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Validating Access Network Maps

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SCTE CABLE-TEC EXPO®22
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AGENDA

1. IMPORTANCE OF HFC PLANT DESIGN AND ACCURACY
2. WHAT IS PRE-VET DATA COLLECTION?
3. SYSTEM OVERVIEW
4. DATA COLLECTION AND CORRELATION
    - Building a Graph of the RF Network
    - Linking Addresses to the Graph
    - Linking Devices to the Graph
    - Data Aggregation
    - Opportunities for Map Improvement
5. VISUALIZATION
6. CONCLUSION

IMPORTANCE OF PLANT DESIGN AND ACCURACY

- Operators of Hybrid Fiber Coaxial (HFC) have a long history of delivering continuous advancements in speed, capacity and performance. DOCSIS 4.0 and 10G will continue that history.
- Changes to the plant in the field may not always be updated in the plant maps.
- Enrich data to improve accuracy of new plant designs for construction and prevent rework.
- Identify where to segment or split the network for capacity upgrades.

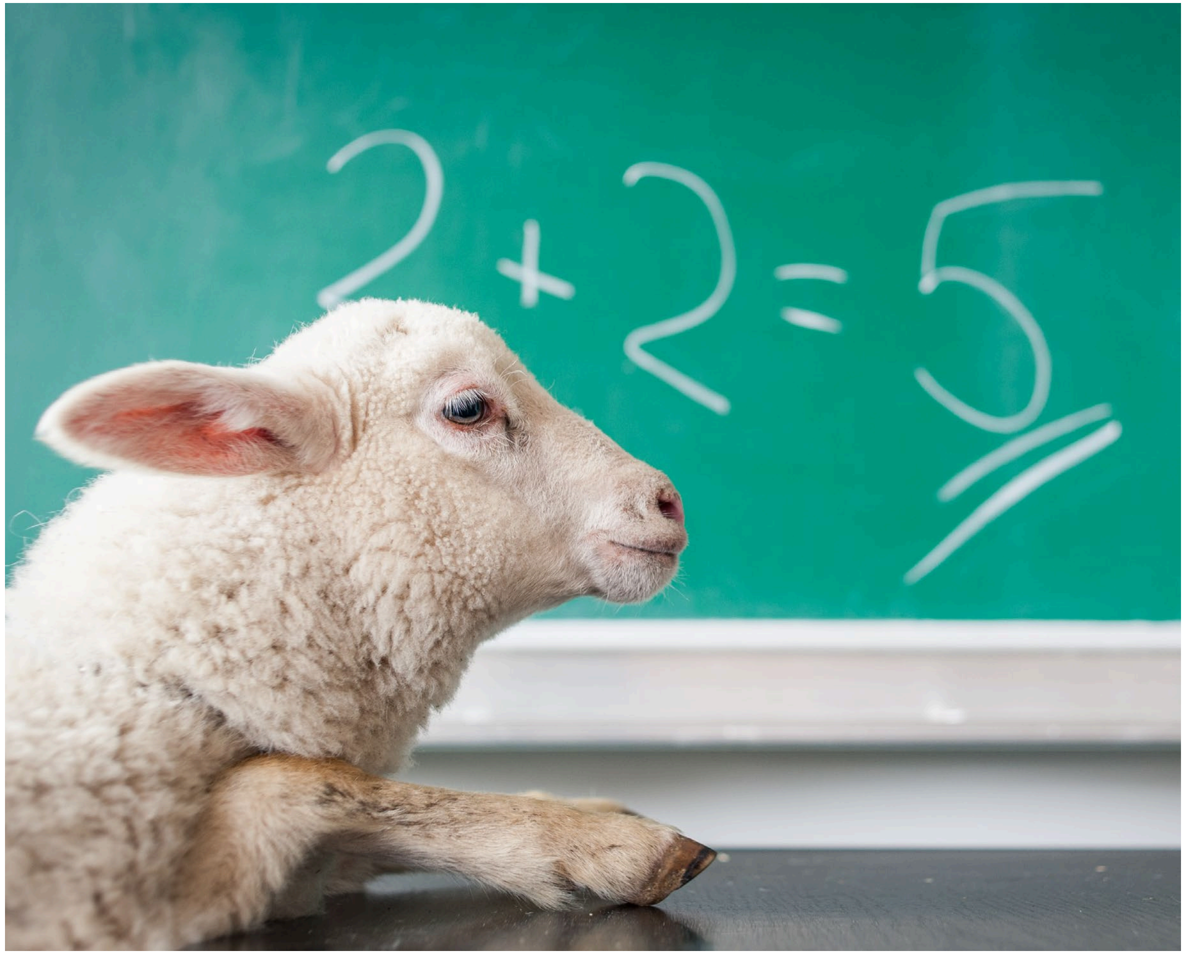


Image provided by https://unsplash.com/

WHAT IS PRE-VET DATA COLLECTION?

EXISTING PLANT MAP

Drafted maps of the RF plant are used to understand where bus legs are located in relation to the node, streets and parcels in the area.

DATA ANALYSIS AND AGGREGATION

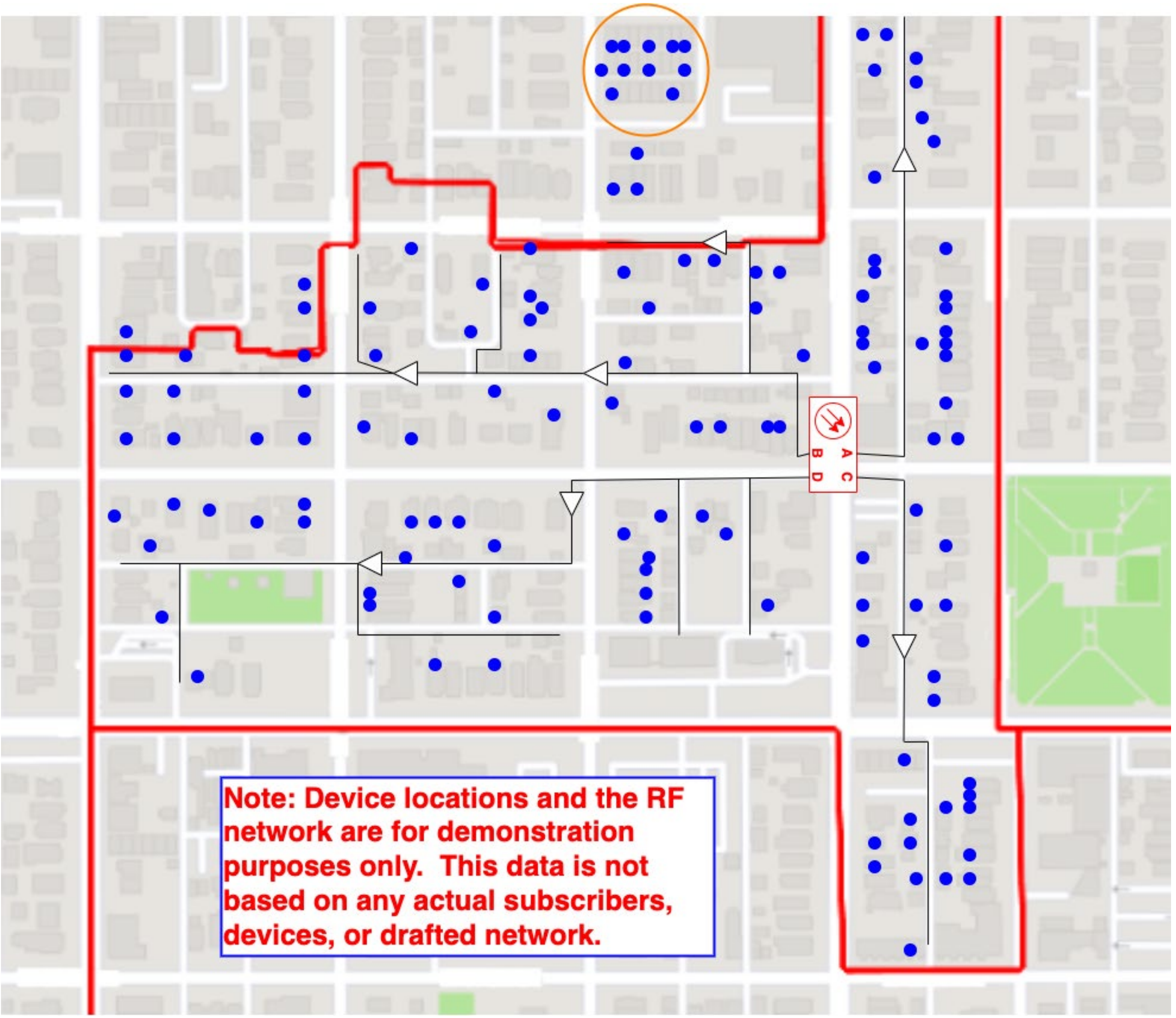
Analysis and aggregation of the high-speed data devices on the CMTS and serviceable addresses that are associated to the node provide additional clarity.

