Case Study: Issue Detection Algorithm In a Cable Company

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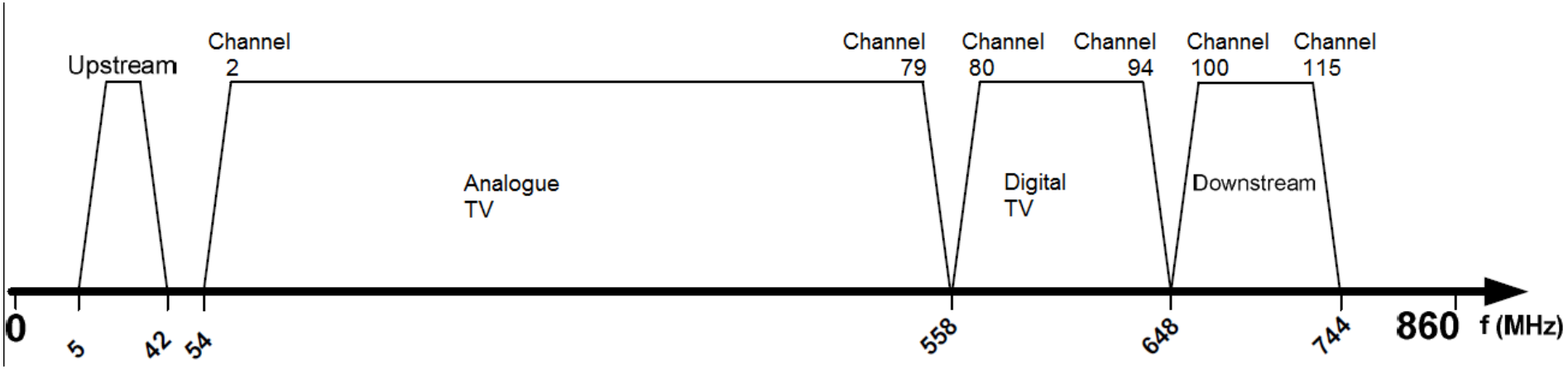
Introduction & Agenda

- DOCSIS and HFC network
- Issues in a HFC network
- Nodes Geolocation
- Issue detection
- Enters Nagios

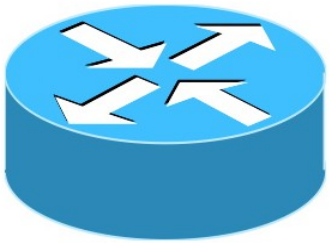
DOCSIS and HFC Network

- Data Over Cable Service Interface Specification
- Uses legacy cable network to transport data.
- Data from ISP to client travels in Downstream.
- Data from client to ISP travels in Upstream



DOCSIS and HFC Network

- Cable Modem Termination System.
- Connects clients in an area to an RF interface
- Decode DOCSIS connection.

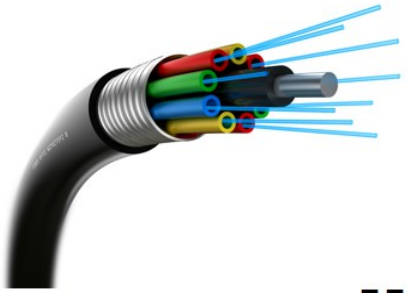


CMTS

Coaxial Cable

HFC Transmission

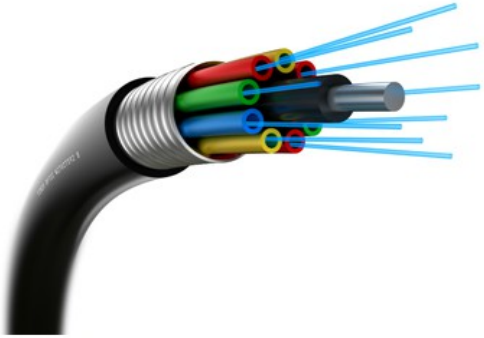
Optical Fiber



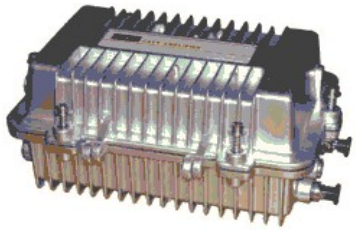
Optical Cable

DOCSIS and HFC Network

- Many fibers are carried in an optical cable.
- The signal is carried kms without degradation.
- In last mile HFC Node converts signal to RF.



