

“Last Mile”

Problem Analysis in Smarts

For DSL & GPON Networks



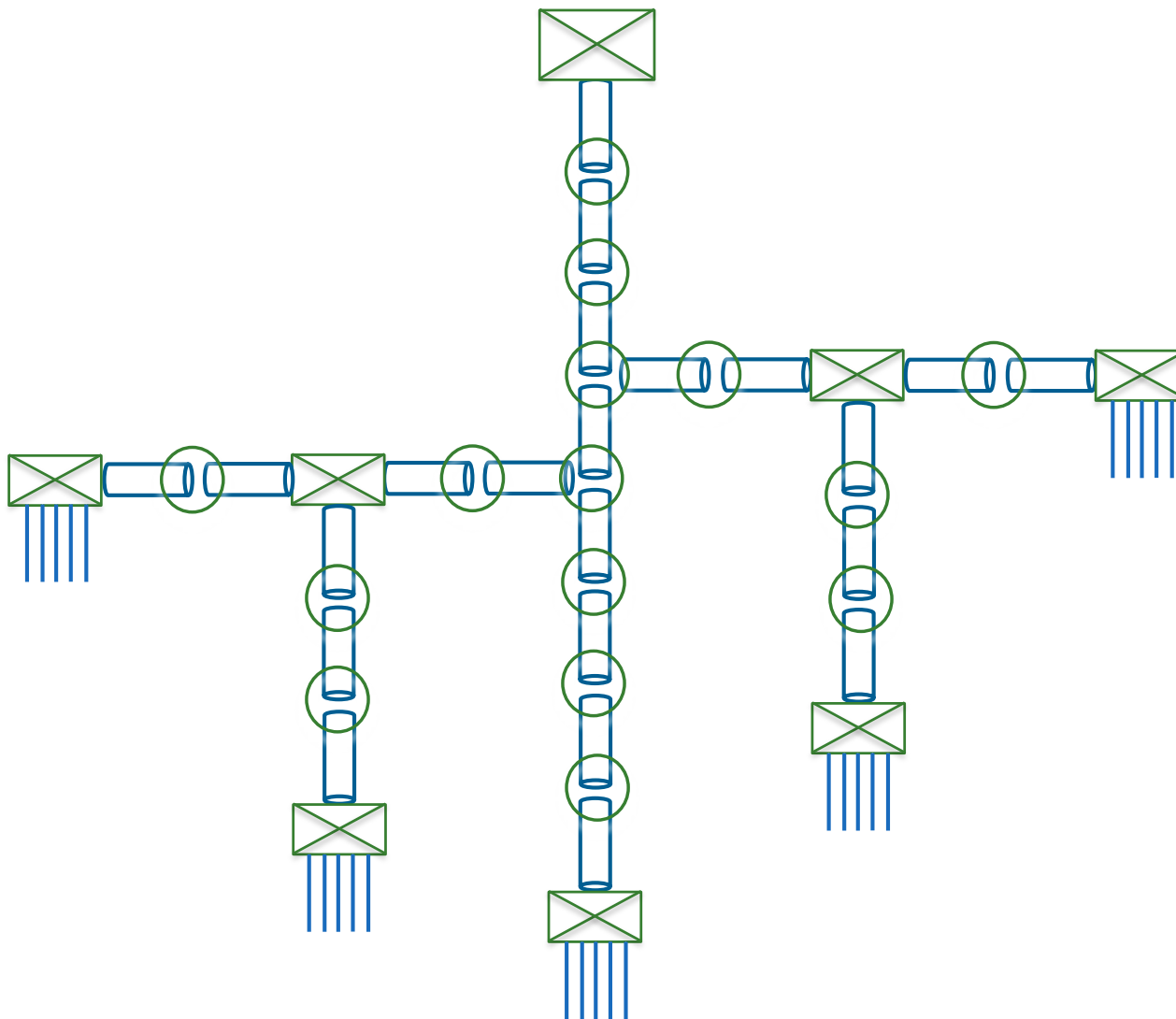
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Challenges



- Large networks of cables, cable segments, splices and distribution frames
 - 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)