DATA VISUALIZATION

Visualization of the aggregated data layered on top of the drafted RF plant maps show the relationships.

SYSTEM OVERVIEW

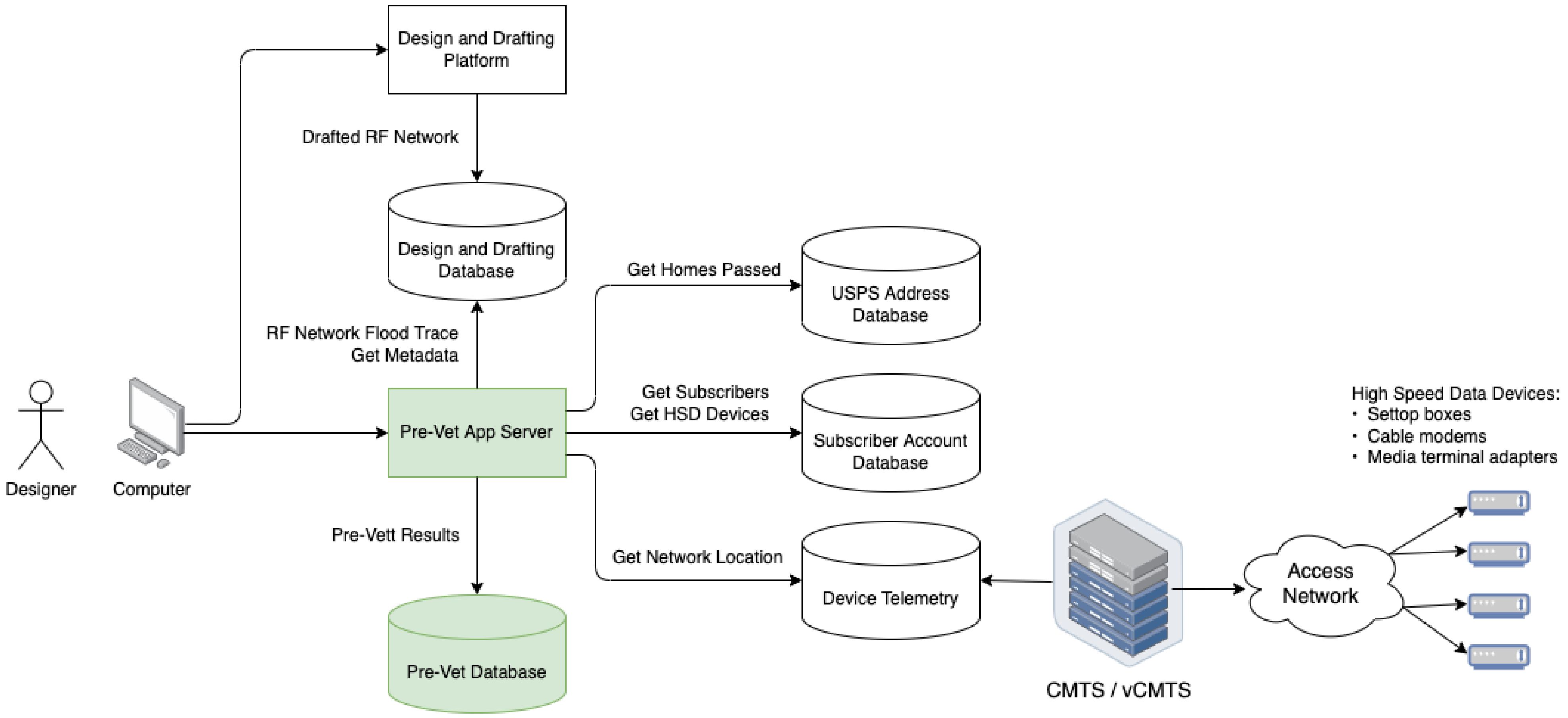
- Subscriber service location (address) and device network communication location correlated against the drafted RF network map provide clues about the accuracy of the maps.
- Once the drafted RF network map has been validated, the pre-vet process calculates homes passed and actual device counts at key locations throughout the RF network map to aid the designers in the capacity upgrade design.



Network maps and data shown in this presentation do not include any names or personal data about subscribers.

SYSTEM FOR PERFORMING THE OPERATION

PRE-VET SYSTEM DIAGRAM



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STEPS TO COLLECT AND CORRELATE DATA

- Build a graph representation of the RF network
- Retrieve the service location addresses based on the node boundary
- Determine node segments if not already known
- Retrieve service location addresses associated with node segments
- Associate service locations to RF taps
- Count homes passed and devices at amplifiers and splitters
- Identify service address or network gaps

RF NETWORK GRAPH

- Understand the relationship between the equipment and cables downstream of the node housing.
- Represent relationships using a graph provides efficient mechanisms for determining connectivity between elements as well as providing searching capabilities.
- Perform an RF flood trace on each bus leg of a node housing to specify a list of elements and connected ports.

