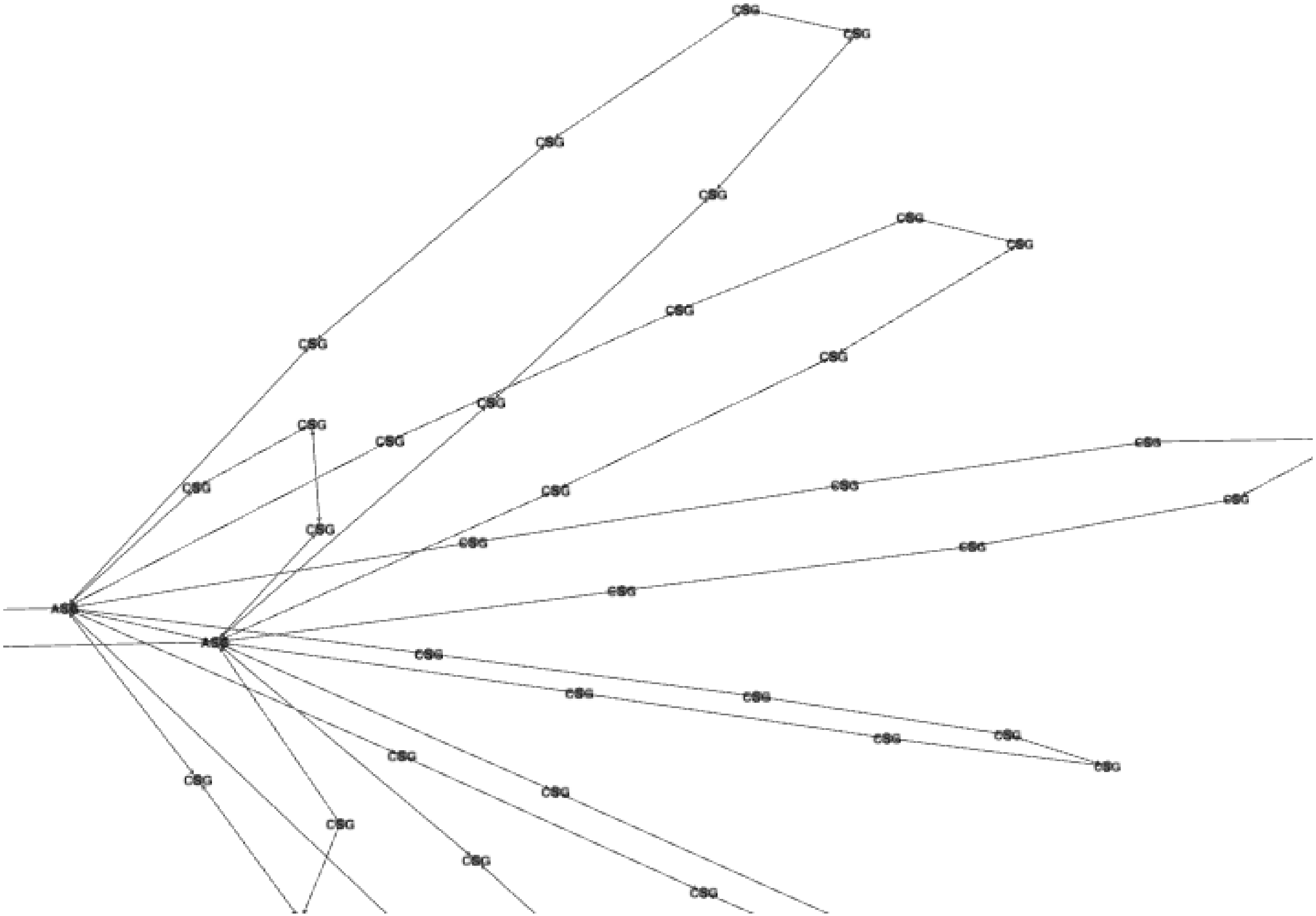
Input: Network Topology



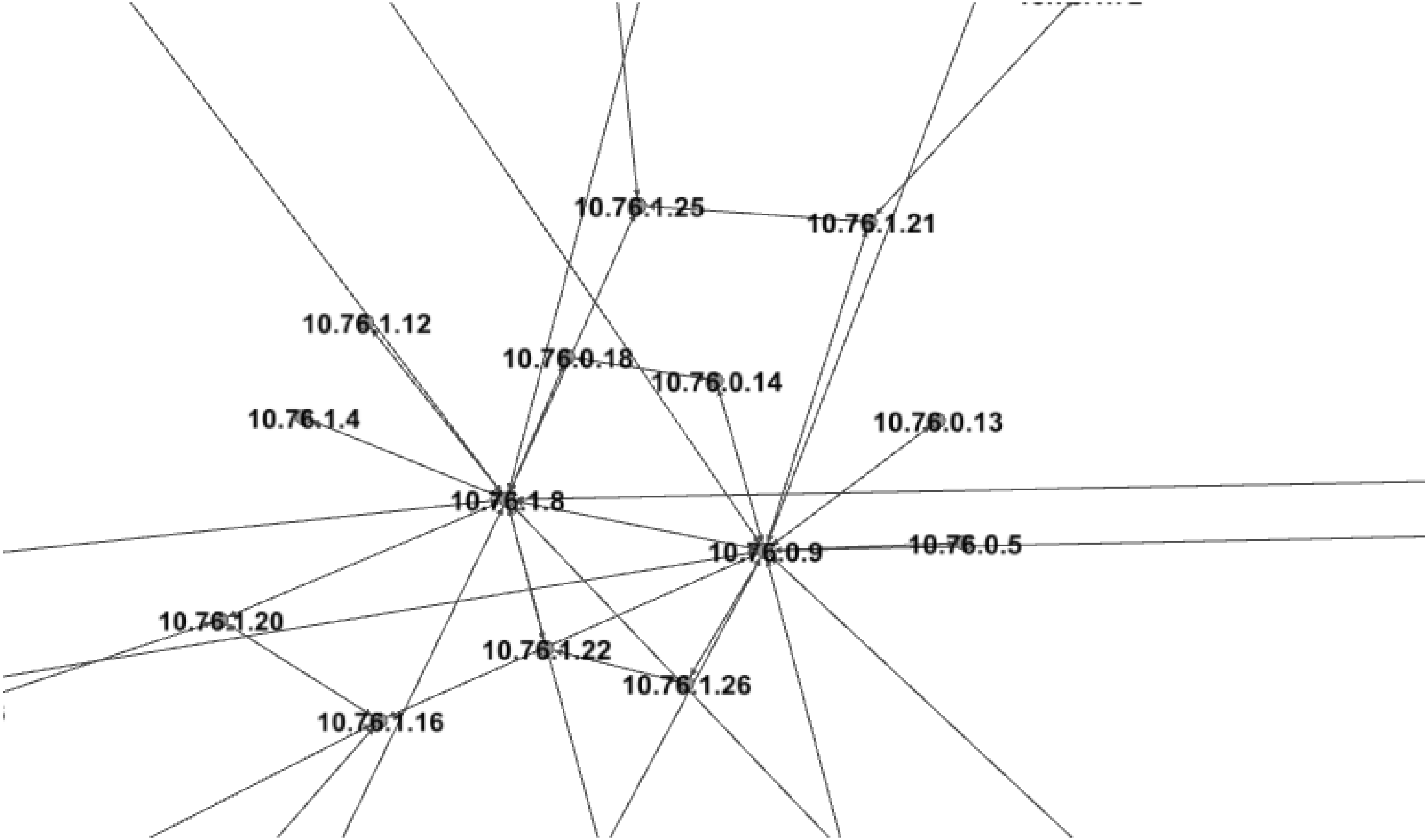