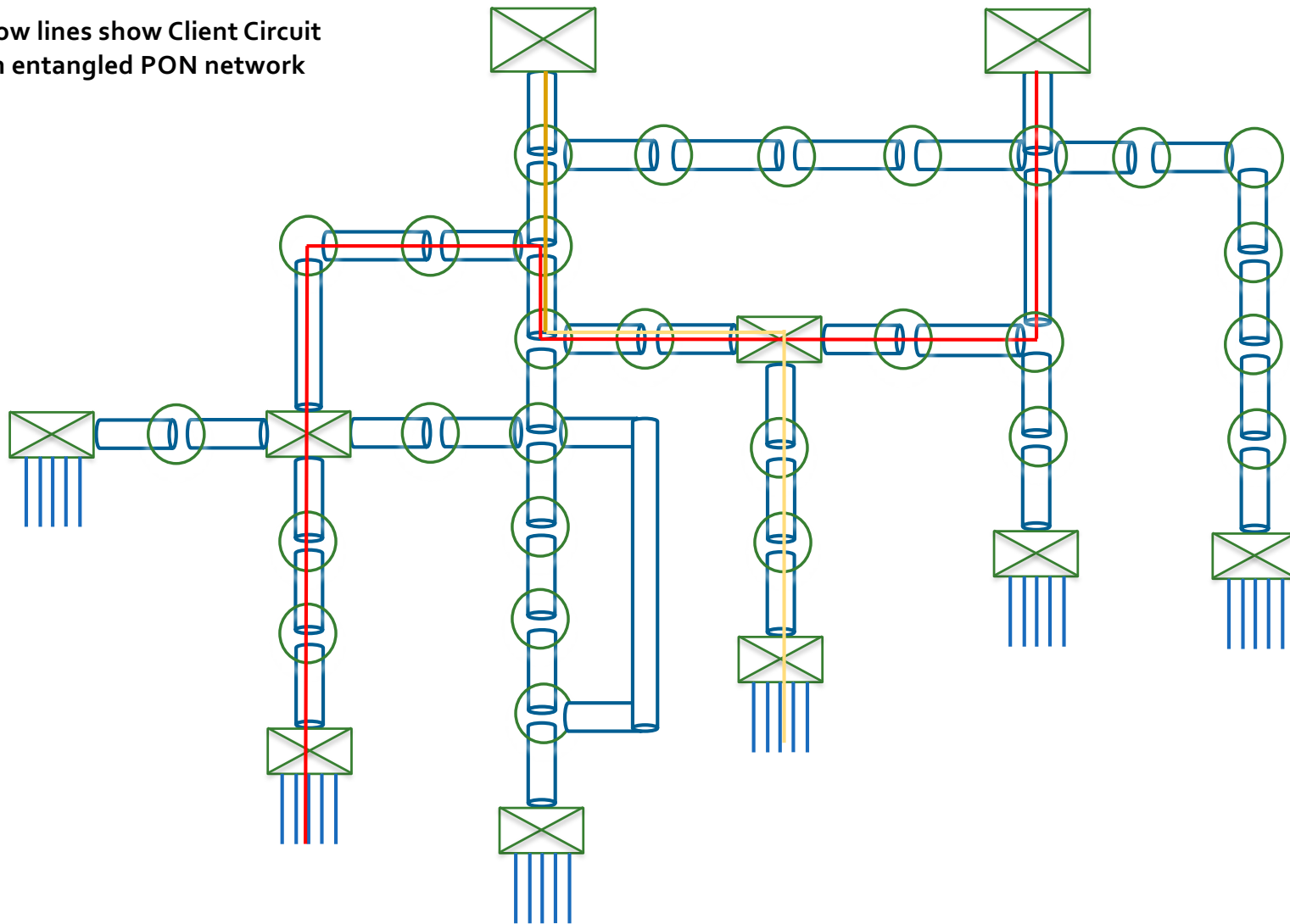
PON Tree Network in theory



PON Network in reality: entanglements



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

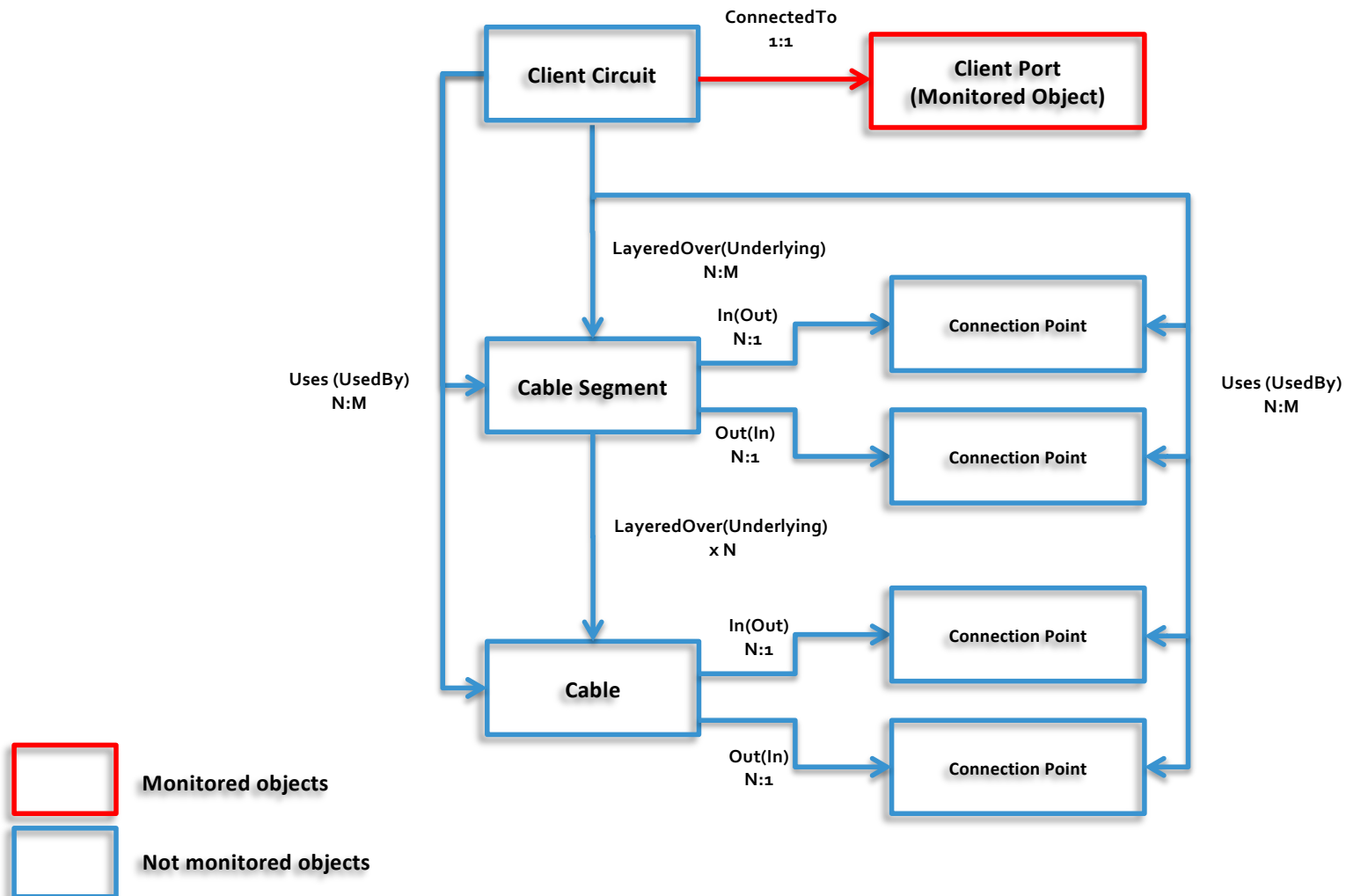


Principles of the Smarts solution

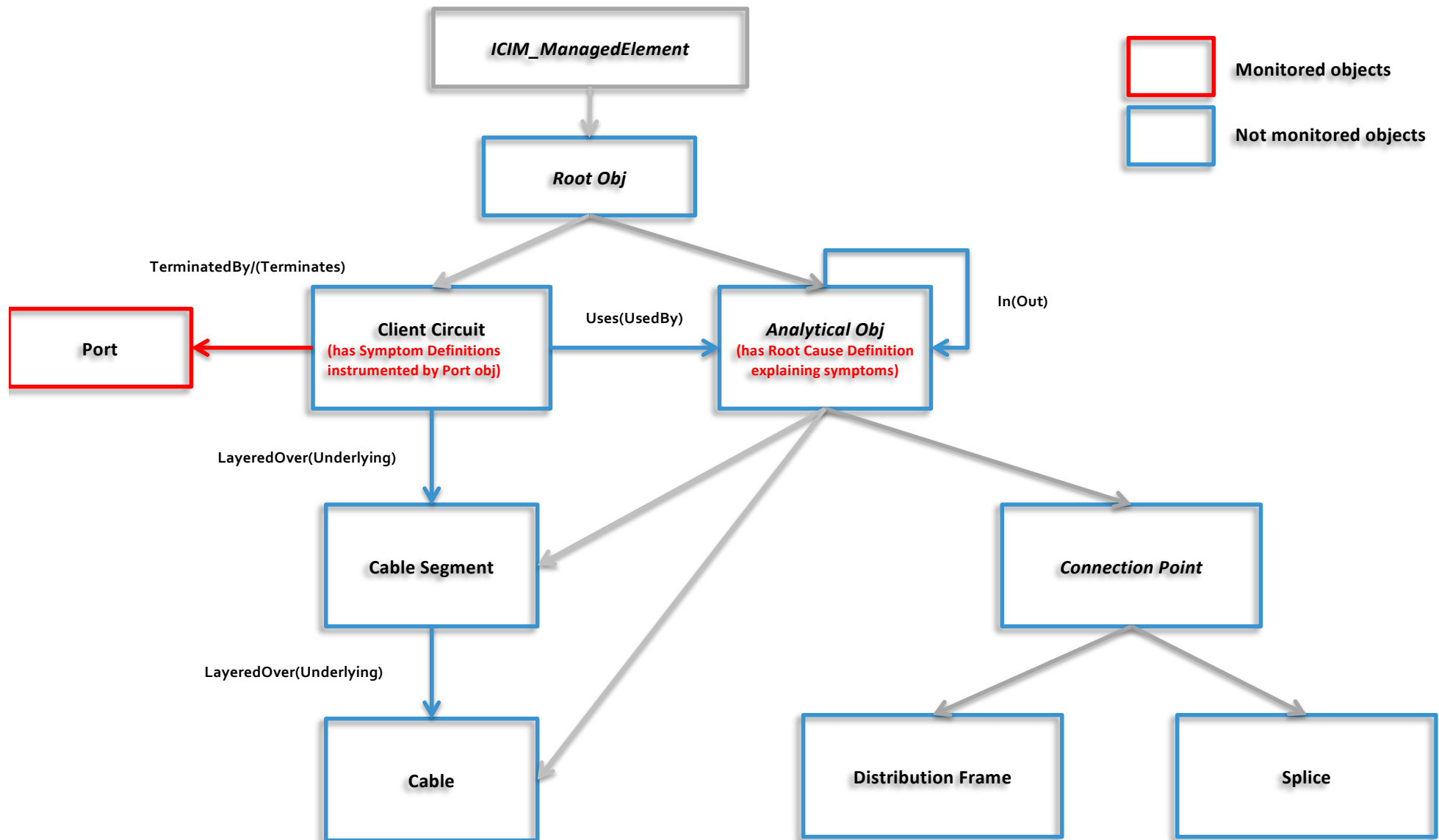


- Only CPE accessibility/availability or performance/quality is available for root cause analytics as PON network is passive.
- Root Cause analytics has to be immune to entangled network structures with re-junctions and “reverse” service direction in the PON networks.