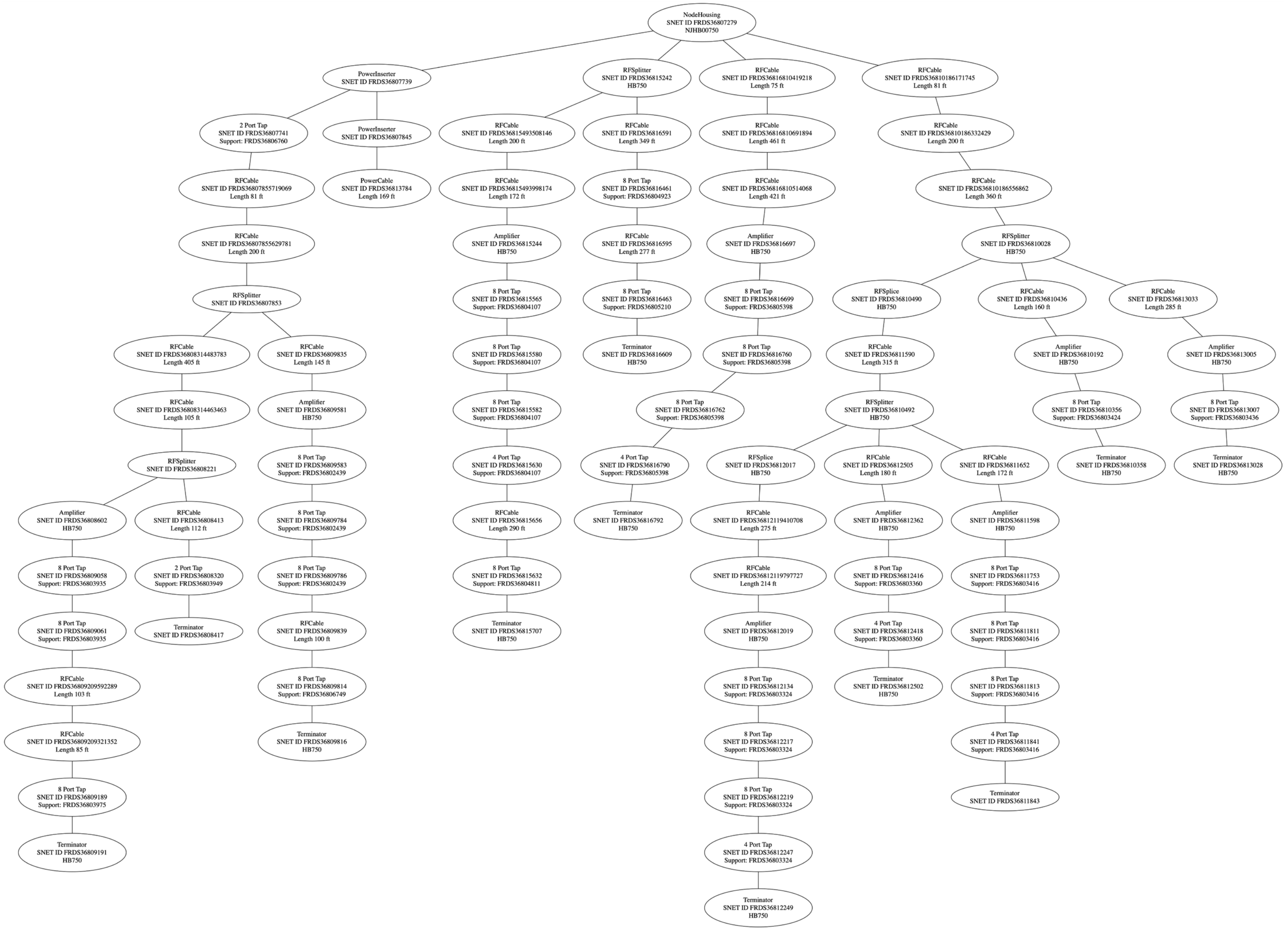
SOURCE			DESTINATION		
TYPE	**ID**	**PORT**	**TYPE**	**ID**	**PORT**
CoaxCable	DMATARCMC1853065972850	N/A	Splitter	DMTARPMC1856598	Input
Splitter	DMTARPMC18536598	Output-1	CoaxCable	DMTARPMC1853065991823	N/A
Splitter	DMTARPMC18536598	Output-2	CoaxCable	DMTARPMC1853065964851	N/A
CoaxCable	DMTARCMC1853065991823	N/A	Tap	DMTARMC18536621	Input

De-duplicate RF elements when creating vertices.

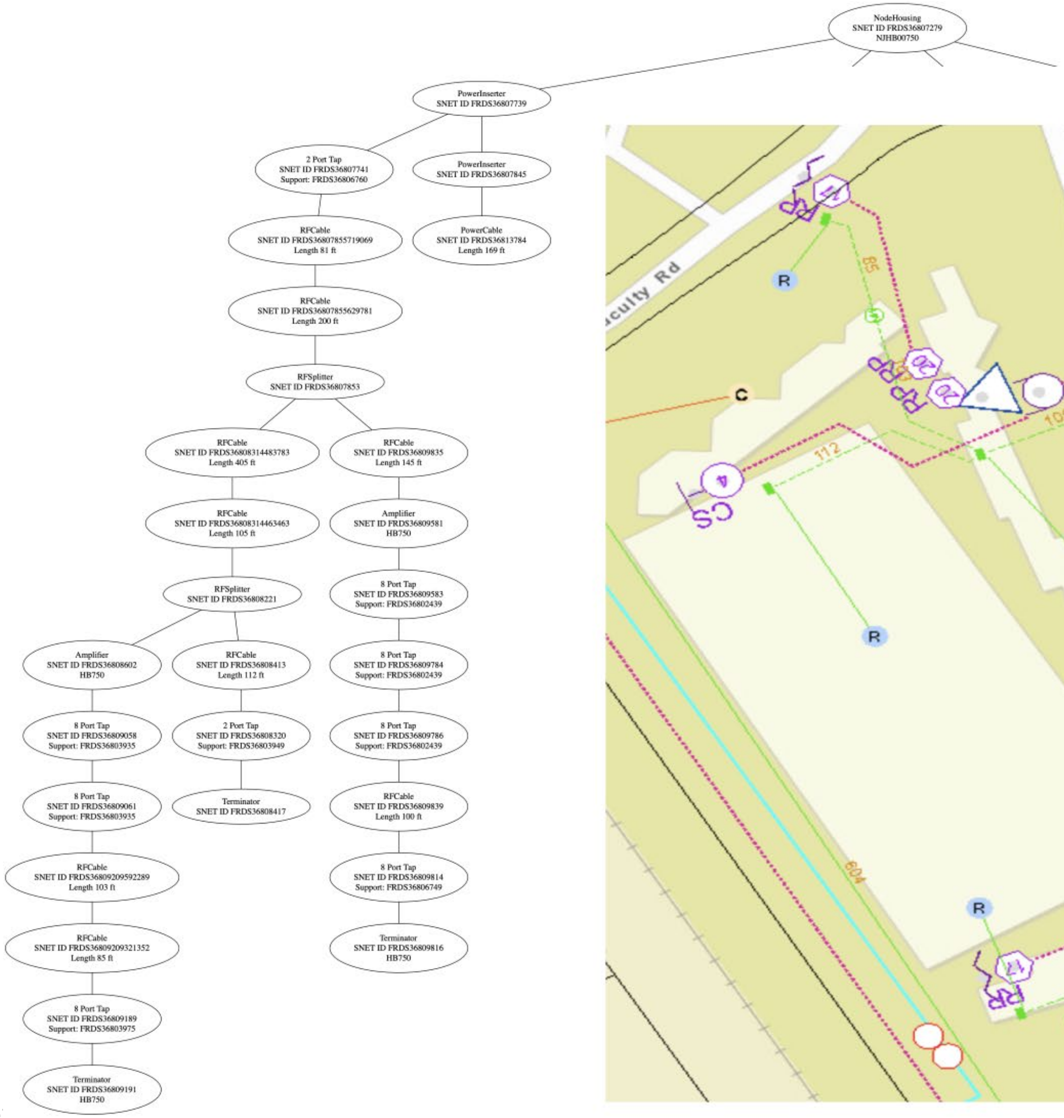
Port conectivity represents edges between vertices..