Optical Cable



HFC Node

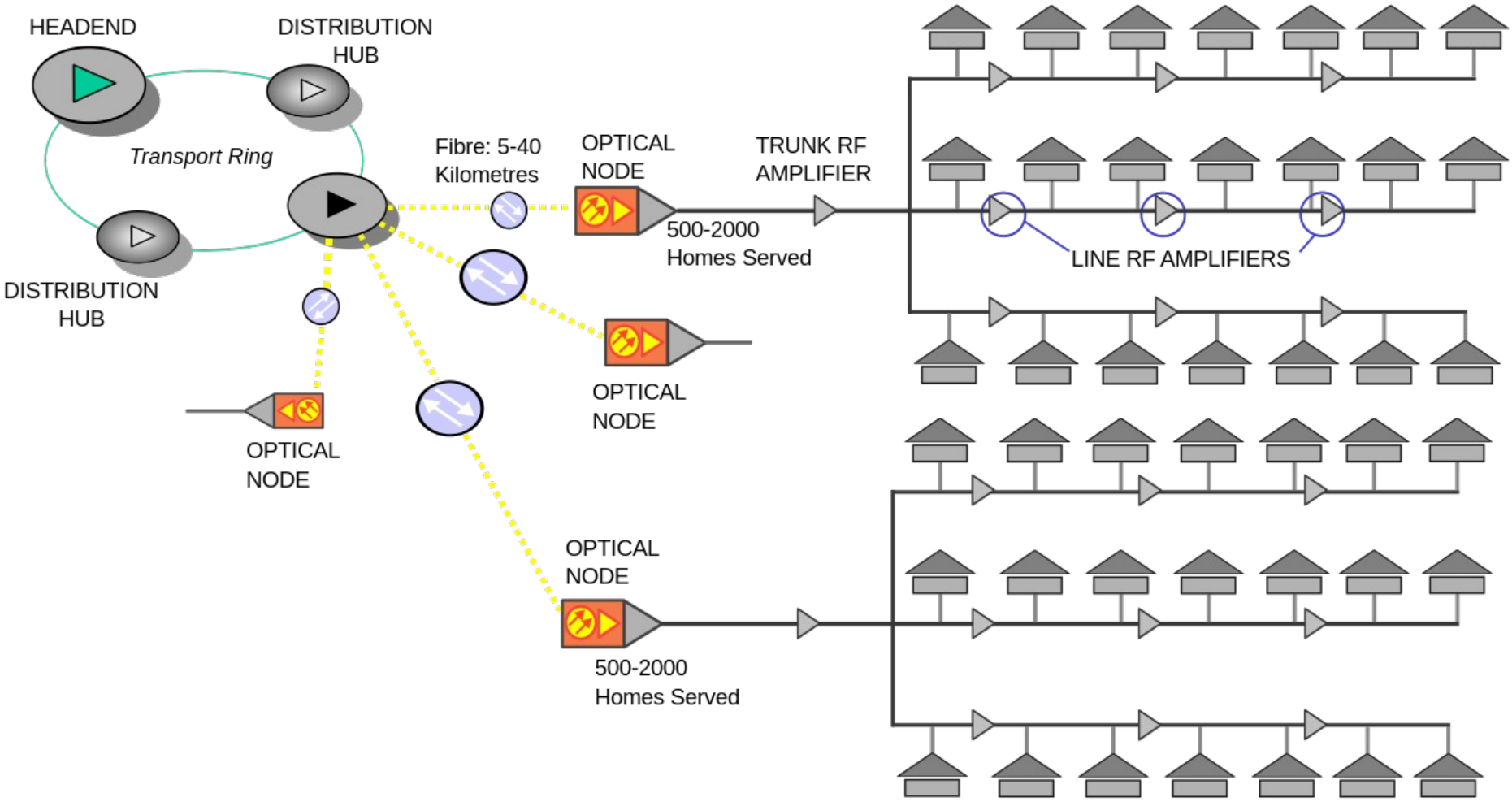
Coaxial Cable

Cable Modem

DOCSIS and HFC Network

- All the clients in C1 share the same Downstream
- Clients send control frames and connect to a specific Upstream.
- A client in the cable shown will be connected to C1U0

