“Last Mile”
Problem Analysis in Smarts
For DSL & GPON Networks

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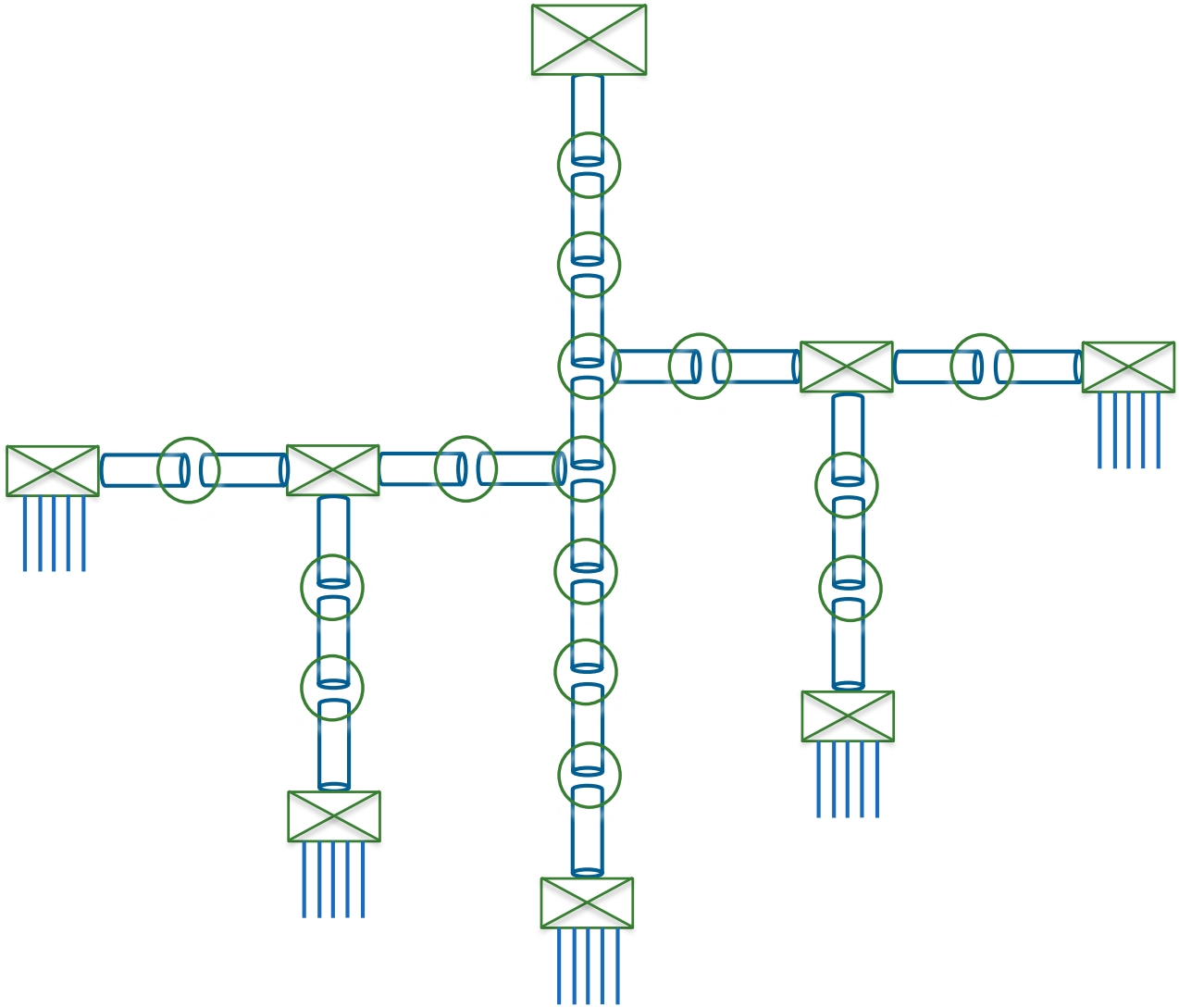
Challenges