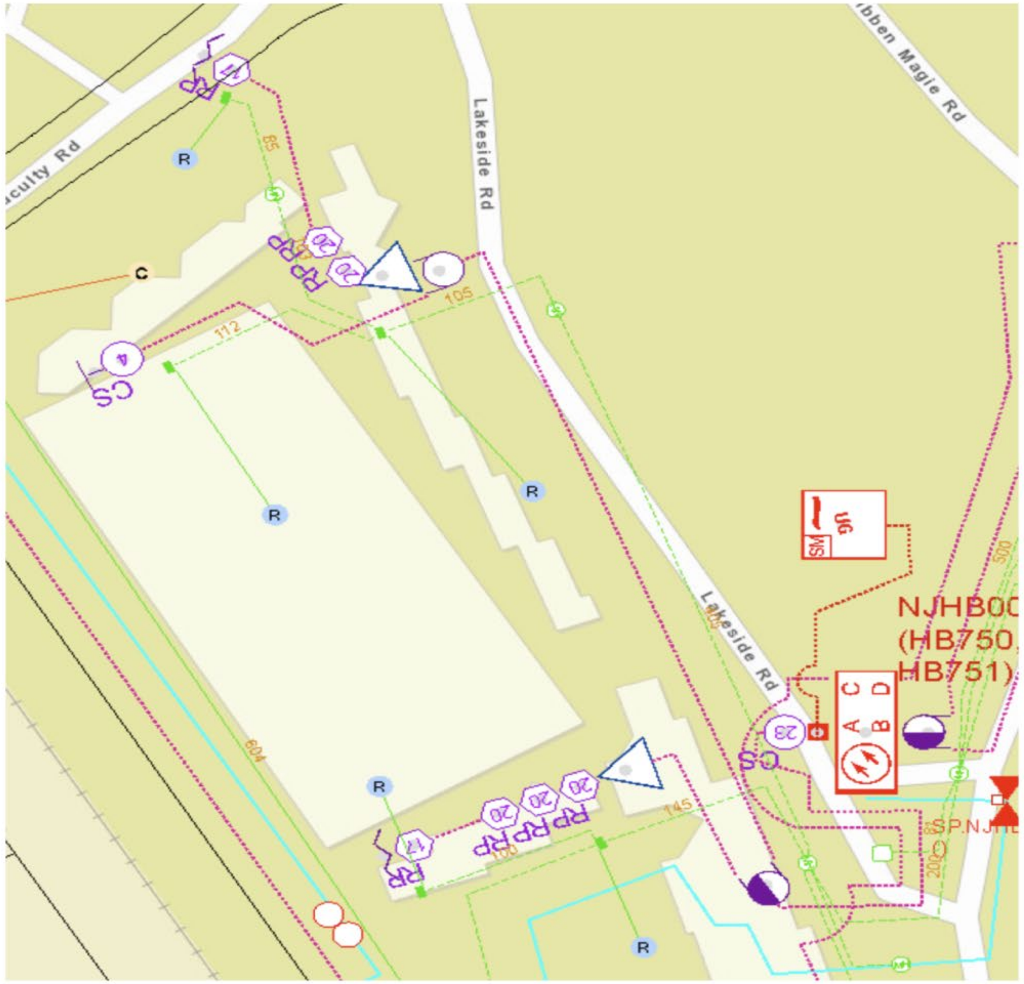
Port connection details are annotated in the edges of the graph.

EXAMPLE RF NETWORK GRAPH



CORRELATING RF NETWORK GRAPH WITH DRAFTED NETWORK





Each RF cable or RF equipment element is represented by a vertex in the graph. Edges in the graph represent connectivity.

Notice that the power supply is missing from the graph. This may be a drafting issue where the power cable running to the power supply is not actually connected.

NODE SEGMENTATION

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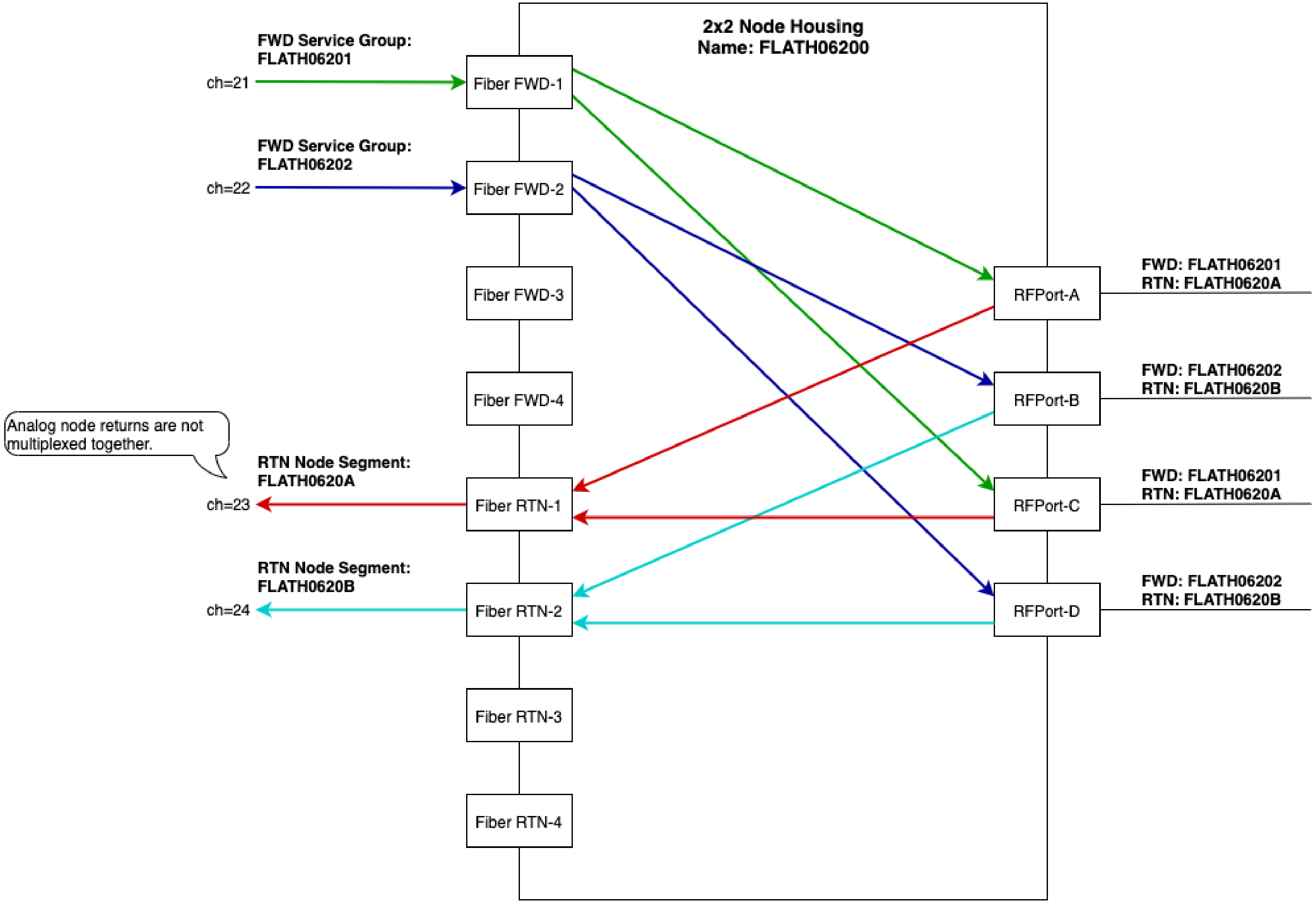
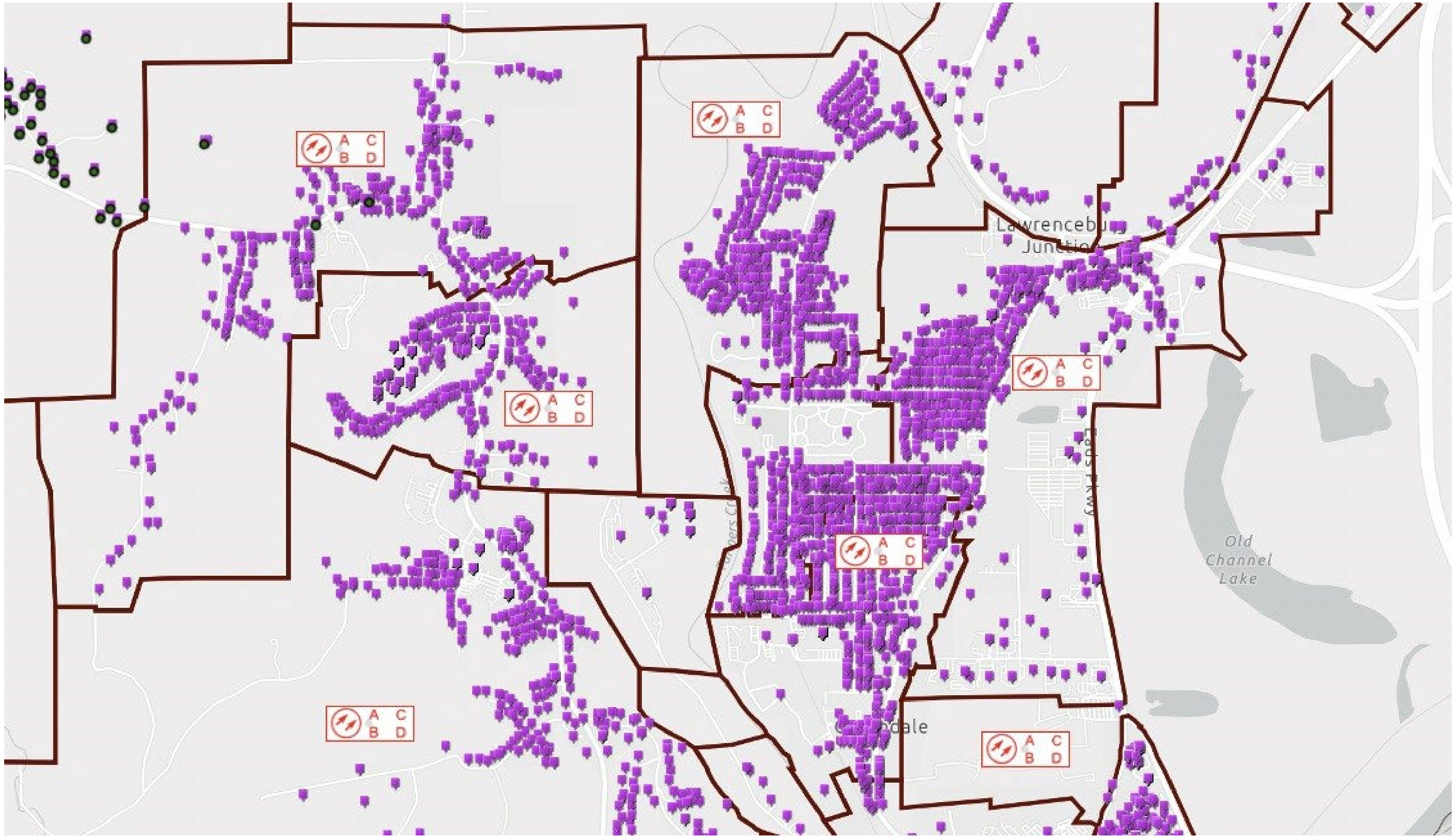