Input: Core Layer & Convergence Layer



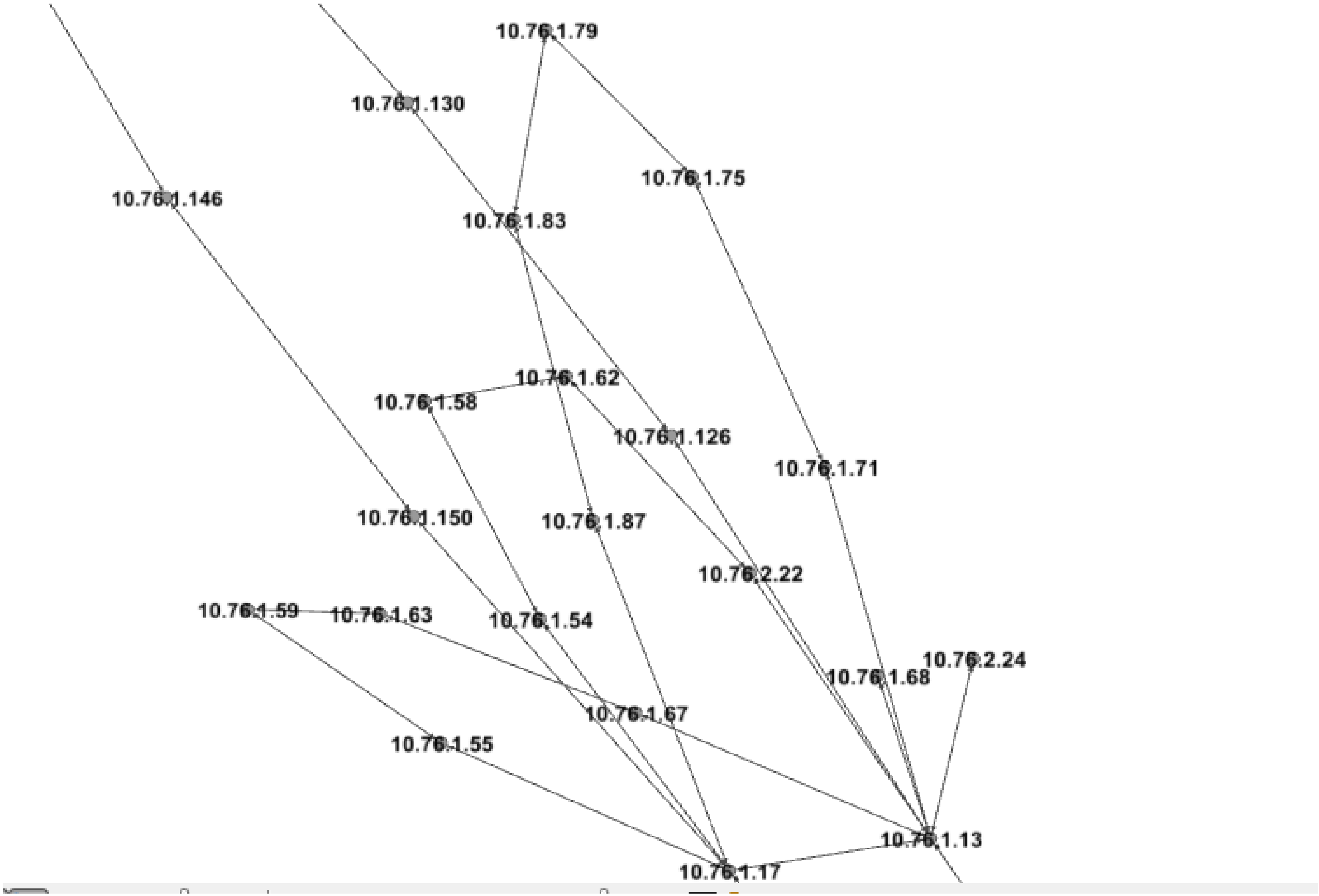
Input: Access Layer



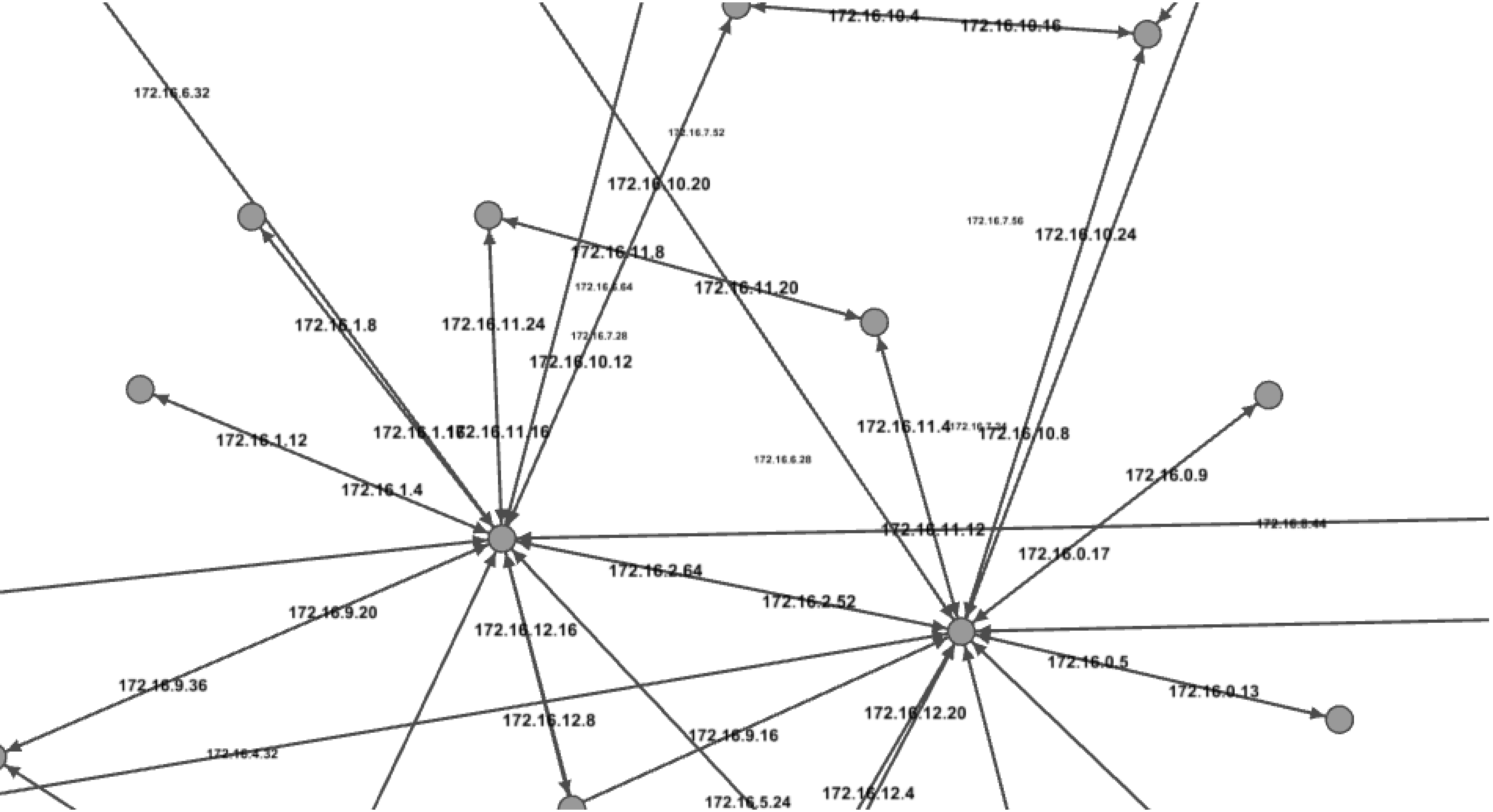