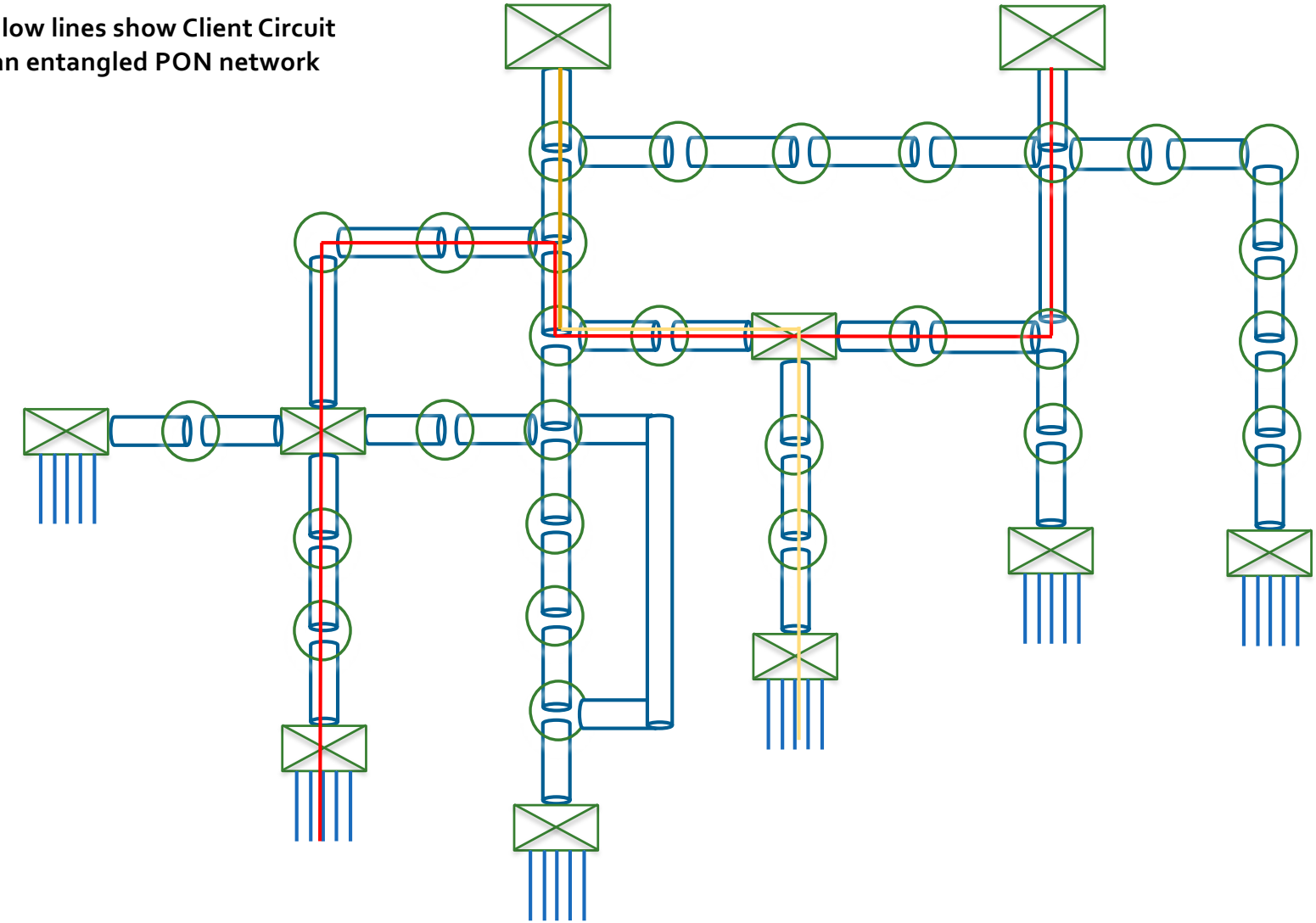
- Large networks of cables, cable segments, splices and distribution fames
  - Theory: Proper Tree networks
  - Practice: Entangled structures, often with “reverse” service direction and branch re-junctions
- Difficult to pin-point „right” cable segment that needs a fix
  - Equipment Vendor’s management lack analytic capabilities to perform any useful correlation based on topology
  - Passive cables cannot be directly monitored (use of dedicated probes per each cable/segment is costly and unrealistic)
  - Single cable fault can affect end-points dispersed in the network (because of entanglements)

PON Tree Network in theory



PON Network in reality: entanglements

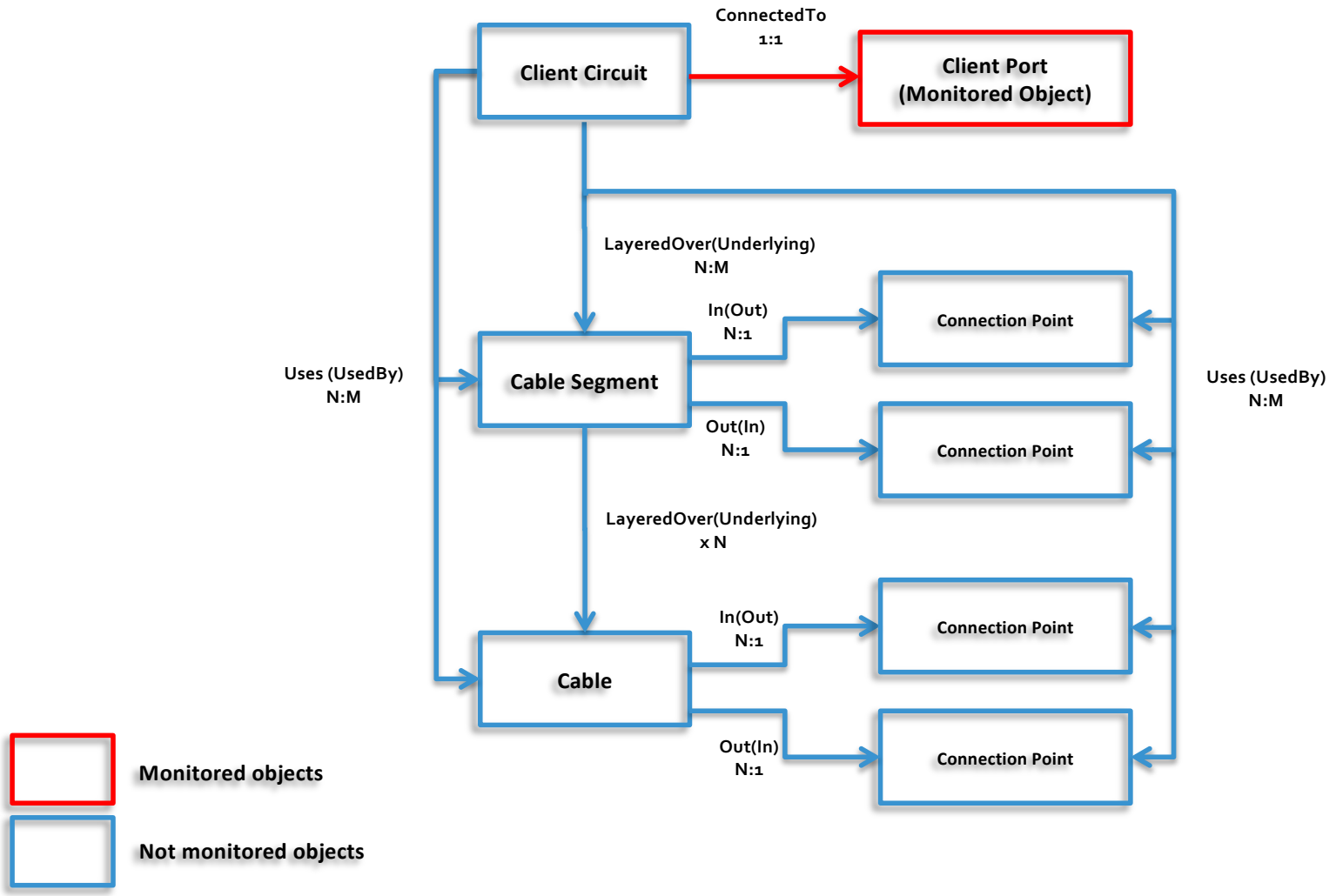
Red and yellow lines show Client Circuit traversing an entangled PON network