 - This practically excludes any 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;

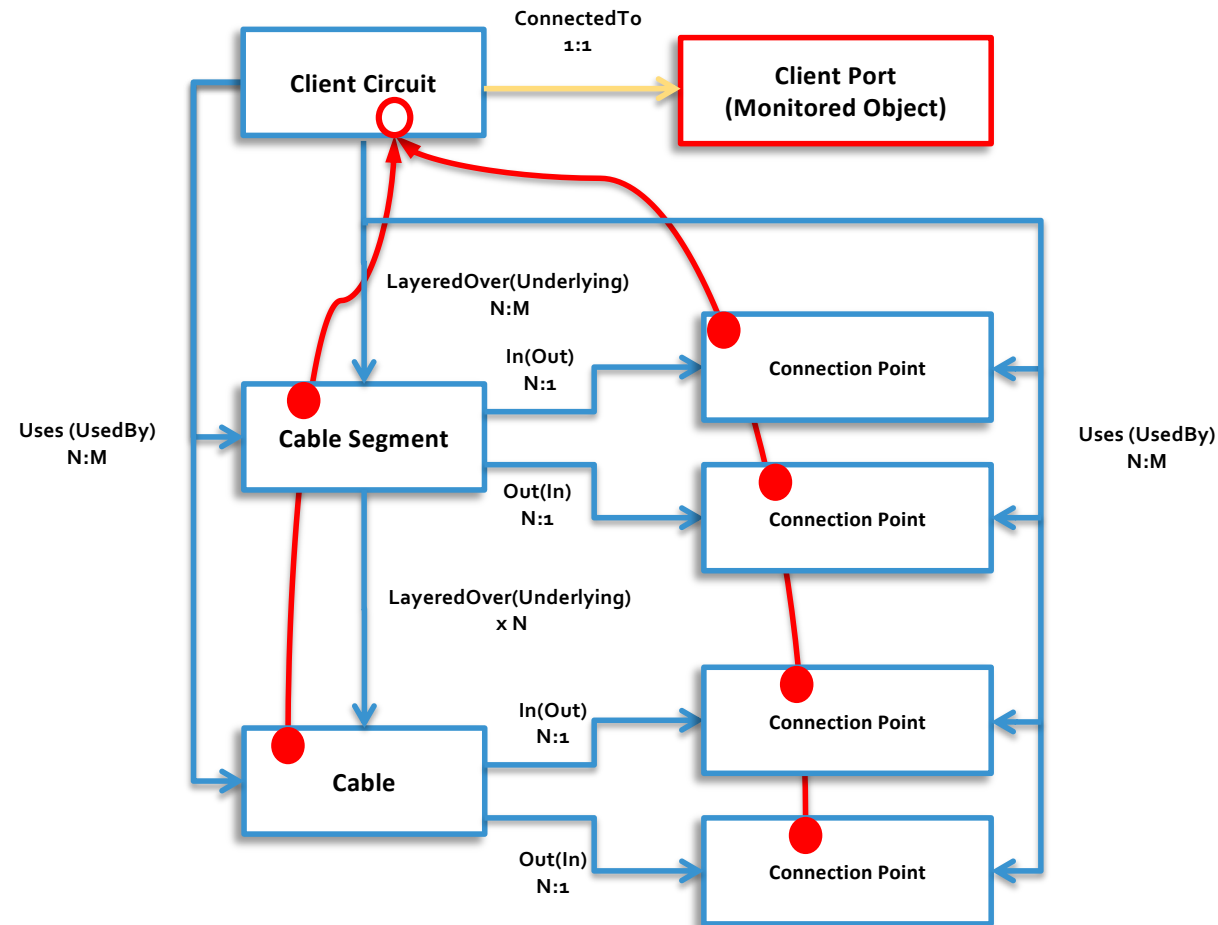
    export Down;
}
```


Smarts CodeBook Correlation

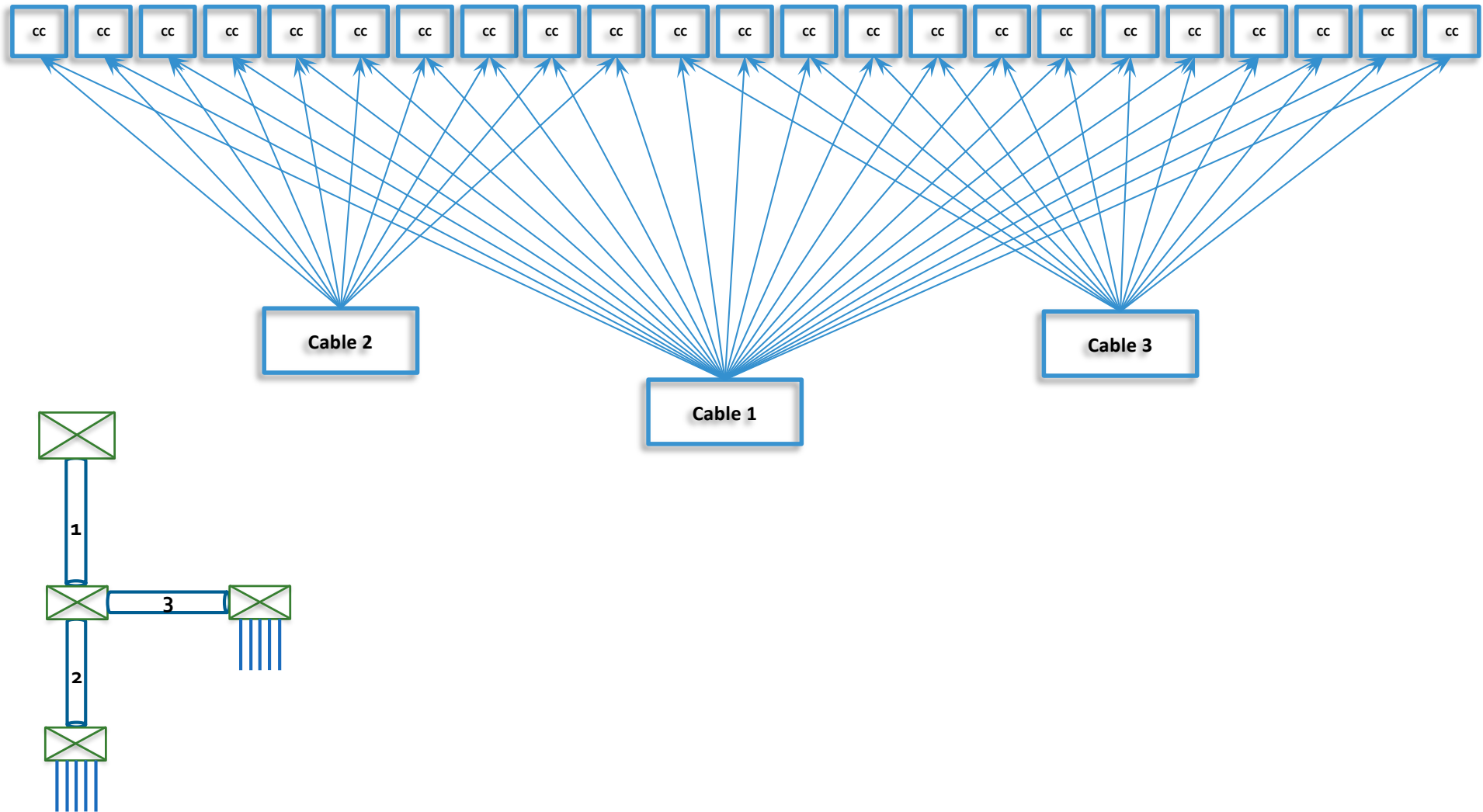


Down Problems “compete” for the same set of symptoms at Circuit Level:

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



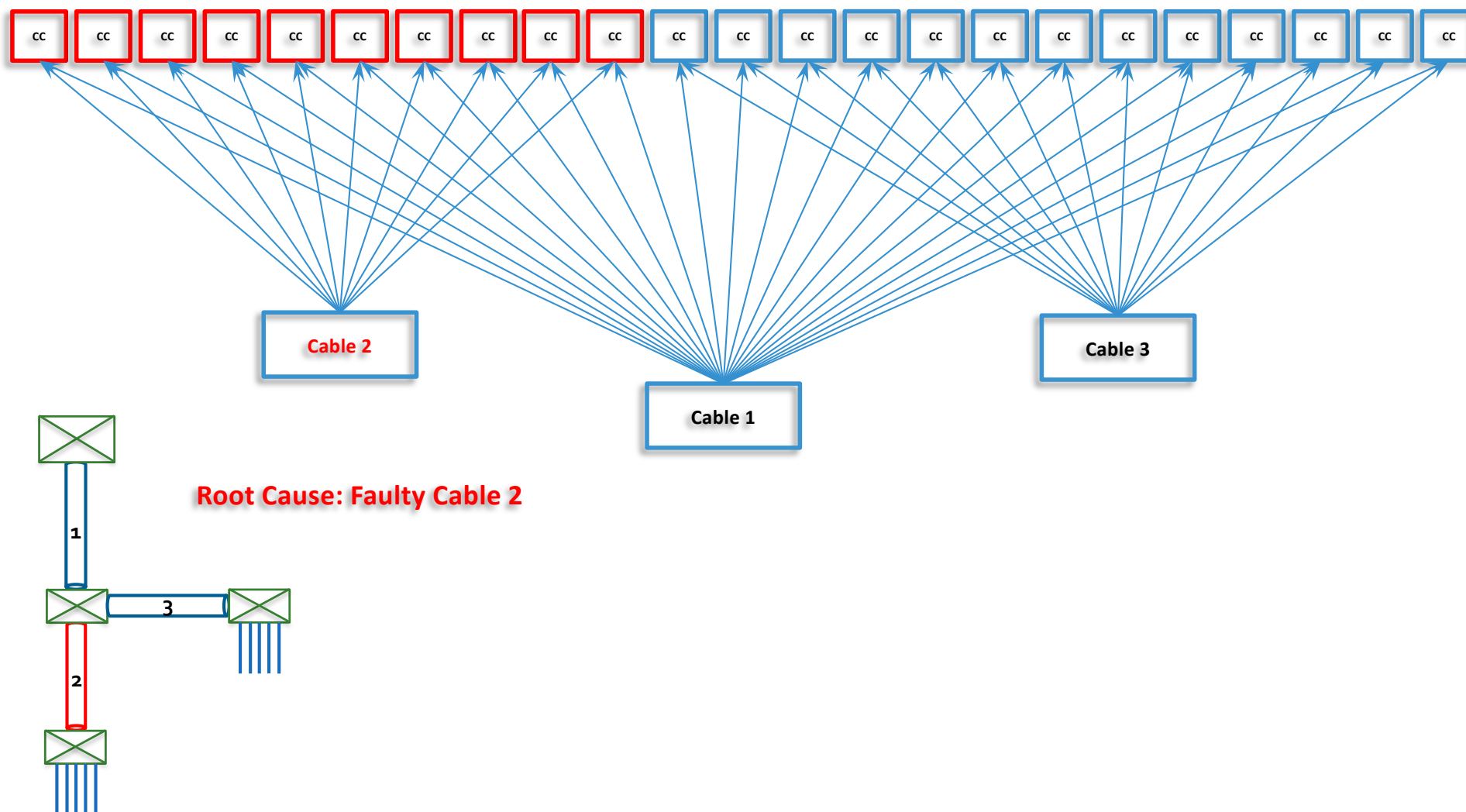
Example: Client Circuit to Cable relations





Example: Client Circuit to Cable relations

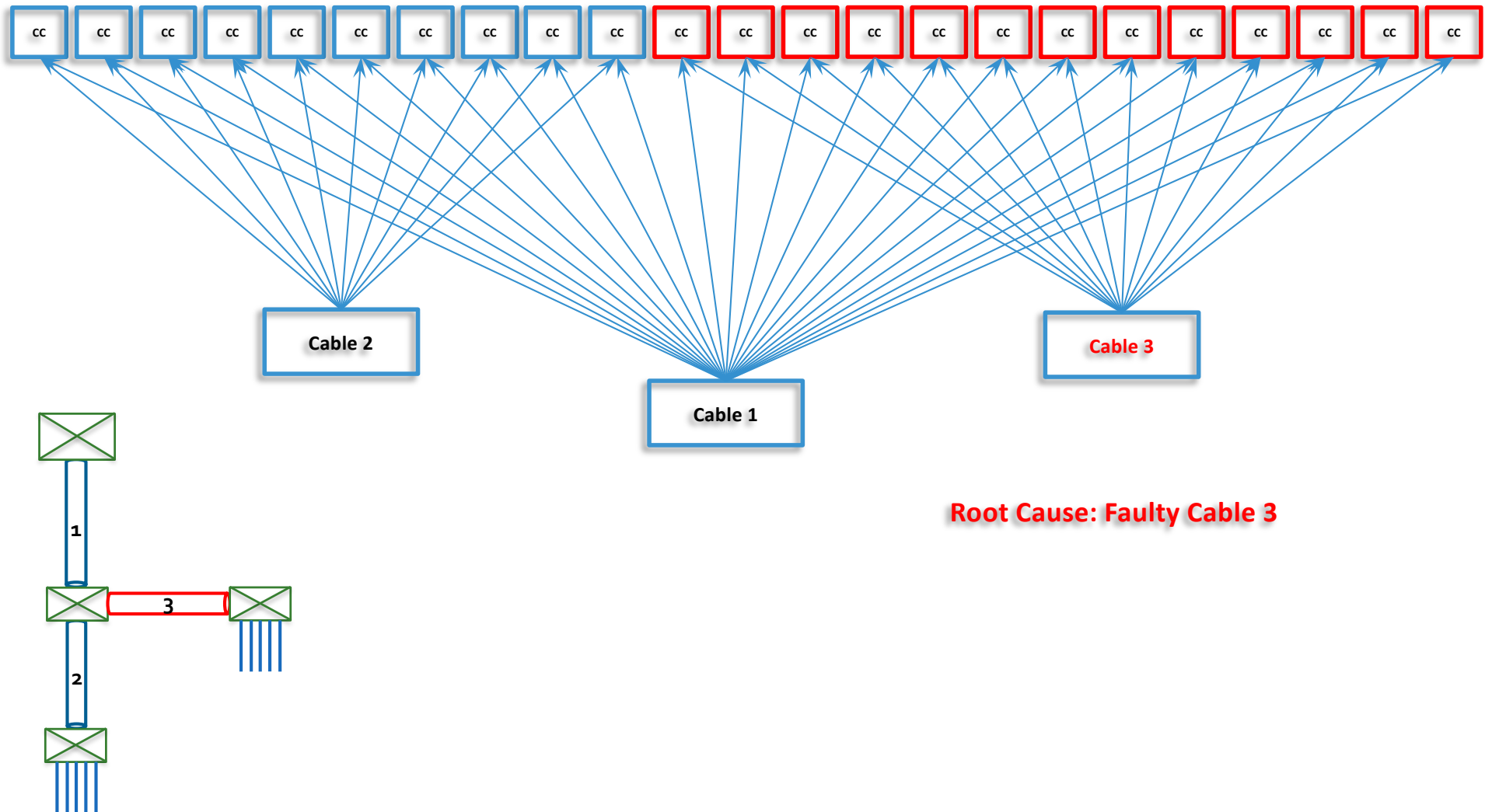
Observed Client Circuit service unavailability alarms



Example: Client Circuit to Cable relations