Output: Loopback IP (Core & Convergence Layer)



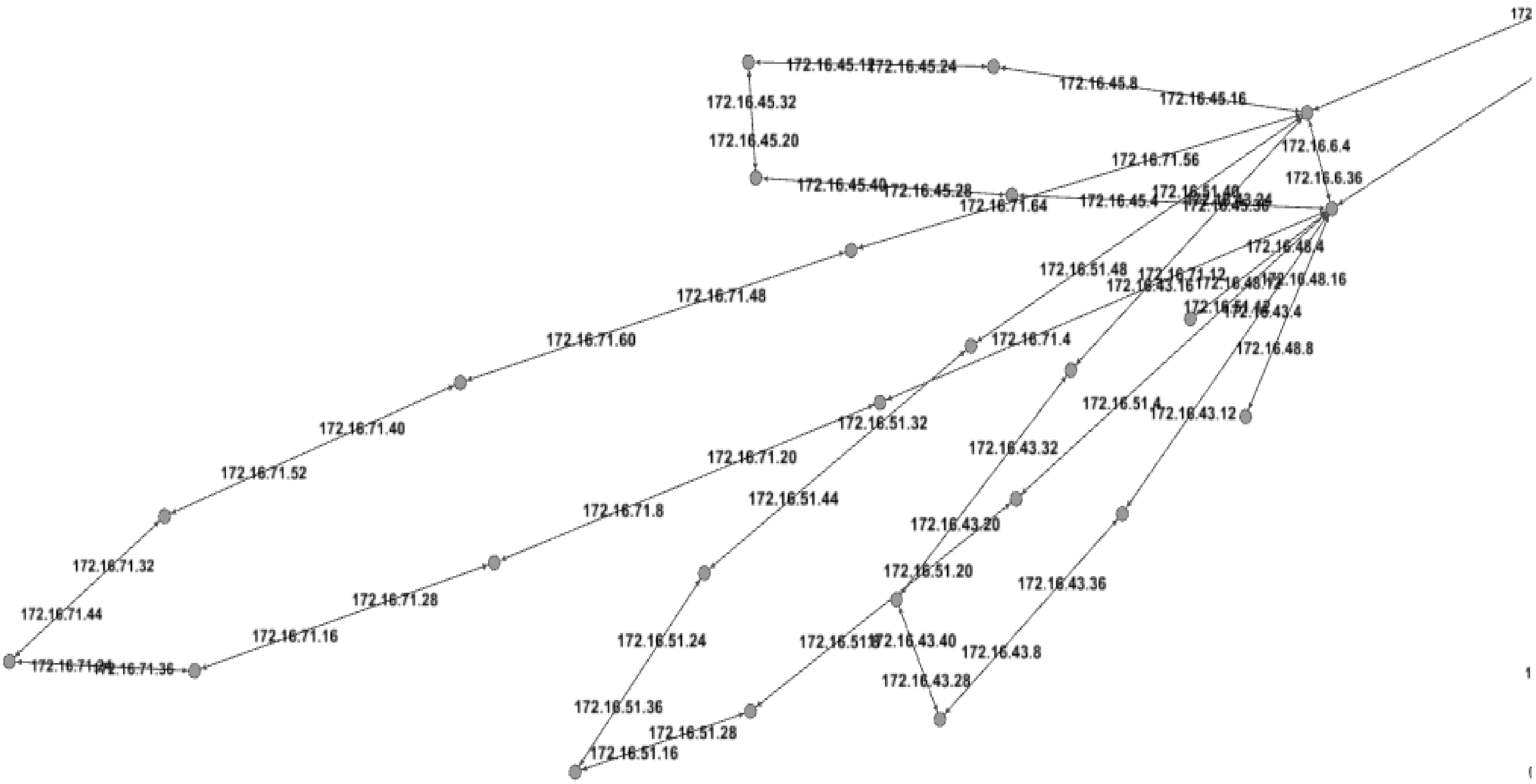
Output: Loopback IP (Access Layer)