An important method to evaluate the accuracy of the drafted RF network is to examine the subscriber locations and the high-speed data (HSD) capable devices on the network.

The set of subscribers that communicate upstream to a specific CMTS or RPD port are described in this presentation as a "node segment." The node segment can be determined when the HSD device communicates with the CMTS or vCMTS.

HSD devices are linked to subscriber accounts. These accounts have service address locations.

ADDRESSES INSIDE NODE BOUNDARY



Querying the drafted node boundary provides most of the addresses needed for the network analysis.

Associating those addresses with active devices will allow discovery of the node segments associated with the node housing.

SERVICE ADDRESS INFORMATION

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ID	NUMBER	STREET	UNIT TYPE	UNIT VALUE	CITY	STATE	ZIP	LAT.	LONG.
2198101	101	Main St.	Apt.	A	Philadelphia	PA	19103	39.9547	75.1685
36198354	222	First Ave.			Philadelphia	PA	19103	39.9621	75.0981

Fields returned in the query include a unique ID assigned to the address location, street number, street name, unit type and value (for multi dwelling units), city, state, postal code, latitude, and longitude. The latitude and longitude are based on the geocoder for the address database, not the drafted location.

We collect, store, and use all data in accordance with our privacy disclosures to users and applicable laws

ADDRESSES ASSOC. WITH NODE SEGMENTS

ACCOUNT ID	DEVICE ID	DEVICE TYPE	NODE SEGMENT
335056384	A3:98:31:C9:ED:71	CM	FLD0010A
242012225	22:3E:C1:B5:CC:8E	CM	FLD00101C
263370322	B7:C0:39:D2:AC:4F	STB	FLD00101D
619042765	FA:45:22:13:D2:1C	CM	FLD00101A
390653365	6F:4A:70:D6:E8:44	MTA	FLD00101B
133703447	35:7B:B2:84:0A:FC	CM	FLD0009D

To identify missing plant extensions from the drafted map, it is not sufficient to only examine the addresses in the drafted node boundary or addresses associated with drafted RF taps.

The address search needs to expand to include any address that has devices in the node segments associated with this node housing.

Join account to device to node segment data.