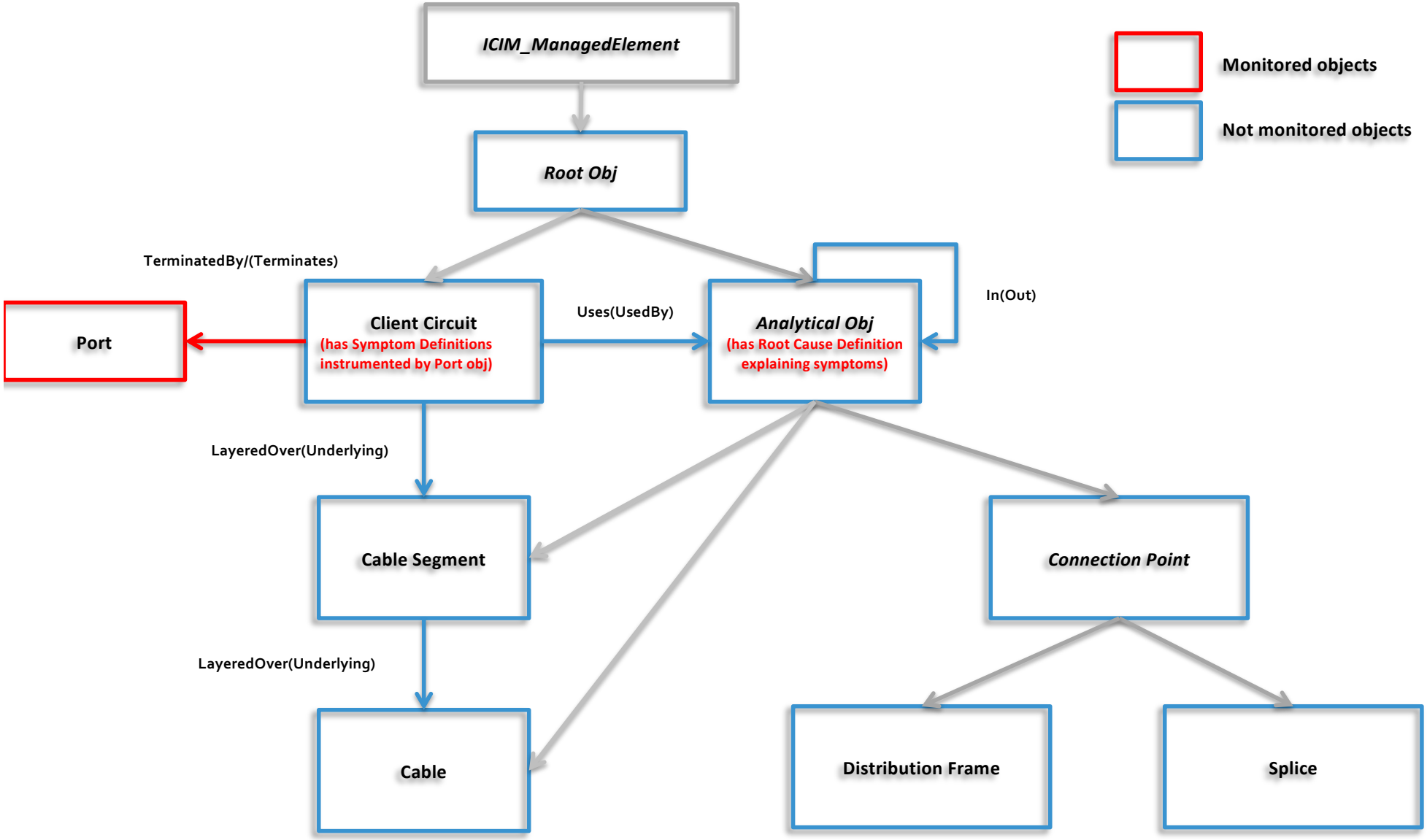
Principles of the Smarts solution

- Only CPE accessibility/availability or performance/quality is available for root cause analytics as PON network is passive.
- Root Cause analytics has to be immune to entangled network structures with re-junctions and “reverse” service direction in the PON networks.
  - This practically excludes any correlation engines based on “what-if” rules, downfall suppression, or similar correlation technics.
  - **Smarts CodeBook correlation that defines all possible problems with their symptoms across topology is a feasible option.**