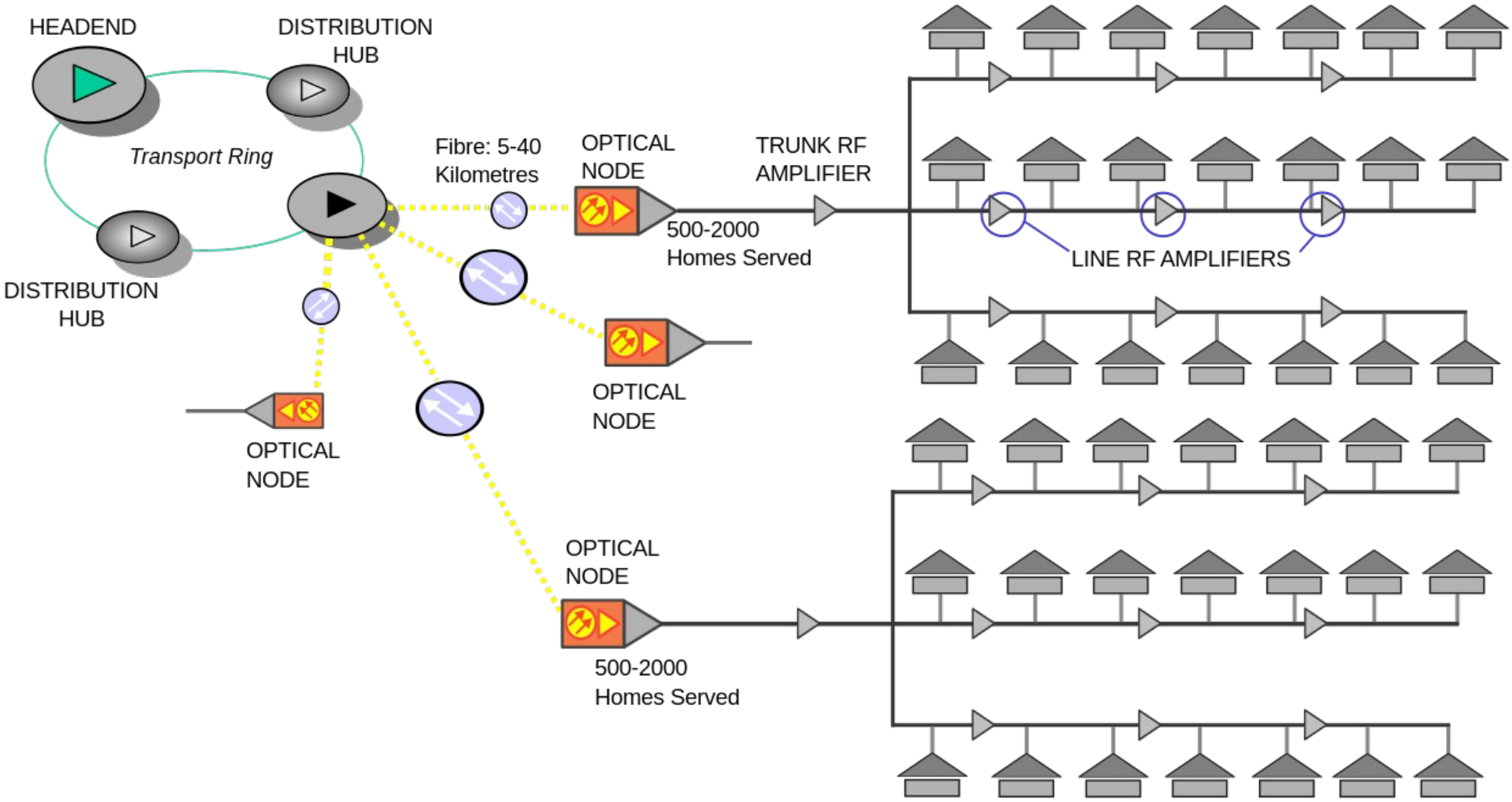
DOCSIS HFC Network



Issues in an HFC network

- Issues can appear in many parts:
  - Line Amplifiers.
  - HFC Nodes.
  - Trunk Amplifiers.
  - Trunk Cable.
  - Optical Fiber.
  - CMTS Card.
  - CMTS.

Issues in an HFC network



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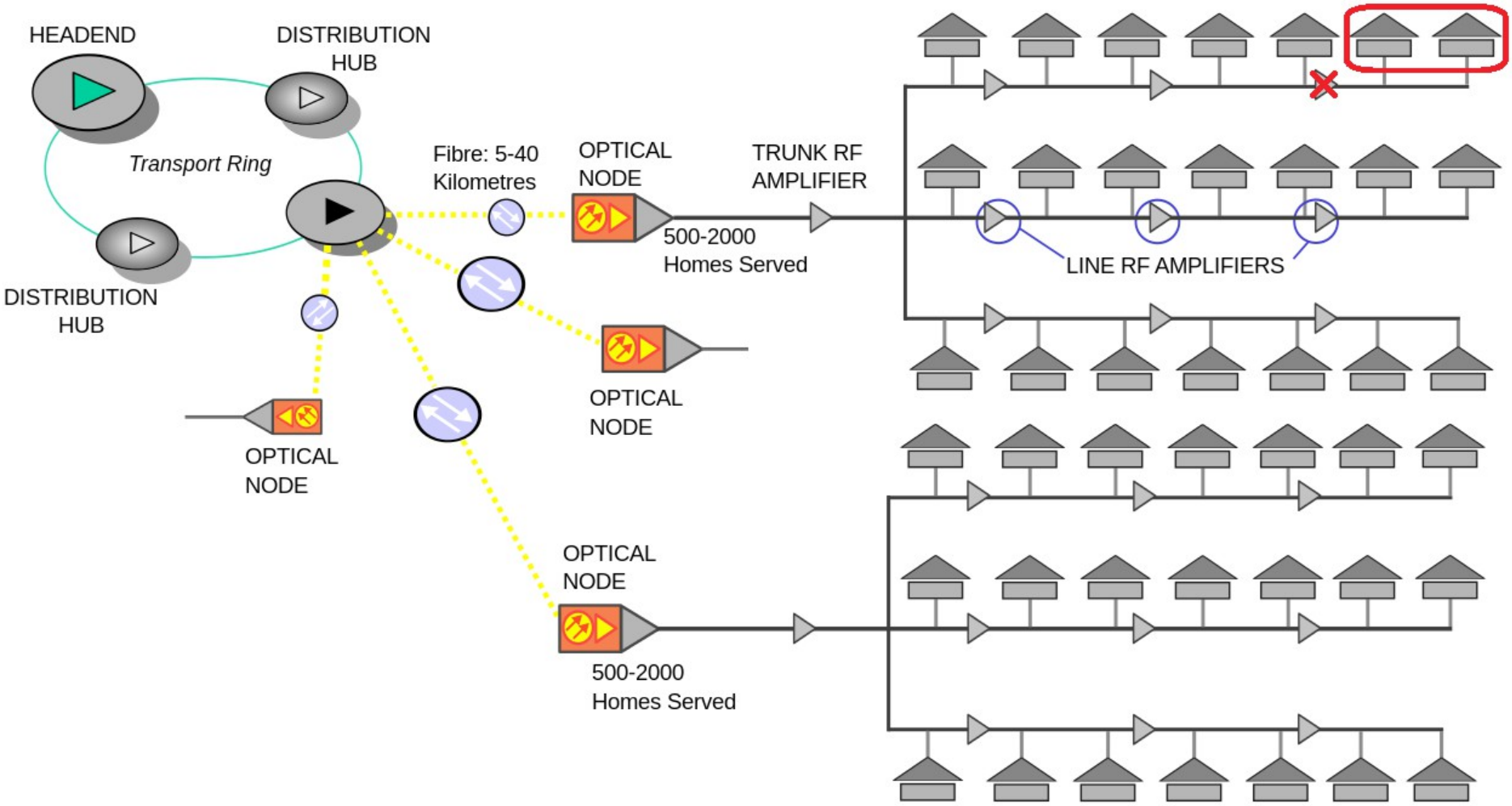