Observed Client Circuit service unavailability alarms

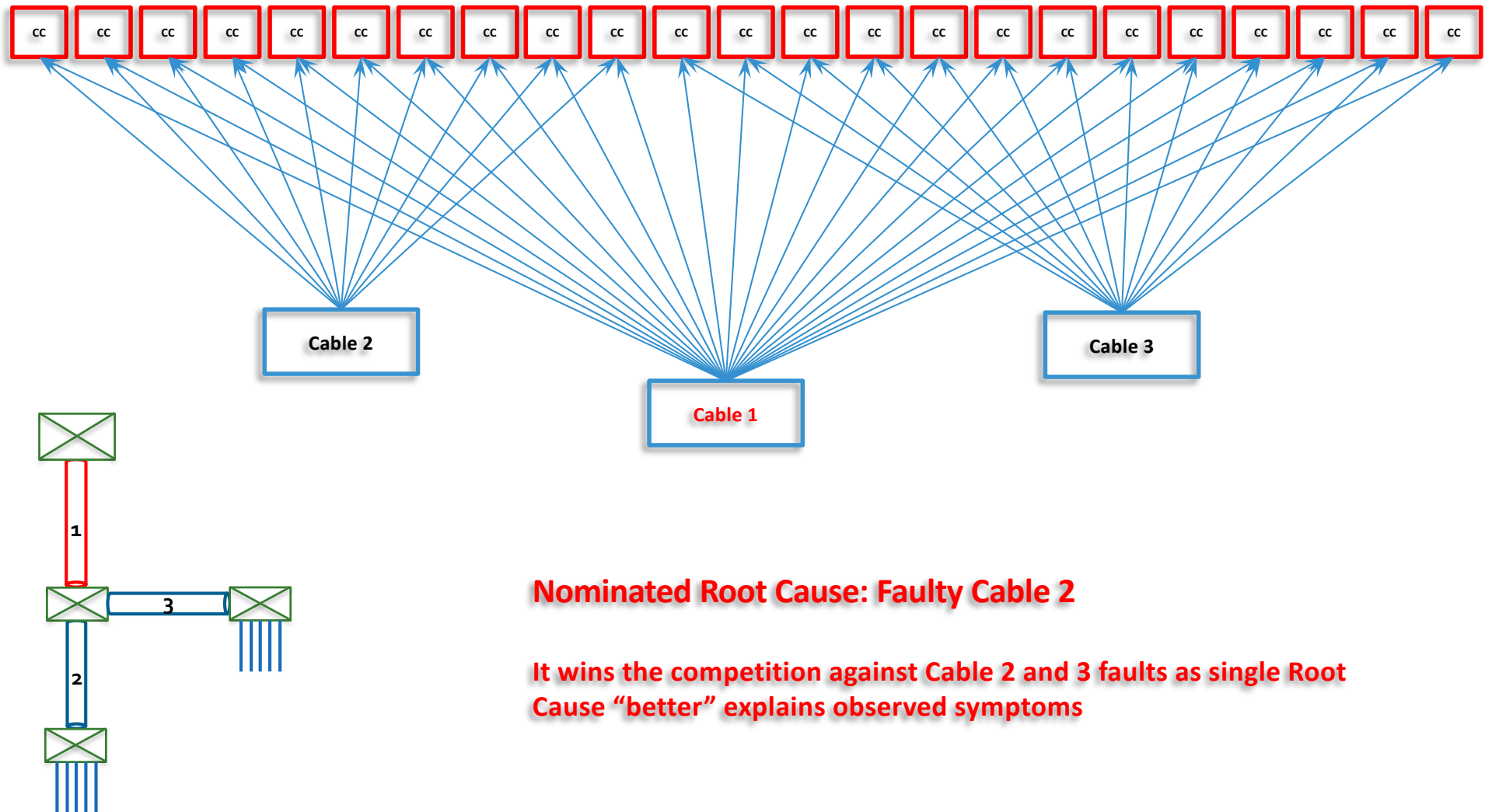


Root Cause: Faulty Cable 3

Example: Client Circuit to Cable relations



Observed Client Circuit service unavailability alarms



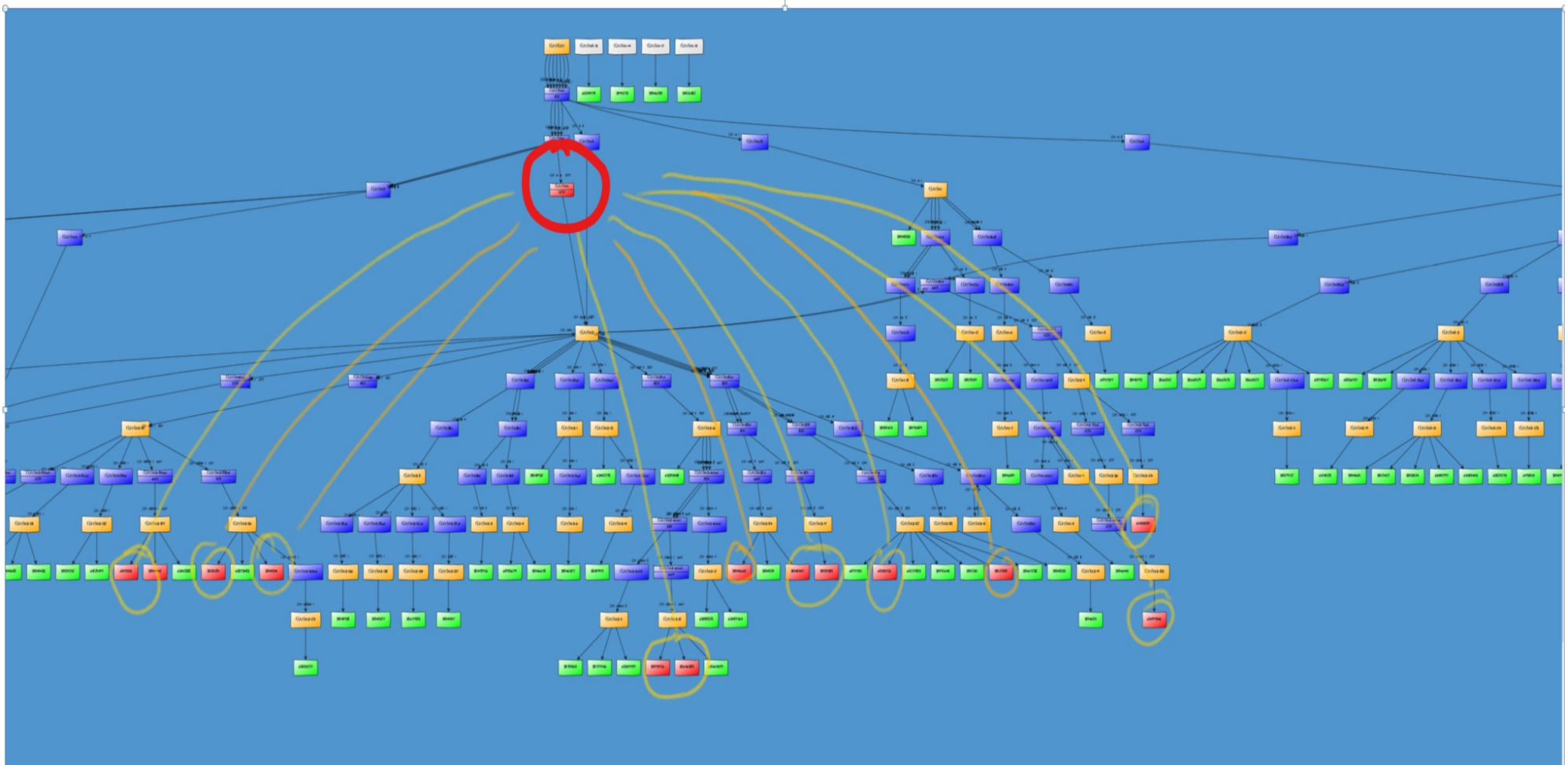
Nominated Root Cause: Faulty Cable 2

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.

Notification Log - Default. Manager: INCHARGE-SA

Sev...	Ack...	Owner	Class	Name	Event	Count	Last Notify	First Notify	User Defined 11	User Defined 12	User Defined 13	User Defined 14
✖	No		Cable		Down	1	03 lis 13:32:29	03 lis 13:32:29	IN FLEXIBILITY POINTS/SPLICES	OUT FLEXIBILITY POINTS/SPLICES	CABLE TRAILS	NO. OF CIRCUITS: 20