Relationship Model in Smarts



Inheritance Model in Smarts



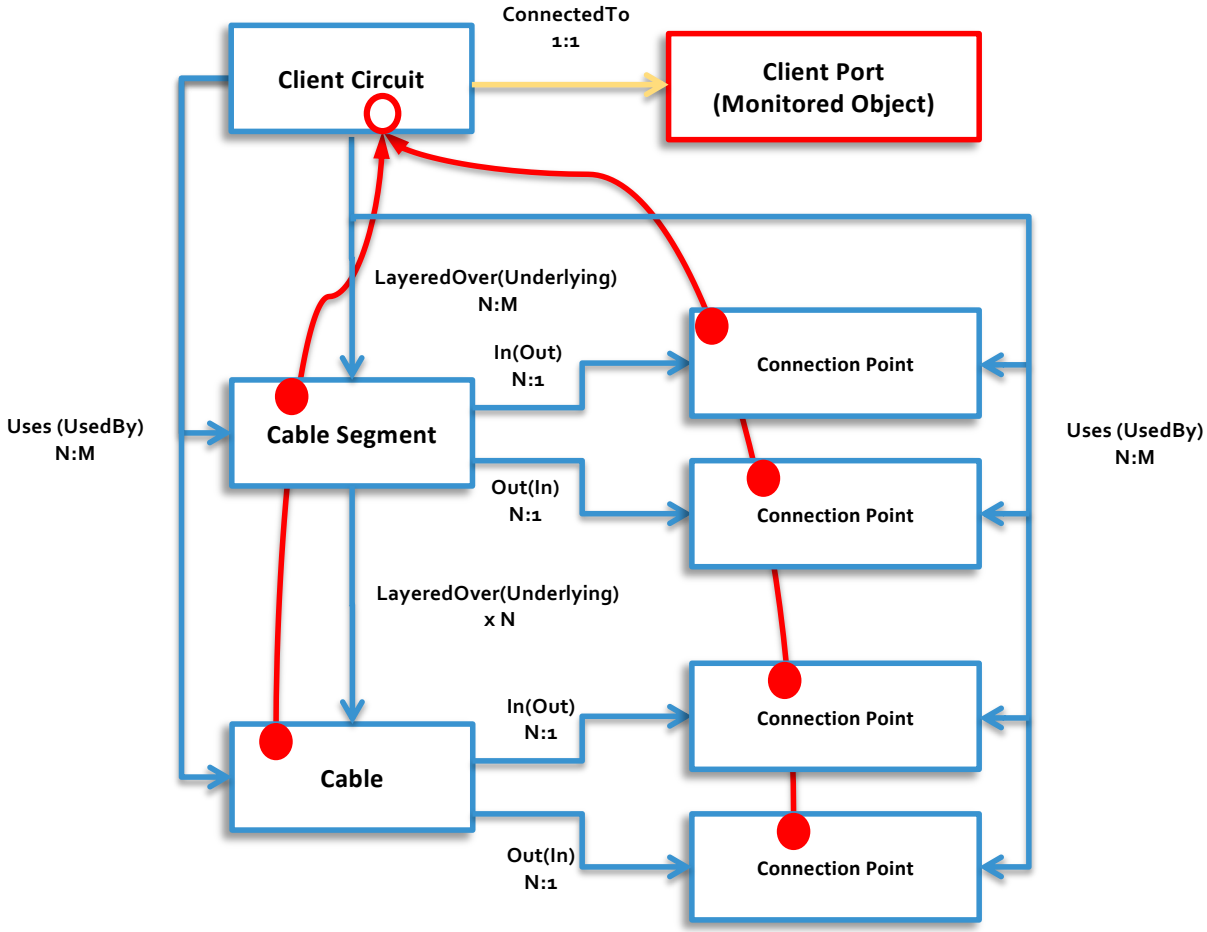
Problem definition in Smarts CodeBook

```
interface Analytical_Obj : Root_Obj
{
      relationshipset Out, Analytical_Obj, In;
      relationshipset In, Analytical_Obj, Out;
      relationshipset UsedBy, Circuit, Uses;

      computed attribute int Circuits = | UsedBy |;

#pragma Uses Propagation
      propagate attribute int sum Faulty_Circuits
         = Circuit, UsedBy, IsDown;

      propagate symptom Down_UsedBy  => Circuit, UsedBy, Down;

      stored attribute float apriori_setting = 0.05;

      problem Down apriori (apriori_setting) =>
            Down_UsedBy 1.0,
            Down_UsedBy explains;

      export Down;
}
```