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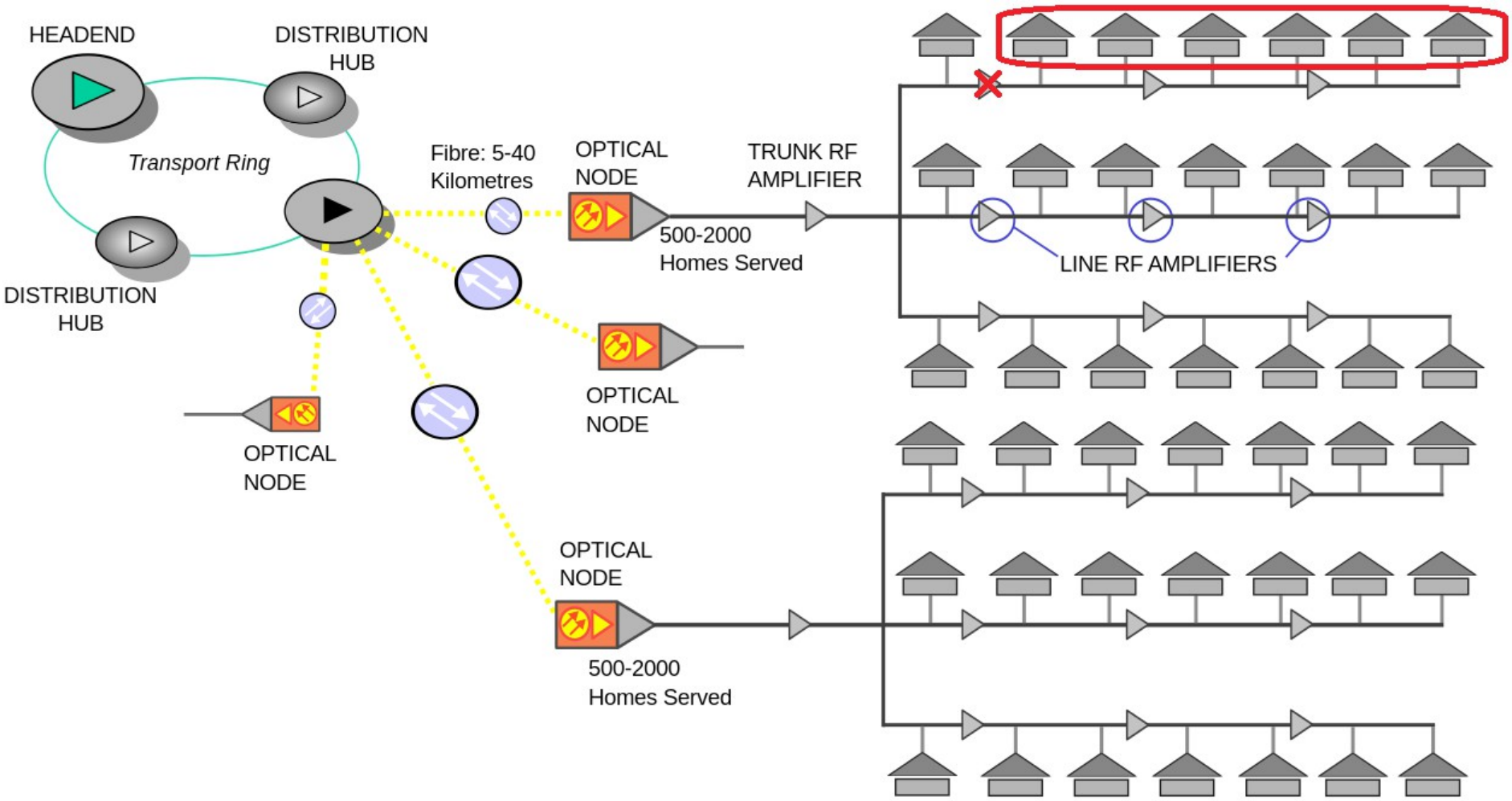