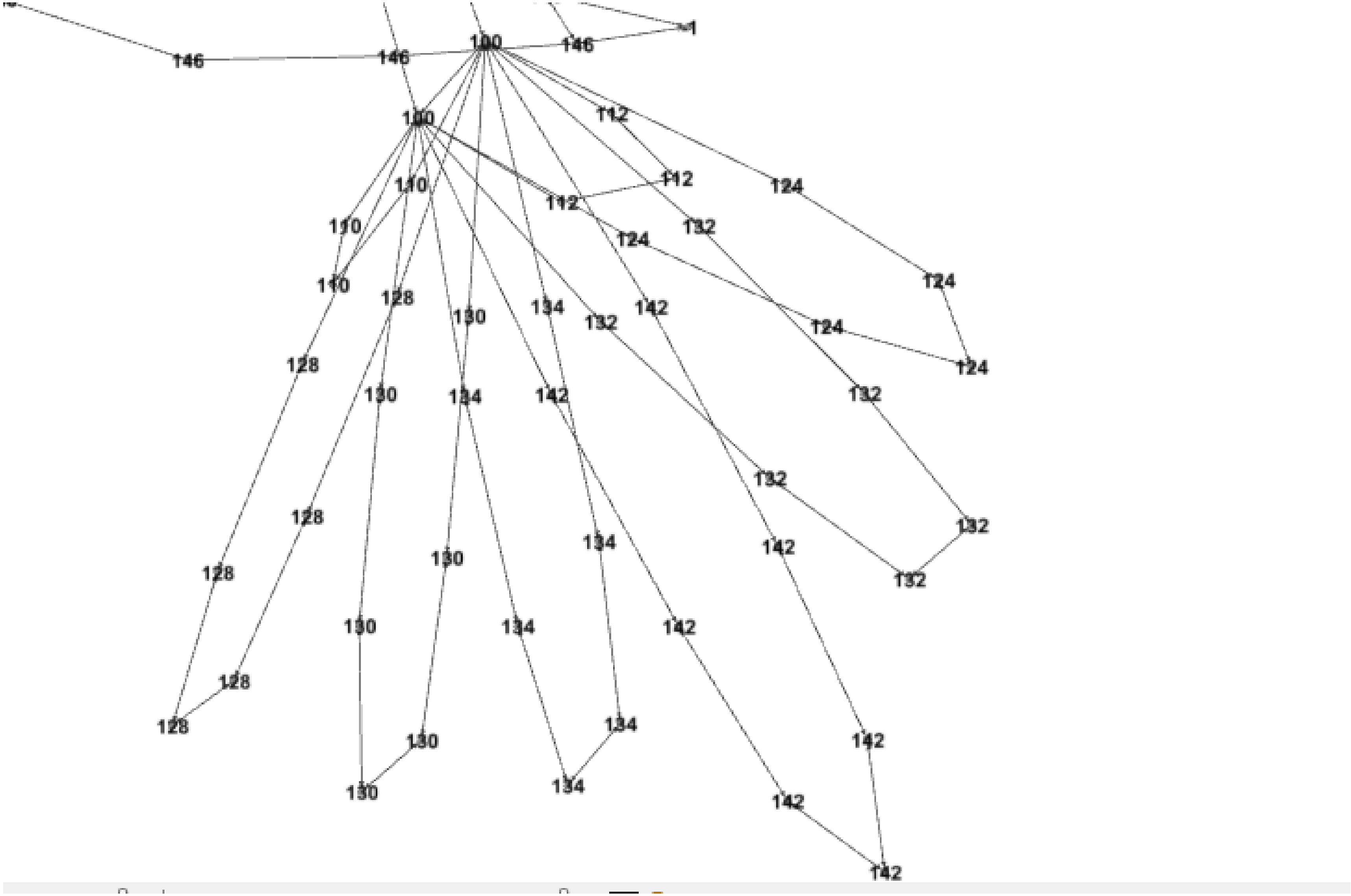
Output: Interface IP (Core & Convergence Layer)