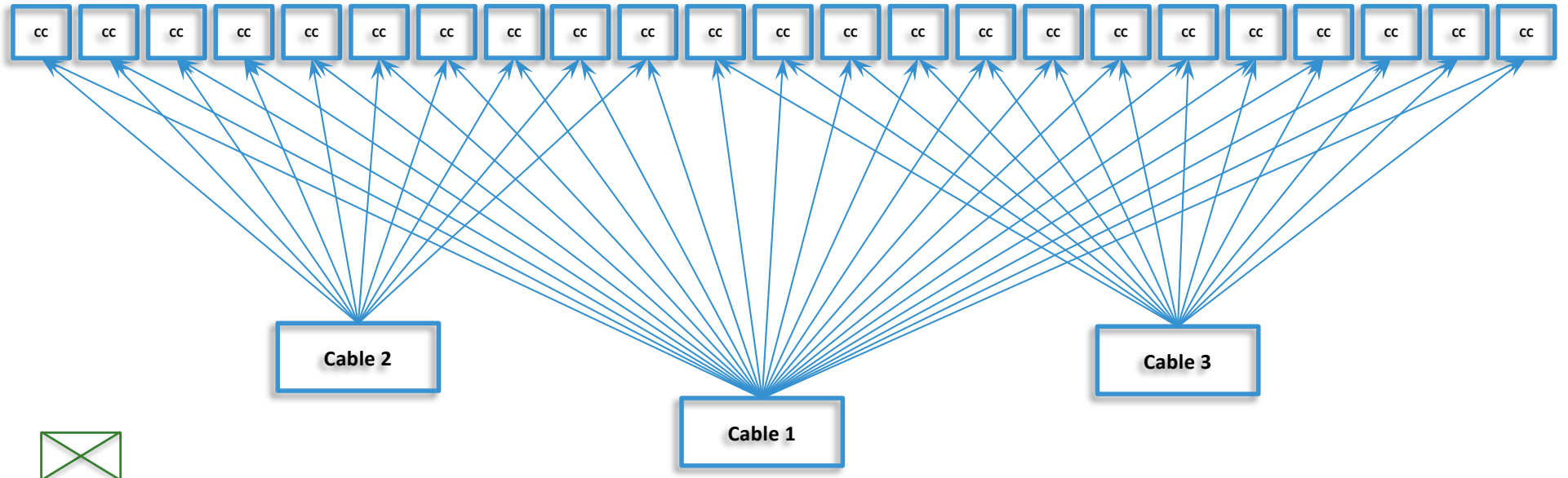
Smarts CodeBook Correlation

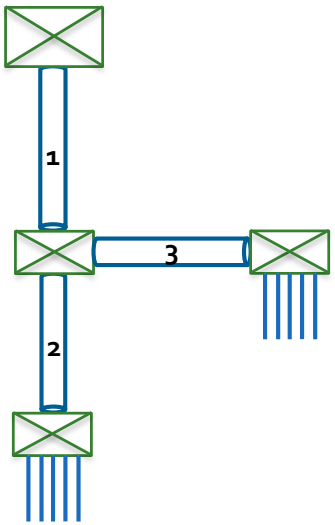
Down Problems "compete" for the same set of symptoms at Circuit Level:

1. **Client Circuit symptoms are instrumented by the Client port objects monitored on MSAN nodes**
2. **Down Problems on different objects (Cables, Segments, Connection Points) can "explain" observed symptoms on Client Circuits**



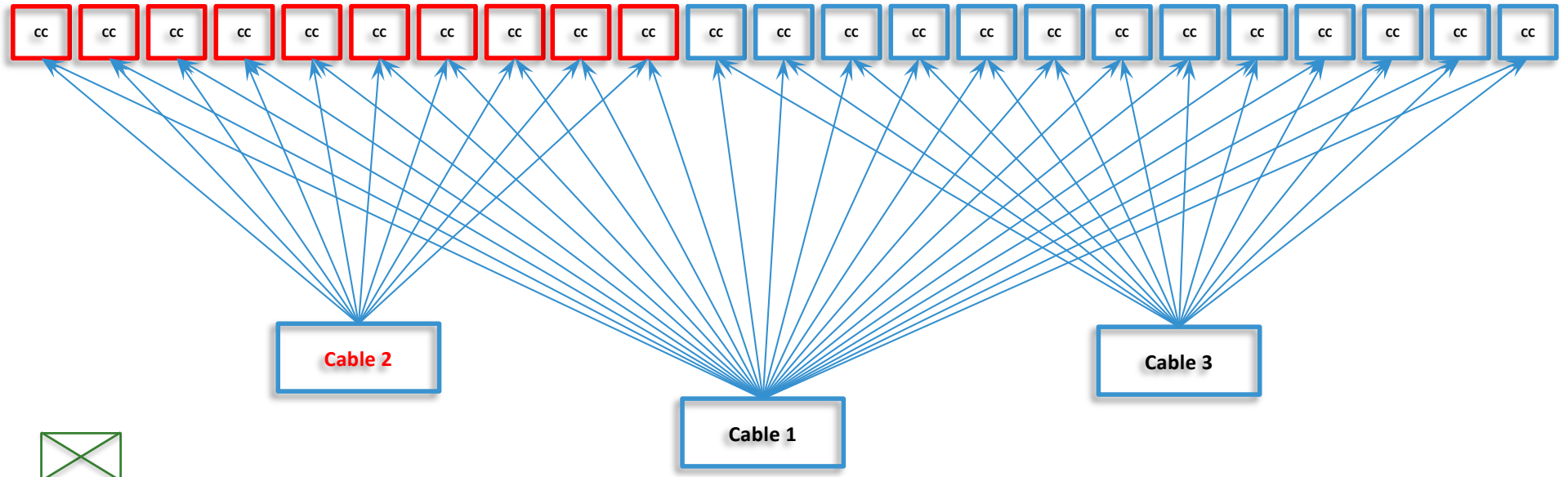
Example: Client Circuit to Cable relations