Notification Log - Default. Manager: INCHARGE-SA

Sev...	Ack...	Owner	Class	Name	Event	Count	Last Notify	First Notify	User Defined 11
✓	No		Circuit	35598906	Down	1	03 lis 13:32:29	03 lis 13:32:29	ROOT CAUSE: Cable:
✓	No		Circuit	32646322	Down	1	03 lis 13:32:29	03 lis 13:32:29	ROOT CAUSE: Cable:
✓	No		Circuit	35645840	Down	1	03 lis 13:32:29	03 lis 13:32:29	ROOT CAUSE: Cable:
✓	No		Circuit	35645847	Down	1	03 lis 13:32:29	03 lis 13:32:29	ROOT CAUSE: Cable:
✓	No		Circuit	61438839	Down	1	03 lis 13:32:29	03 lis 13:32:29	ROOT CAUSE: Cable:
✓	No		Circuit	61775086	Down	1	03 lis 13:32:29	03 lis 13:32:29	ROOT CAUSE: Cable:
✓	No		Circuit	35646144	Down	1	03 lis 13:32:29	03 lis 13:32:29	ROOT CAUSE: Cable:
✓	No		Circuit	61575818	Down	1	03 lis 13:32:29	03 lis 13:32:29	ROOT CAUSE: Cable:
✓	No		Circuit	32128021	Down	1	03 lis 13:32:29	03 lis 13:32:29	ROOT CAUSE: Cable:
✓	No		Circuit	35645814	Down	1	03 lis 13:32:29	03 lis 13:32:29	ROOT CAUSE: Cable:
✓	No		Circuit	35639355	Down	1	03 lis 13:32:29	03 lis 13:32:29	ROOT CAUSE: Cable:
✓	No		Circuit	35601790	Down	1	03 lis 13:32:29	03 lis 13:32:29	ROOT CAUSE: Cable:
✓	No		Circuit	35645755	Down	1	03 lis 13:32:29	03 lis 13:32:29	ROOT CAUSE: Cable:
✓	No		Circuit	35637679	Down	1	03 lis 13:32:29	03 lis 13:32:29	ROOT CAUSE: Cable:
✓	No		Circuit	35645572	Down	1	03 lis 13:32:29	03 lis 13:32:29	ROOT CAUSE: Cable:
✓	No		Circuit	62881706	Down	1	03 lis 13:32:29	03 lis 13:32:29	ROOT CAUSE: Cable:
✓	No		Circuit	63282144	Down	1	03 lis 13:32:29	03 lis 13:32:29	ROOT CAUSE: Cable:
✓	No		Circuit	35645663	Down	1	03 lis 13:32:29	03 lis 13:32:29	ROOT CAUSE: Cable:
✓	No		Circuit	35600252	Down	1	03 lis 13:32:29	03 lis 13:32:29	ROOT CAUSE: Cable:
✓	No		Circuit	63499346	Down	1	03 lis 13:32:29	03 lis 13:32:29	ROOT CAUSE: Cable:

EMC Ready

Saved on: INCHARGE-SA, user: admin, as: DSLAM-TEST



Thank you