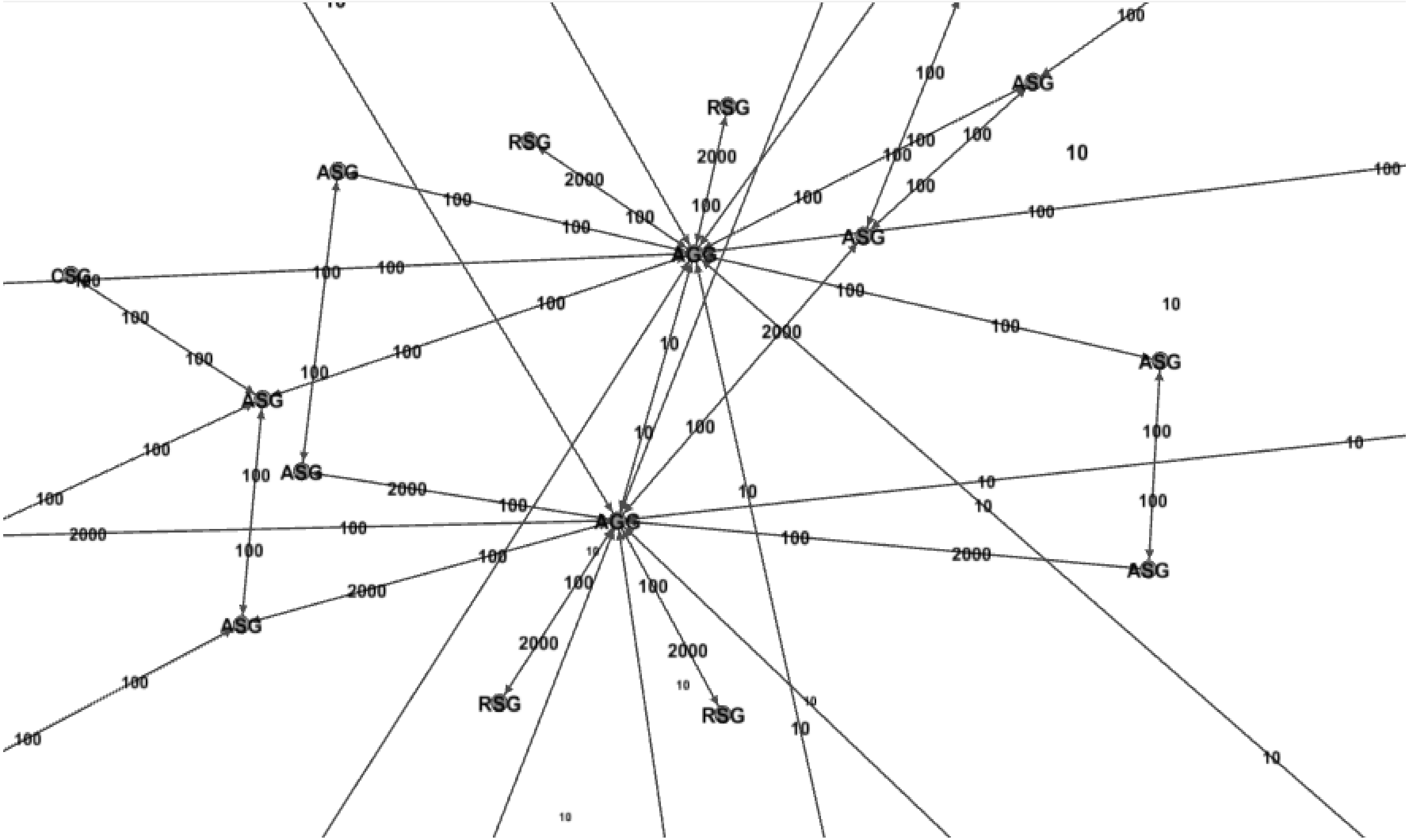
Output: Interface IP (Access Layer)



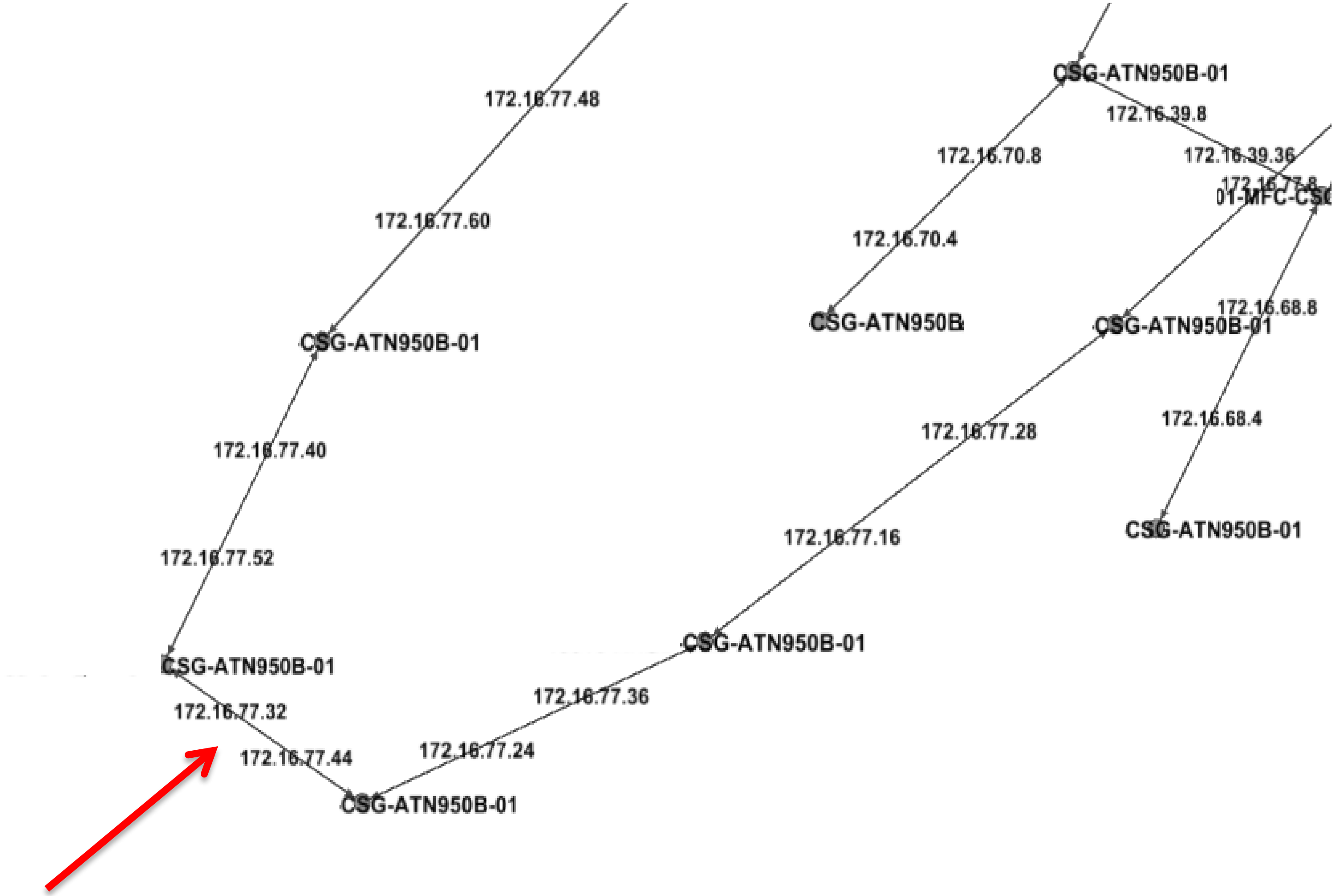
Output: IGP Area ID (Access Layer)