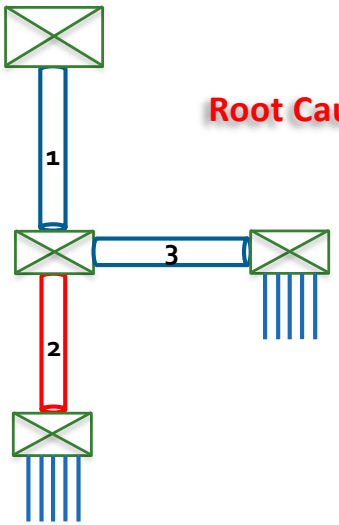




Example: Client Circuit to Cable relations

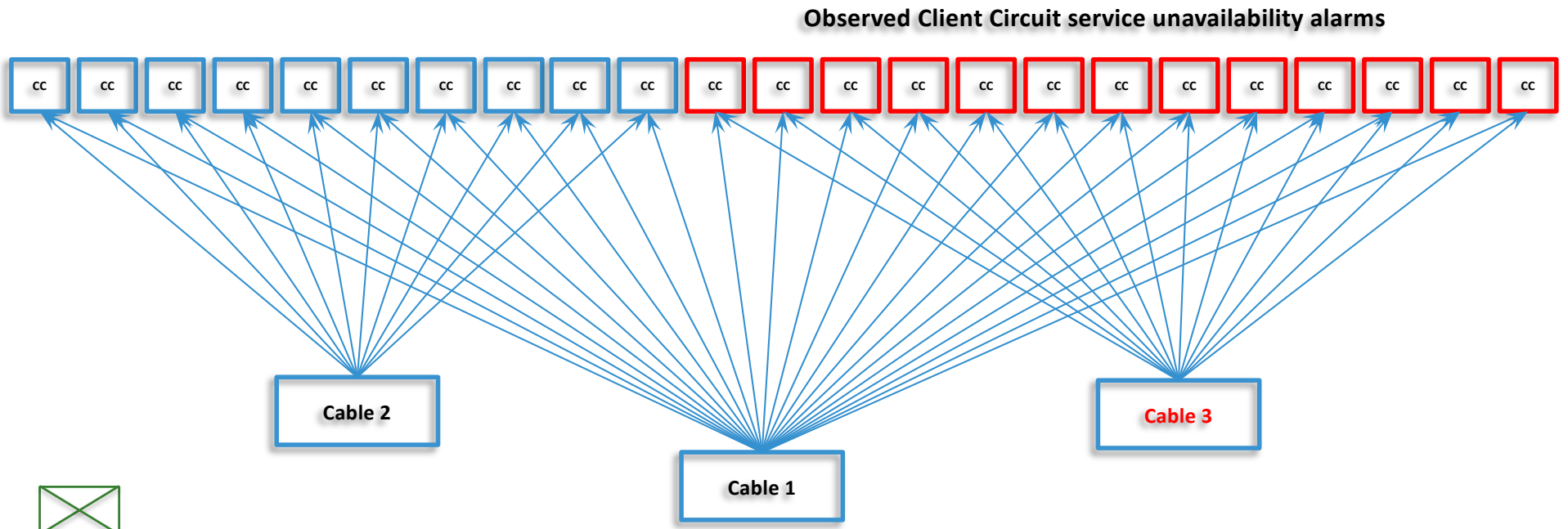
Observed Client Circuit service unavailability alarms