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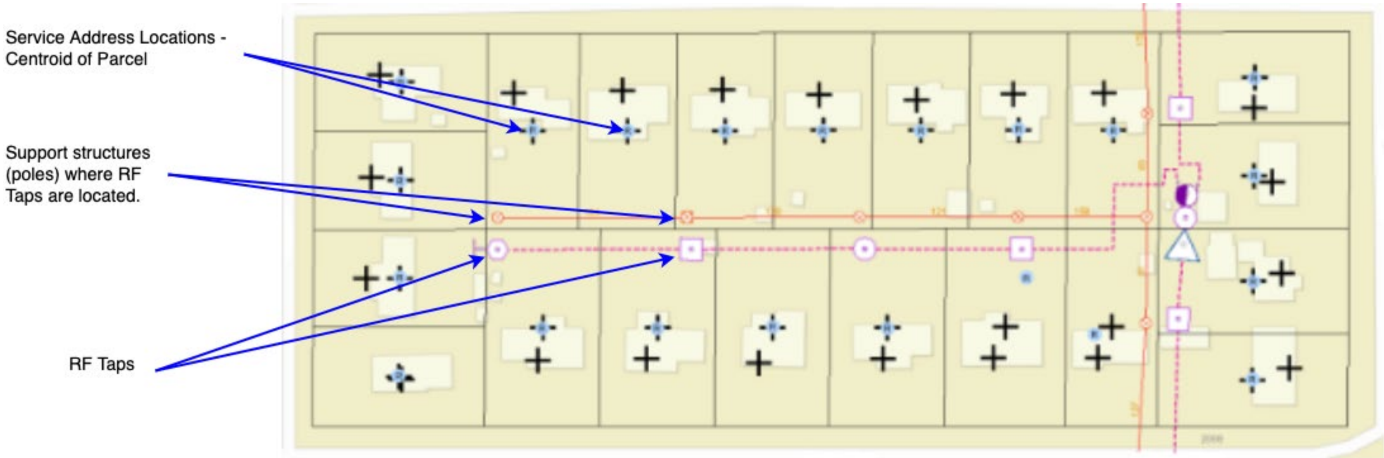
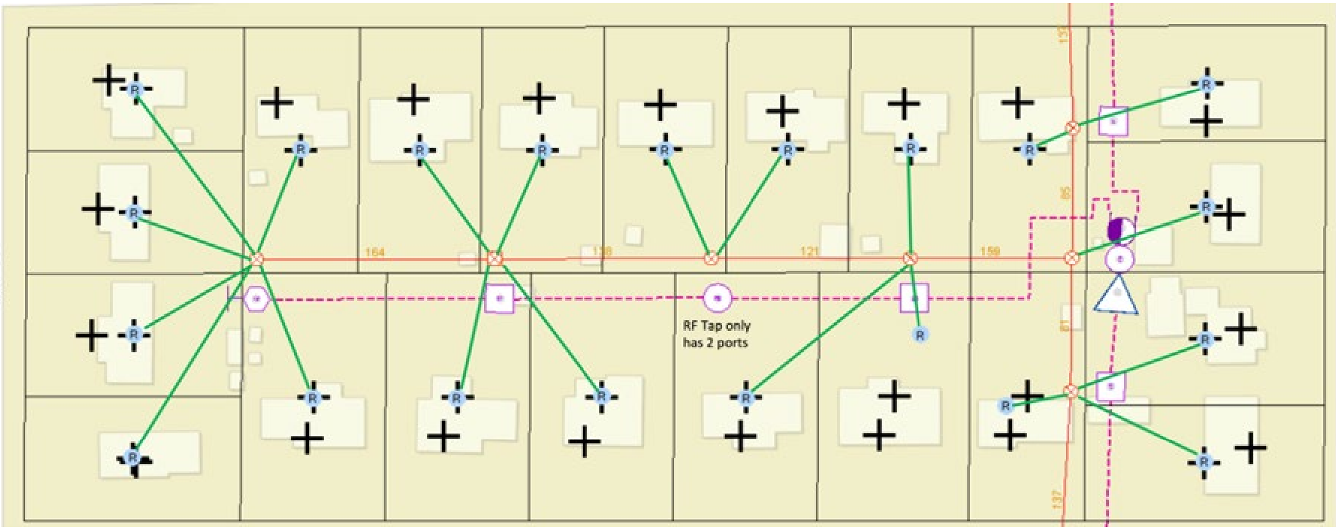
LINK ADDRESSES TO RF NETWORK



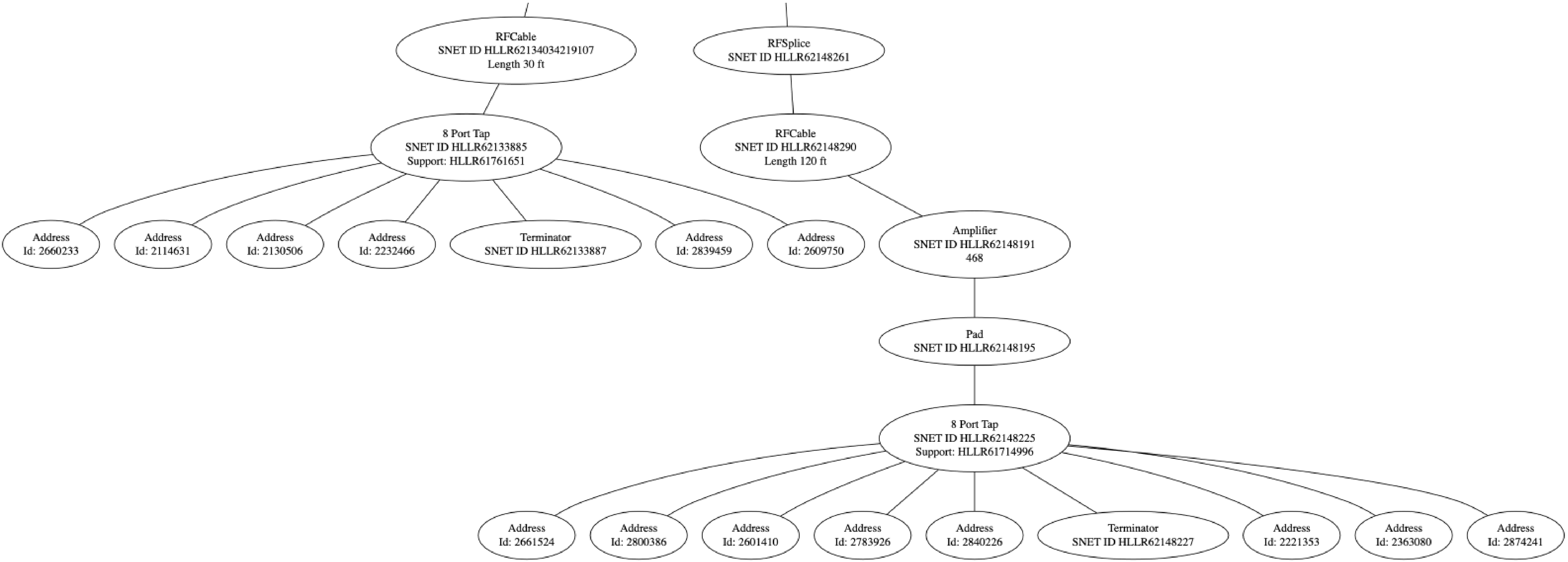


Addresses must be associated to RF taps in the graph to find map inconsistencies, calculate homes passed and device counts, and find the node segment per bus leg.