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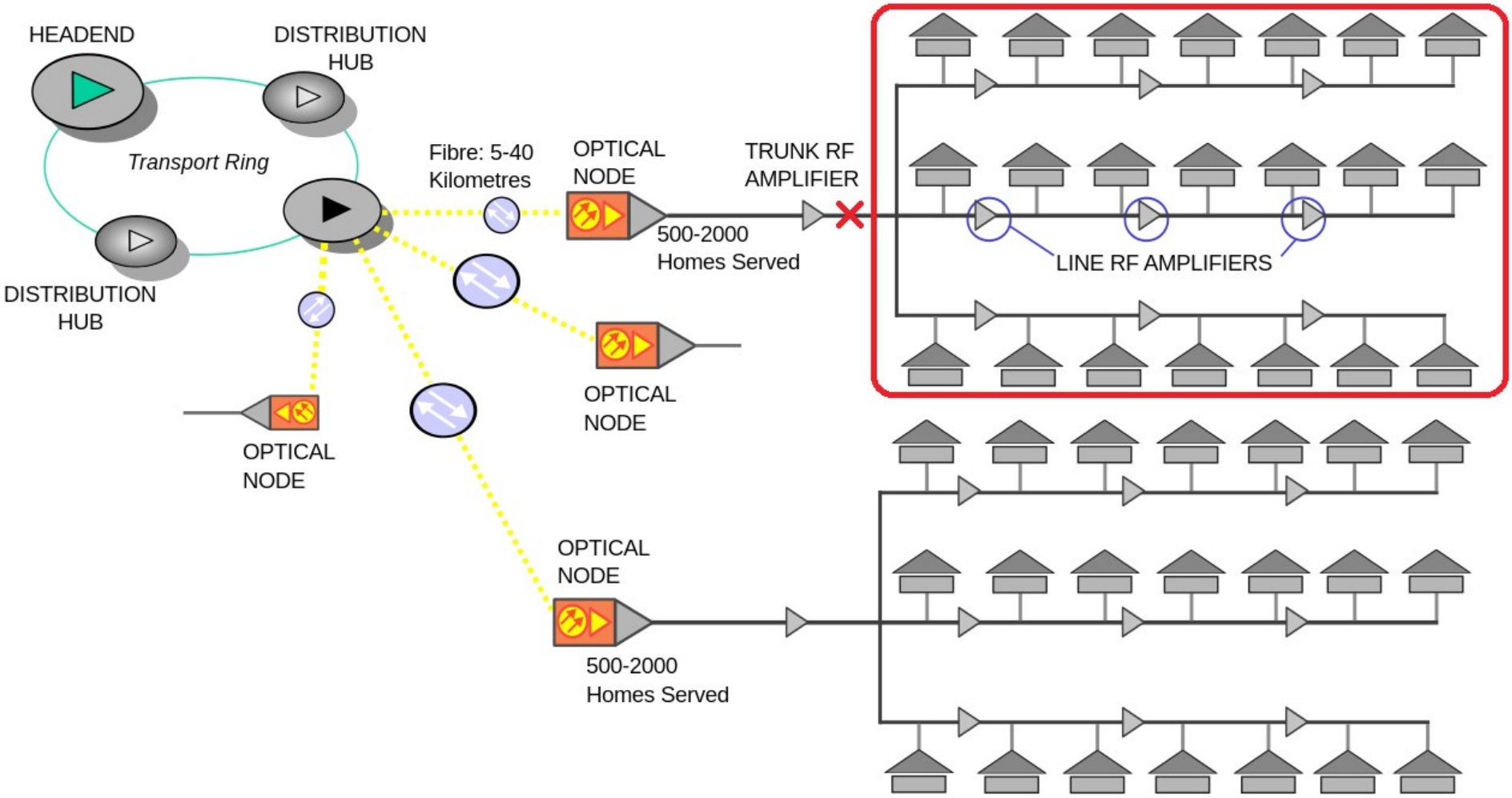