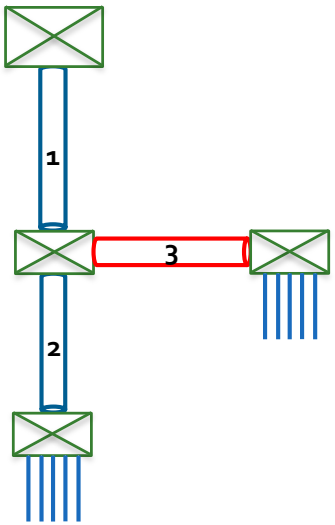




Root Cause: Faulty Cable 2

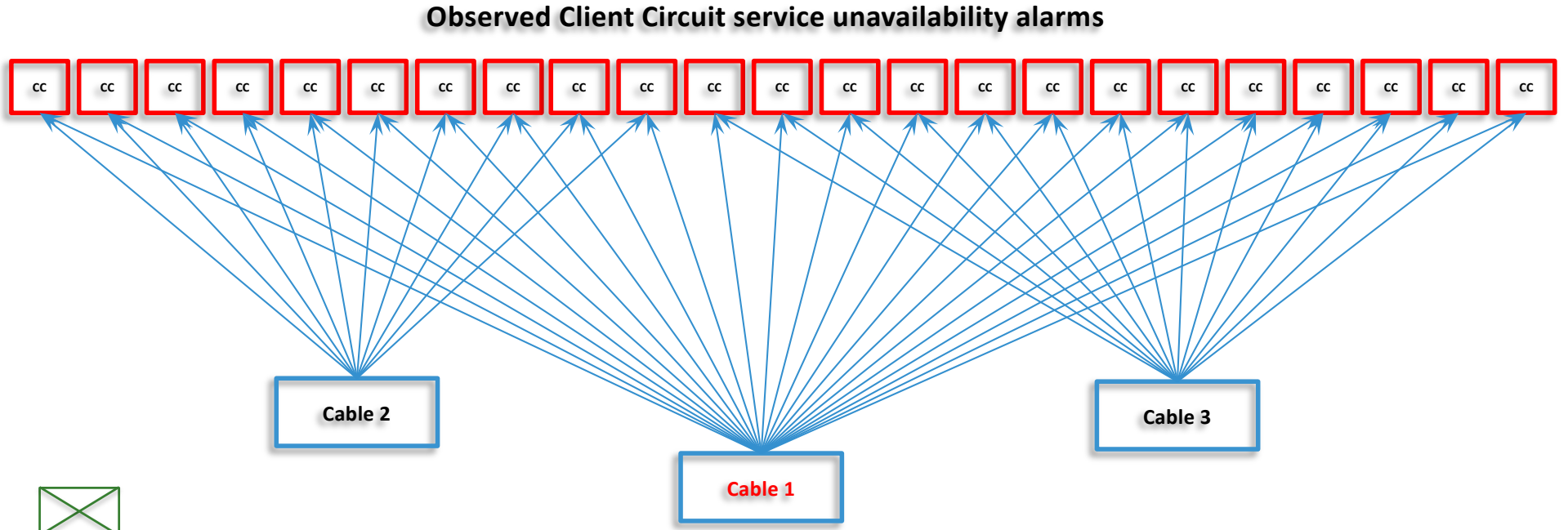
Example: Client Circuit to Cable relations