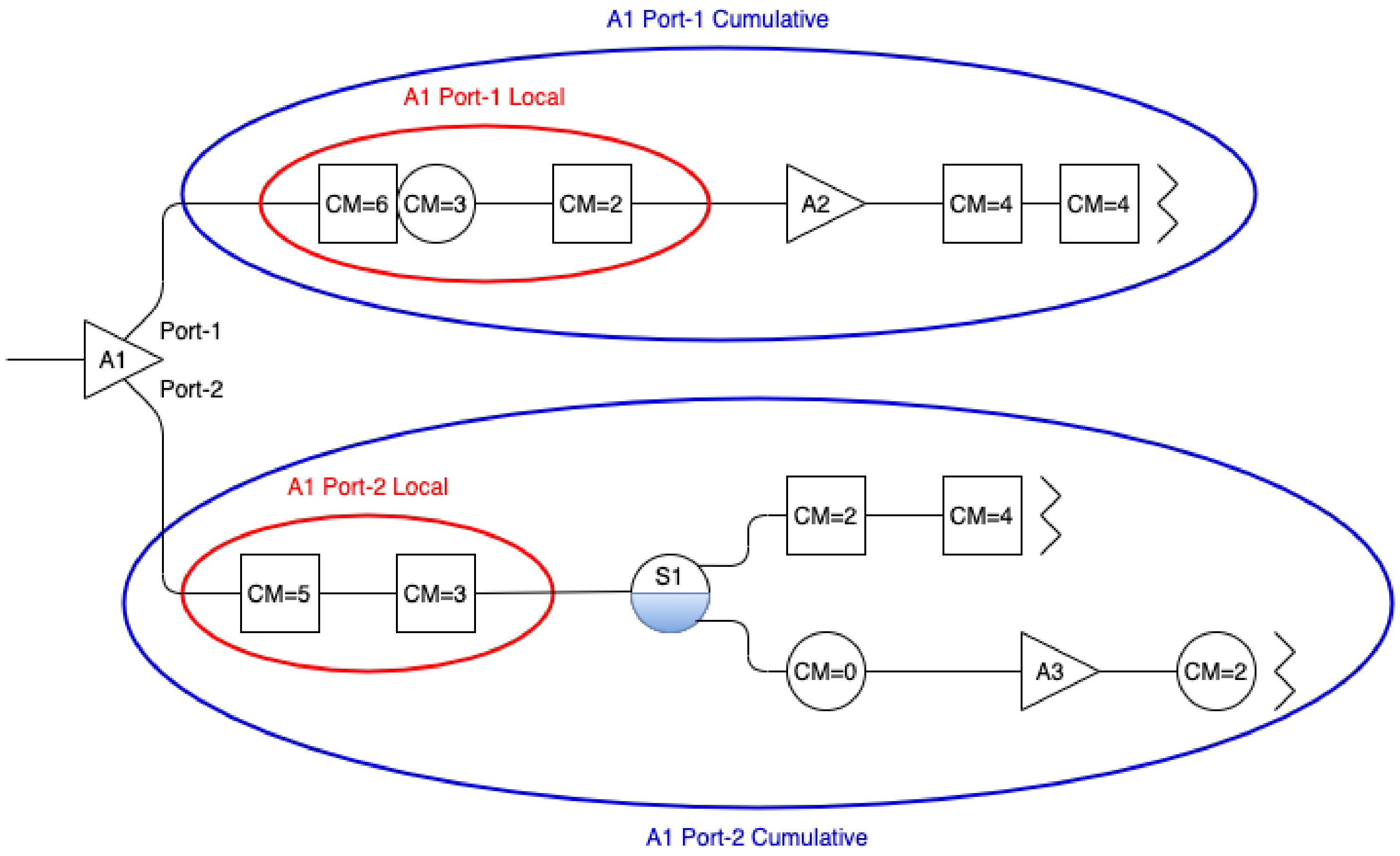
Use the proximity of the address geolocation to the support structure on which the RF tap is attached.

Must take support structure house count and RF tap port count into account for proximity-based assignment.

ADDRESS LOCATIONS IN RF NETWORK GRAPH

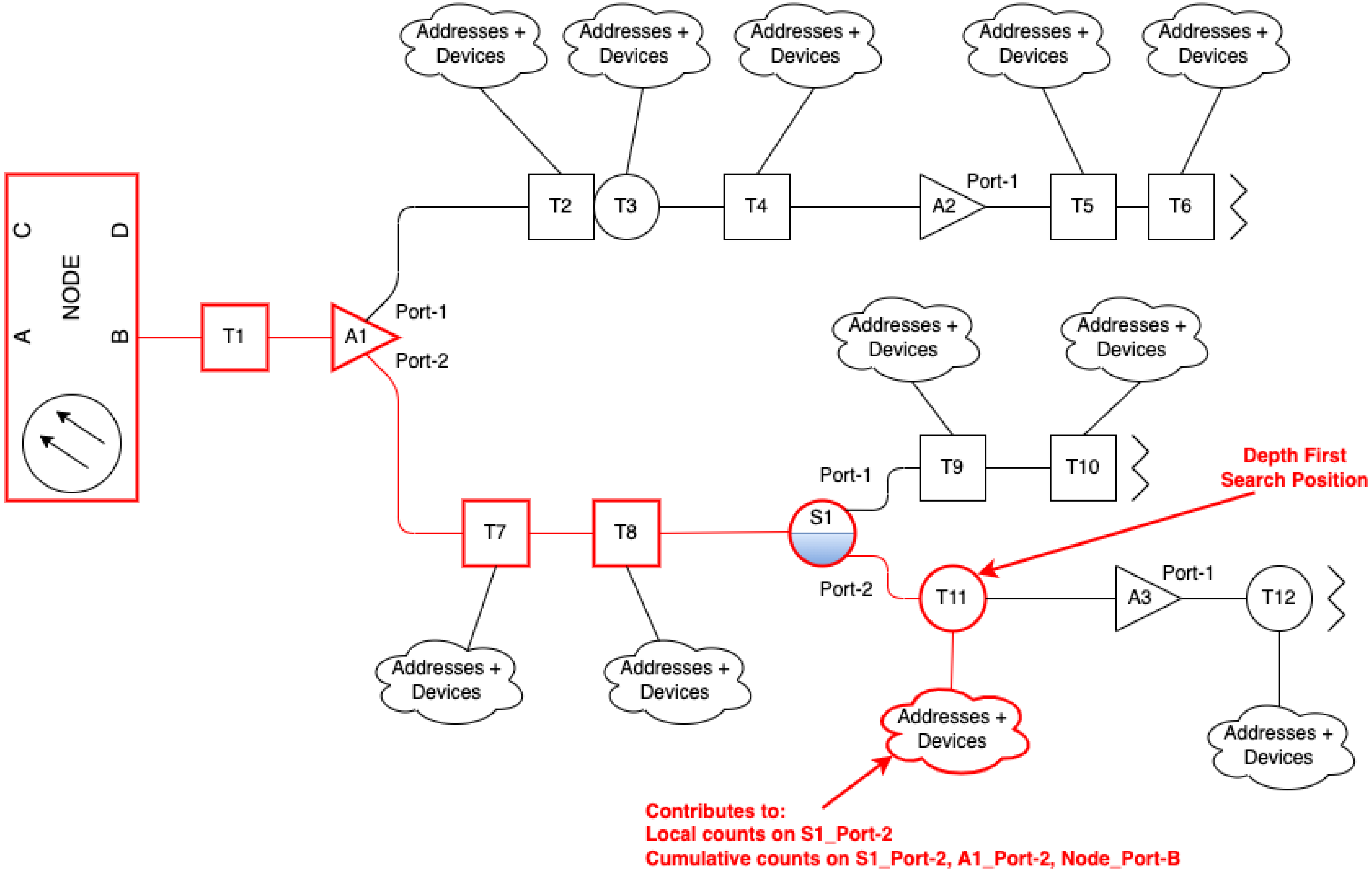


AGGREGATING DEVICE COUNTS AT AMPLIFIERS



Amplifier 1 Device Totals		
	Local	Cumulative
A1 Port-1	CM=11	CM=19
A1 Port-2	CM=8	CM=16

DEPTH FIRST SEARCH TO CALC. DEVICE AND HOMES PASSED COUNTS



Stack of Aggregators	
Splitter S1, Port-2	top
Amp A1, Port-2	
Node, Port B	bottom