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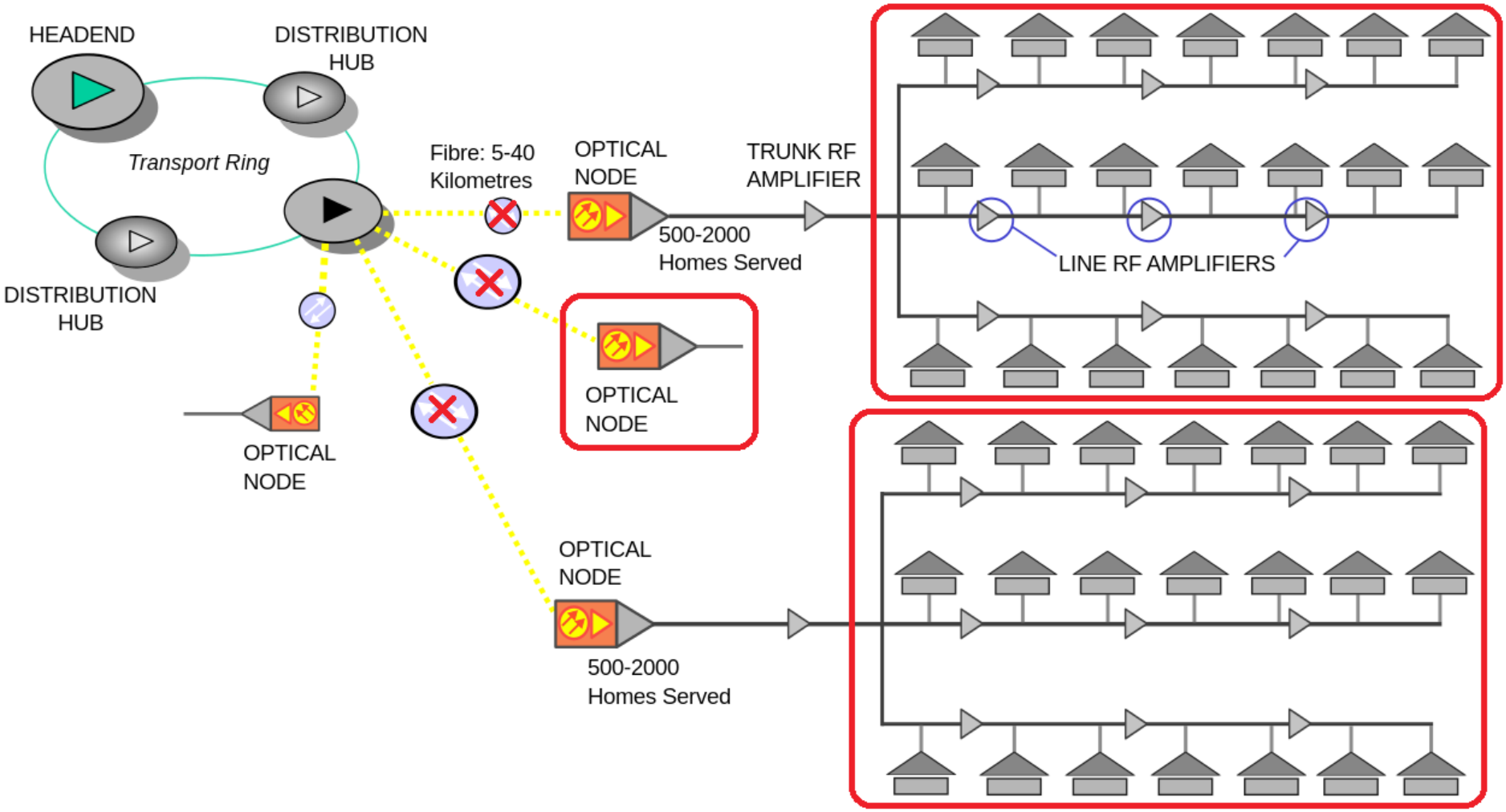
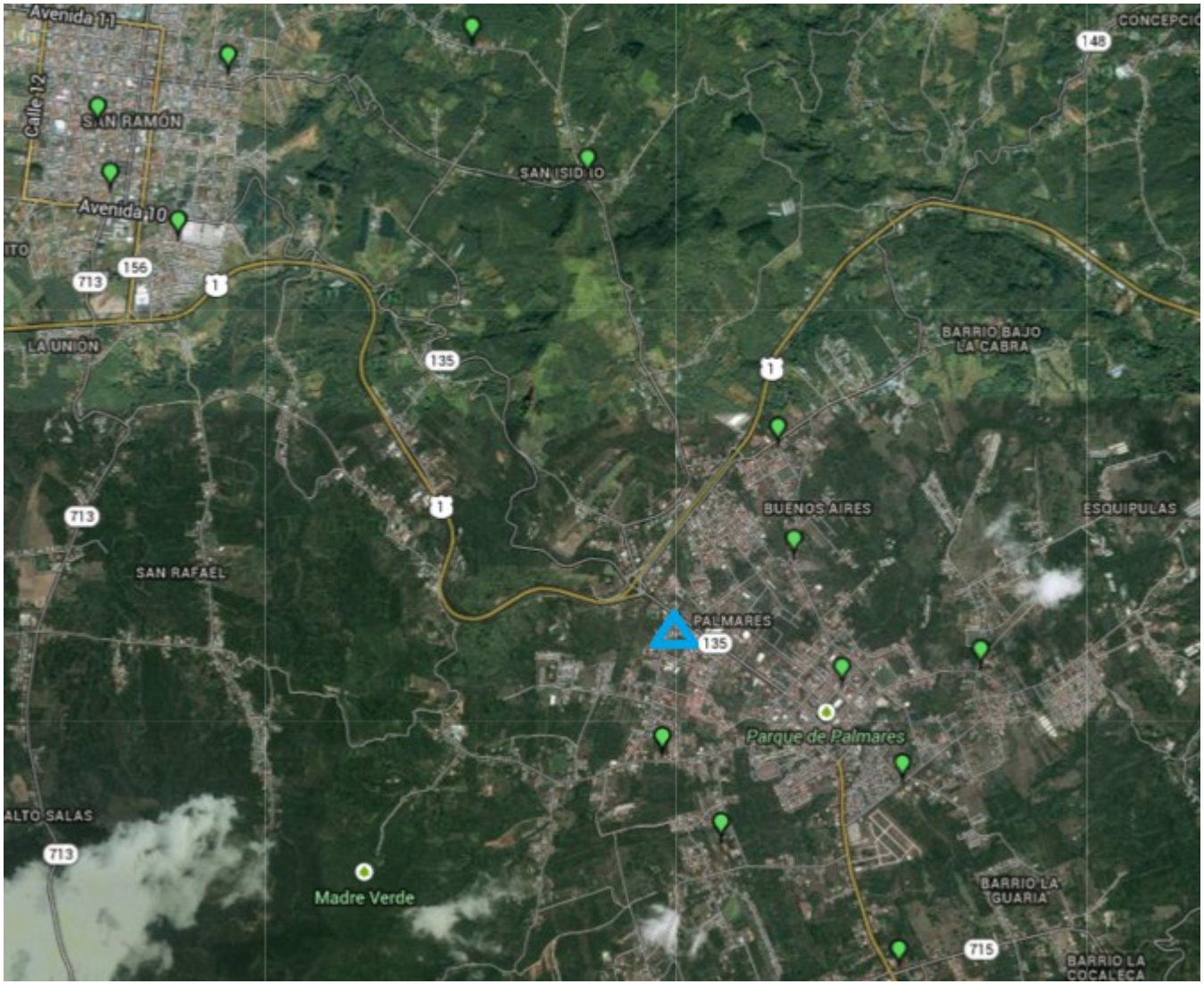