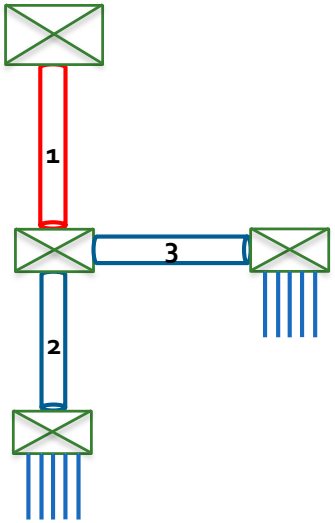




Root Cause: Faulty Cable 3

Example: Client Circuit to Cable relations



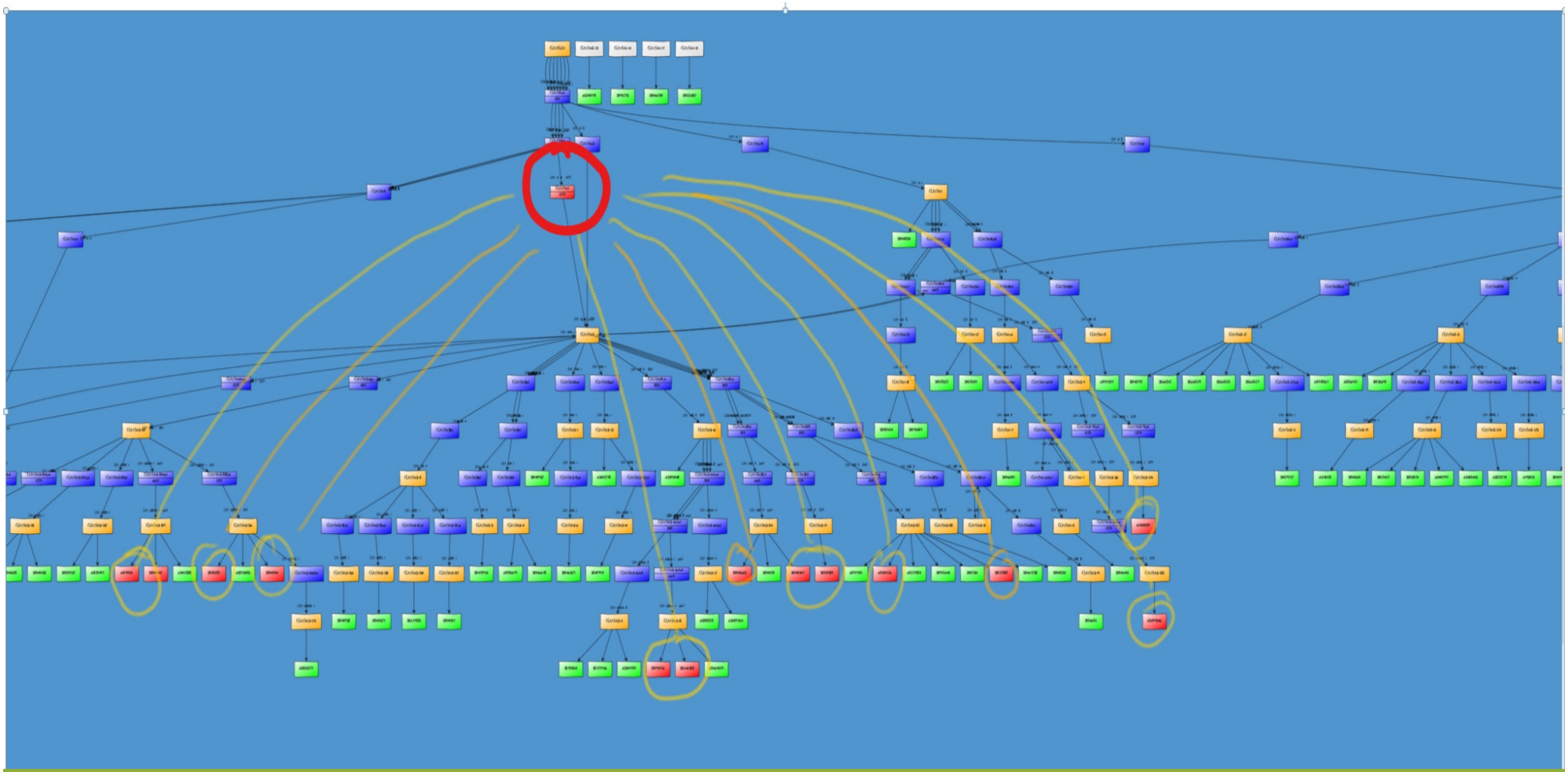


Nominated Root Cause: Faulty Cable 2

It wins the competition against Cable 2 and 3 faults as single Root Cause "better" explains observed symptoms

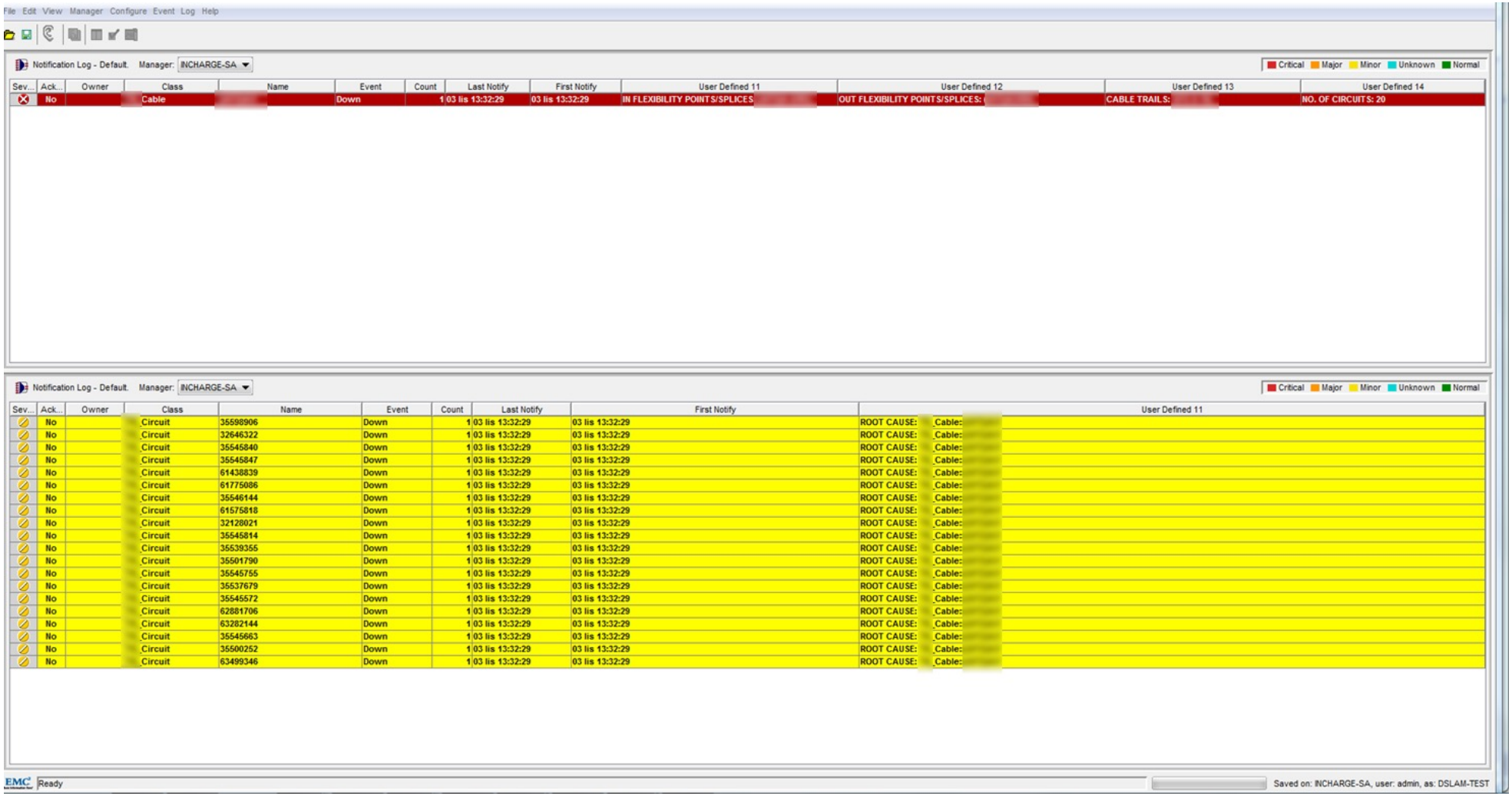
Complex case used for testing

This is example of a real cable fault resulting in service unavailability scattered across the network



Correlation result for the complex case

All the collected unavailability events are correlated by Smarts into single root cause notification identifying the right cable fault.




Thank you