DEVICE AND HOMES PASSED COUNT AGGREGATOR

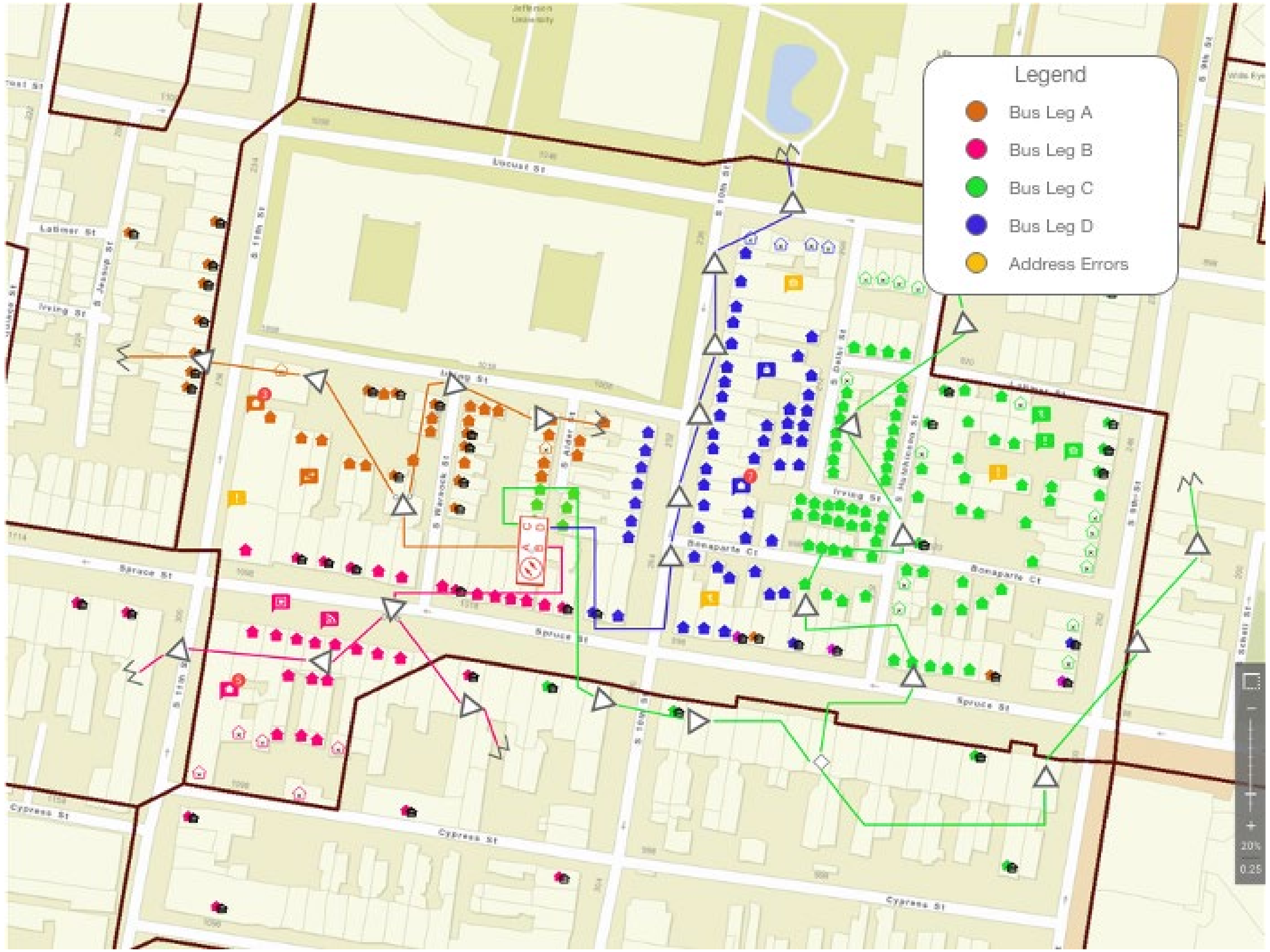
TYPE	DEVICE ID	PORT	LOCAL				CUMULATIVE			
			HOMES	CM	STB	MTA	HOMES	CM	STB	MTA
Node	UTAARMC18121634	D	0	0	0	0	96	39	43	69
Amp	UTAARAMC18121825	1	4	2	1	3	55	23	21	39
Amp	UTAARAMC18121825	2	3	1	2	2	41	16	22	30
Split	UTAARPMC18121923	1	2	1	1	1	21	8	8	17
Split	UTAARPMC18121923	2	0	0	0	0	30	11	12	19

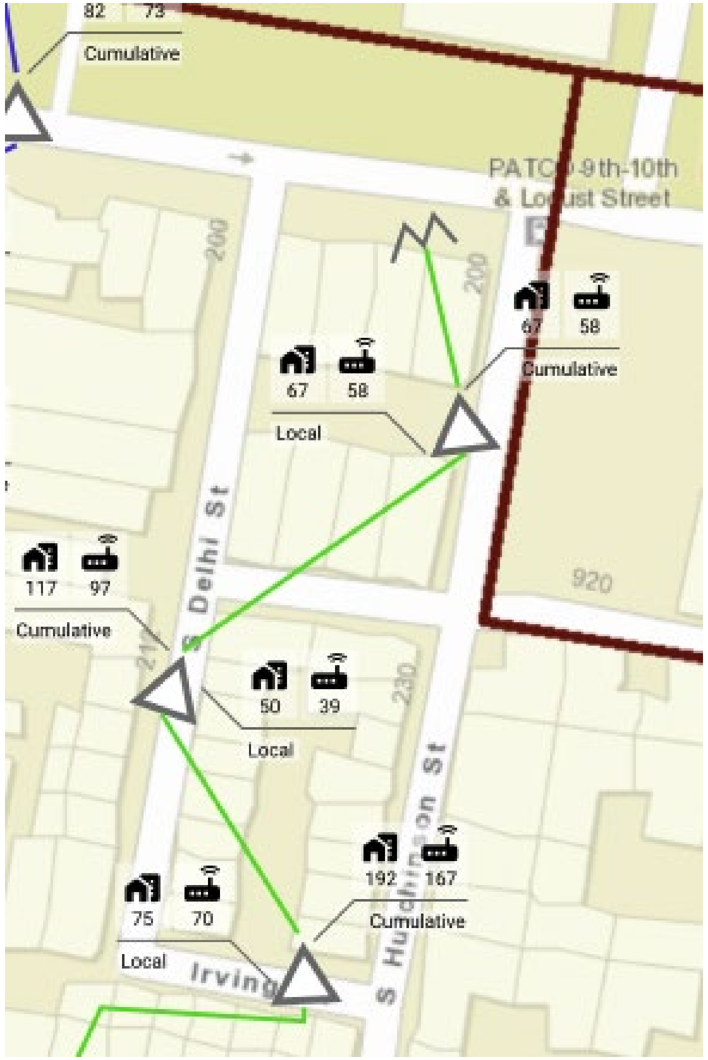
After executing the algorithm, the bus legs of the node housing and the RF output ports of amplifiers and splitters will have local and cumulative counts of devices and homes passed. The maximum number of amplifiers and maximum amplifier cascade will be known by bus leg.

OPPORTUNITIES FOR MAP IMPROVEMENTS

- Unconnected Subscriber
- Address Not Serviceable
- Unconnected RF Tap
- Incorrect Node Segment
- Node Segment to Bus Leg Mismatch
- Outside Node Boundary

VISUALIZATION OF PRE-VET RESULTS





CONCLUSION

- The pre-vet process aggregates and correlates data from multiple sources, which is used to analyze the drafted RF network and decide whether the existing drafted maps are accurate.
- The process to automate these steps involves building a graph model of the RF network for a given node housing based on data in the design and drafting platform.
- A depth first search algorithm is employed on the graph to aggregate homes passed and device counts at the bus legs, amplifiers, and splitters.
- A view of the distribution of homes passed and devices across the network aids the designer when performing the capacity upgrade design.
- Automating many of the pre-vet steps reduces the amount of time a designer dedicates to this process.

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Thank You!

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