Nodes Geolocation

- Node converts to last mile coaxial access, it serves a specific geographic location.
- Clients from a region are connected to the same CMTS card.
- Clients served by the same node are kept in small numbers due to Downstream saturation.
- Nodes in the same region are linked back to headend by the same optical cable.

Nodes Geolocation



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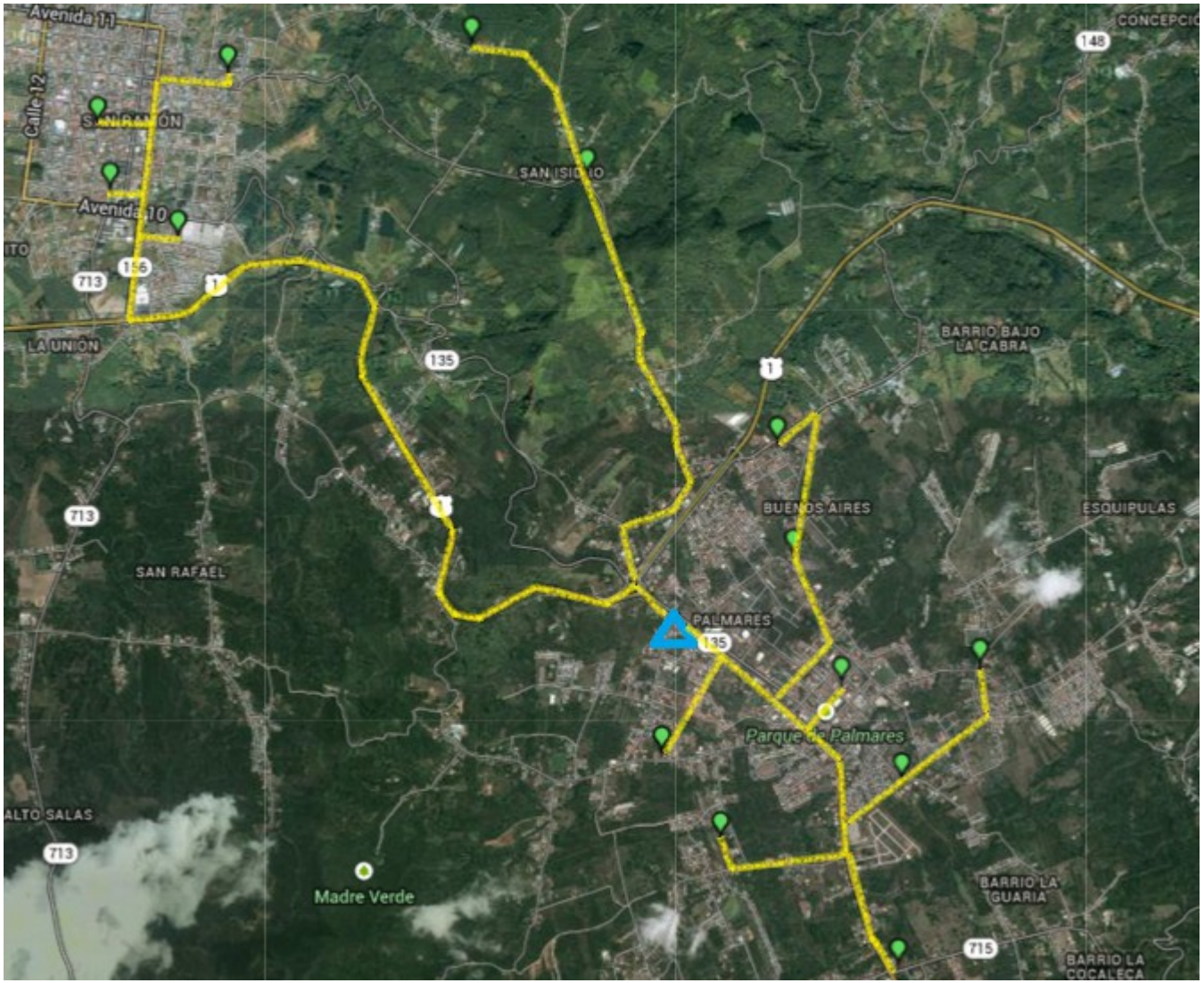