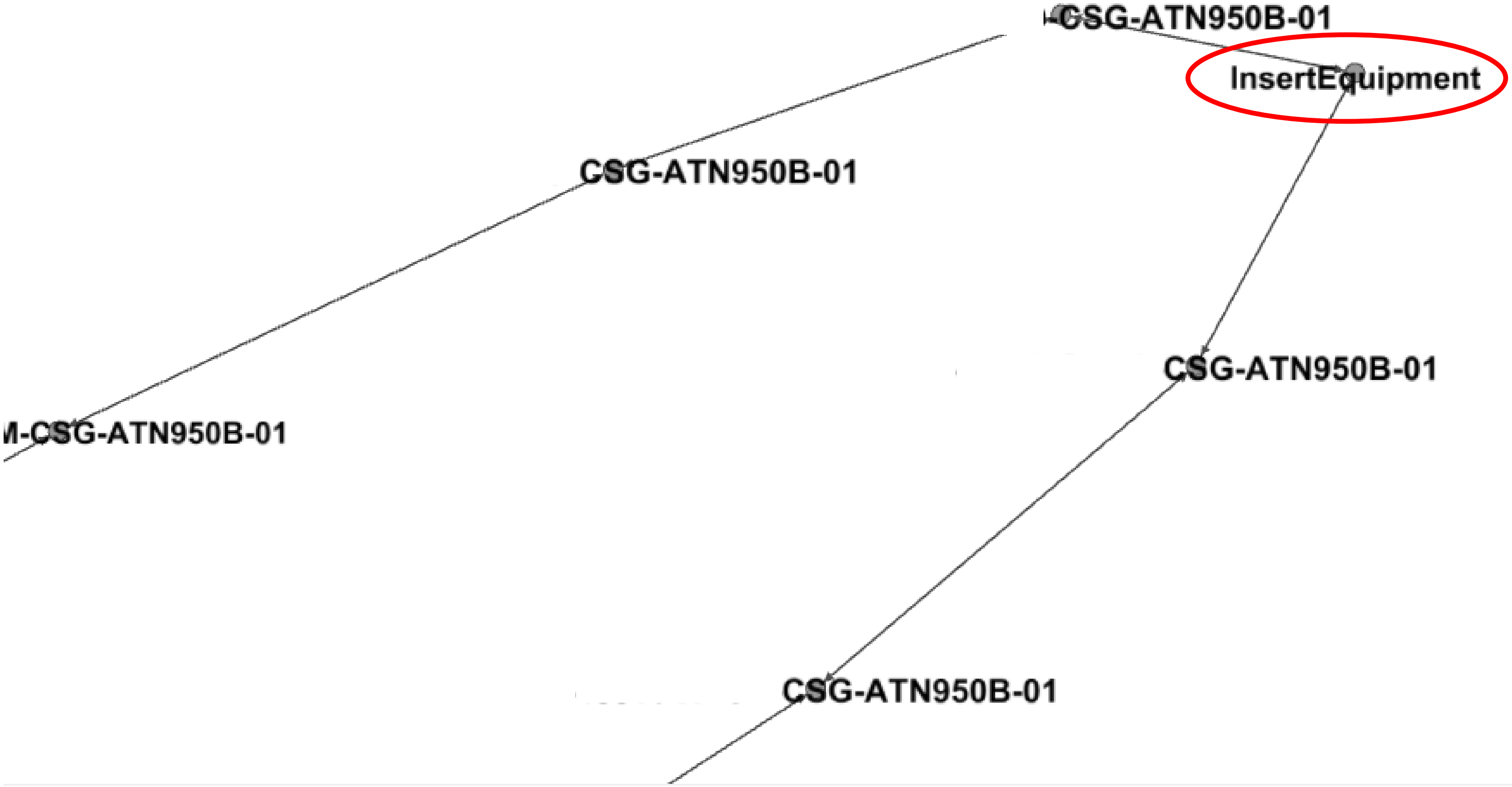
Output: IGP Cost



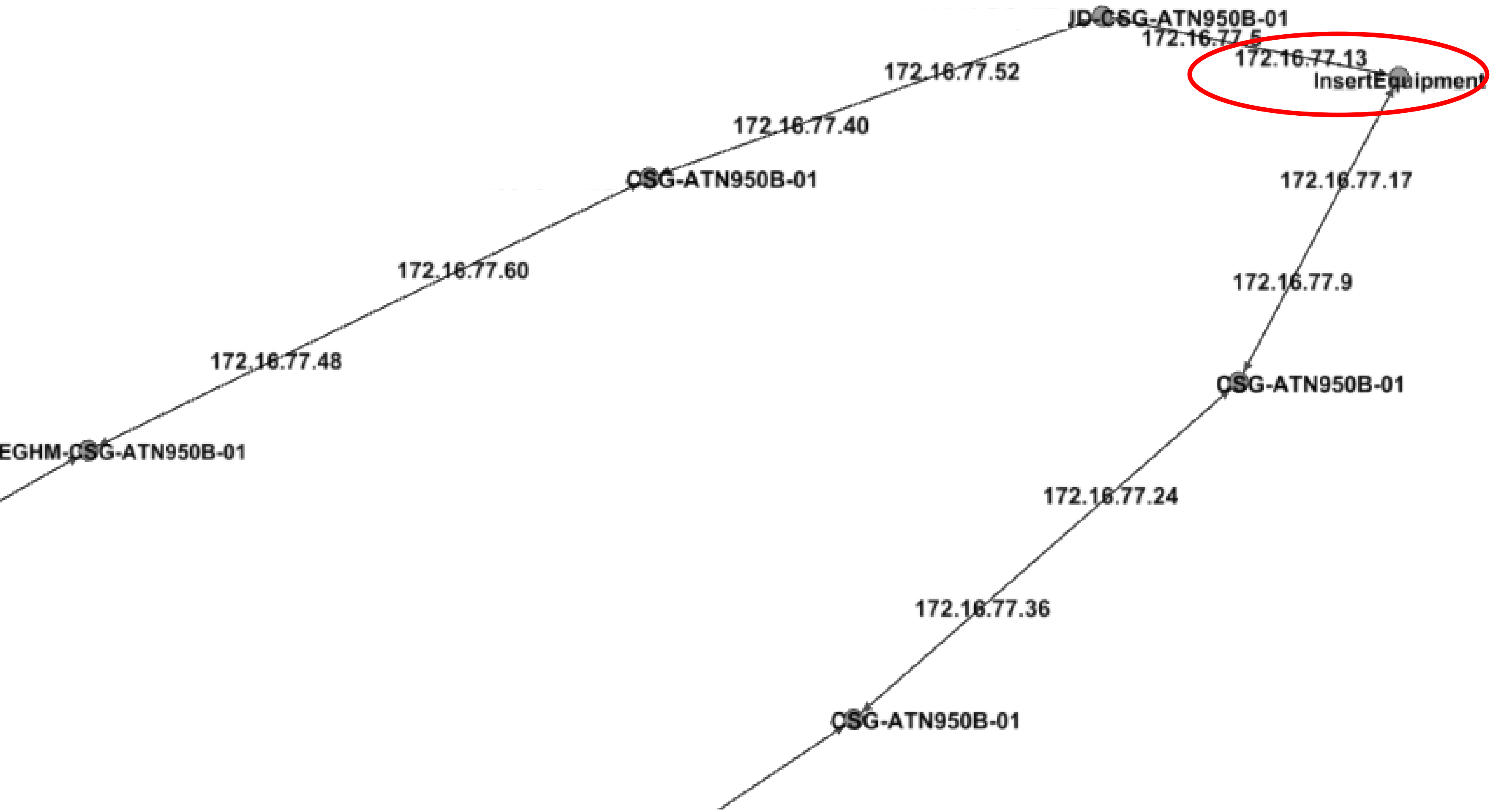
Local Update: Add New Device



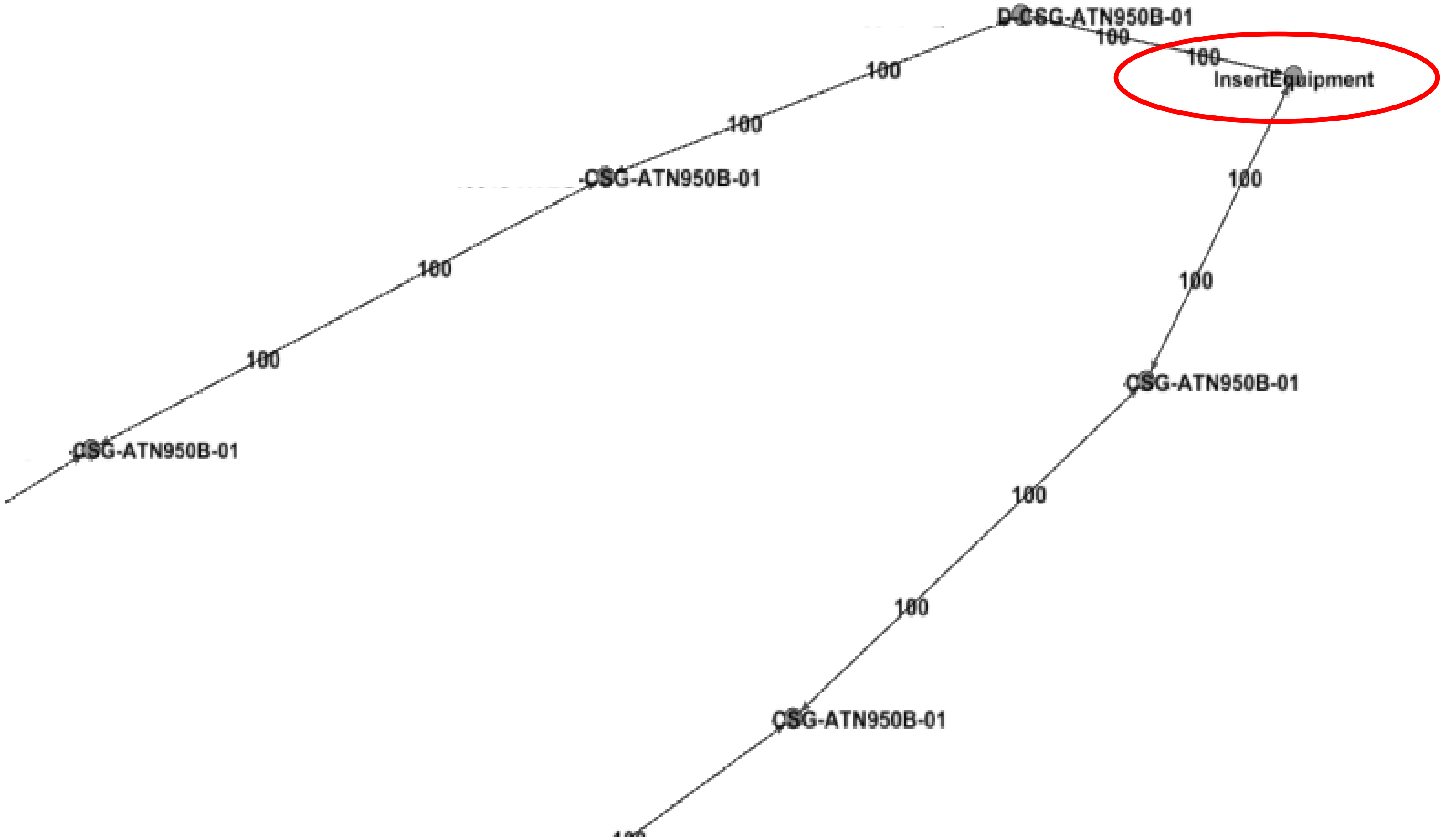
Local Update: Add New Device



Add New Device: Interface IP



Add New Device: IGP Cost



Summary

- Flexible and Universal: learn from existing networks, taking common rules as prior-knowledge.
- Extensible: system considers extensibility and modularity.
- Balance global and local configuration

Whenever we have got adequate data, consider Machine Learning Systems.

Key Issues in Machine Learning Procedure

- Clear Problem Definition:

  Data never tell where to go.

  Make clear the learning aim (i.e. data distribution, patterns, decisions)

  Make clear how to evaluate the results.

Key Issues in Machine Learning Procedure

- Adequate Representative Data

The learning data are expected to well represent the whole searching space. Random re-sampling is preferred, and data cleaning is necessary.

The training samples are expected to be much more than the testing samples & samples to be predicted.

Key Issues in Machine Learning Procedure

- Proper Features: original & artificial features

Object and feature definition is the most essential part of system design.

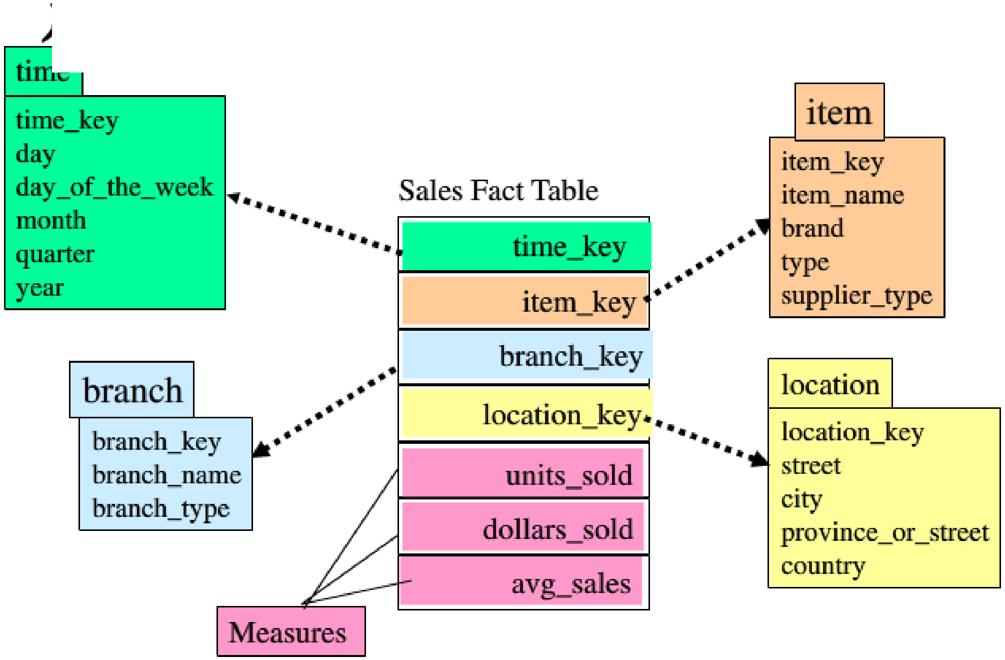
Artificial features usually deliver more valuable information than original features. (Machine is not that clever!)

Collect relevant features as much as possible, figure out the most important ones, and transform them if possible.

Key Issues in Machine Learning Procedure

Database Design

Organize the data into relation tables to facilitate learning procedures.



time
time_key
day
day_of_the_week
month
quarter
year

Sales Fact Table
time_key
item_key
branch_key
location_key
units_sold
dollars_sold
avg_sales

item
item_key
item_name
brand
type
supplier_type

branch
branch_key
branch_name
branch_type

location
location_key
street
city
province_or_street
country

Measures

Key Issues in Machine Learning Procedure

- Suitable Methods & Algorithms

  Try out effective methods & algorithms.

  No prefect algorithms for application cases.

  Data-oriented algorithm optimization.

  Big data decrease effect of algorithm selection.

Key Issues in Machine Learning Procedure

- Statistically Significant Results

Machine learning delivers results of high statistical possibility rather than truth.

If the predictive results are not statistically significant, machine learning is in vain. That is, the predictive results should be of much higher possibility than random cases.

Thank You