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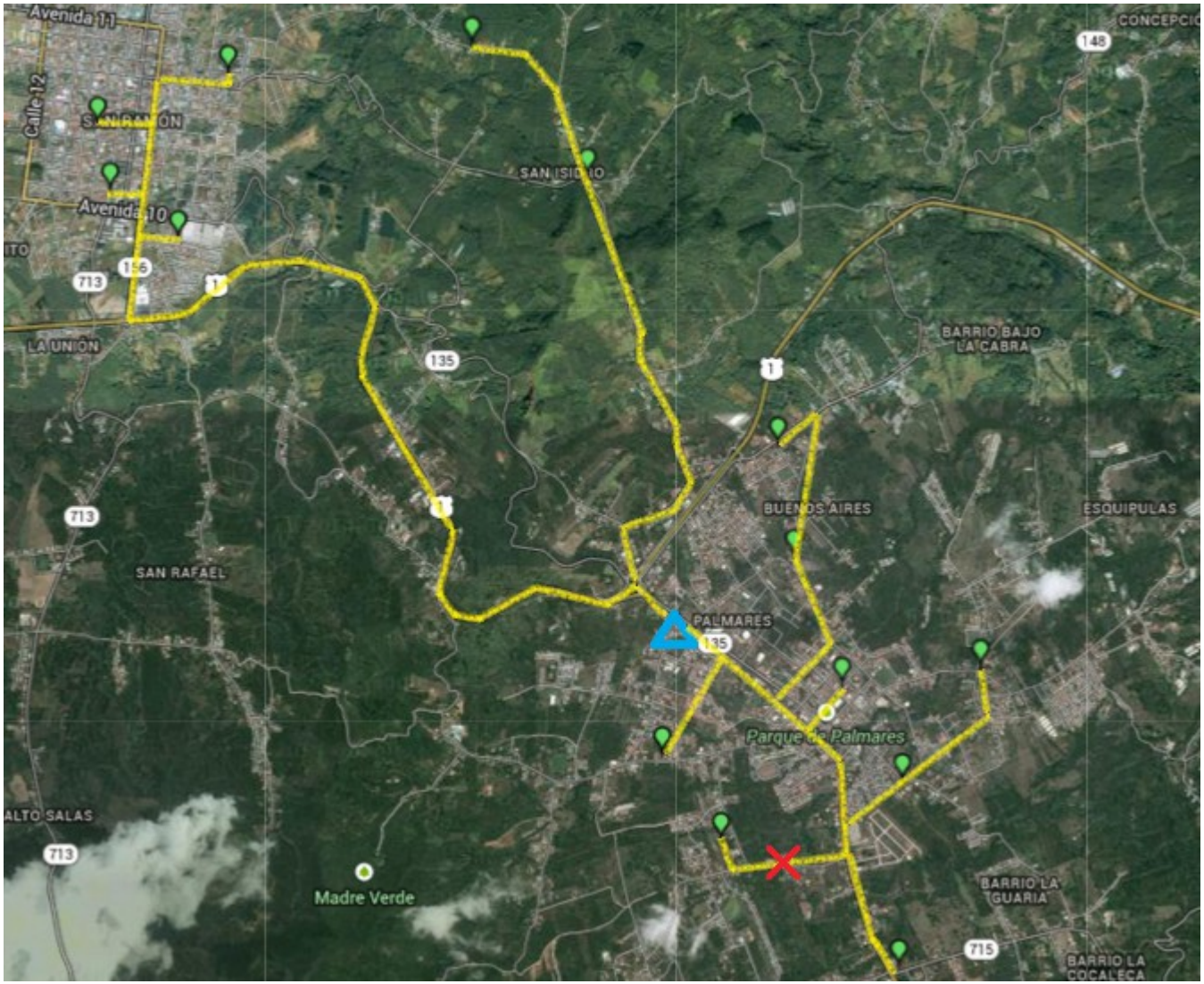

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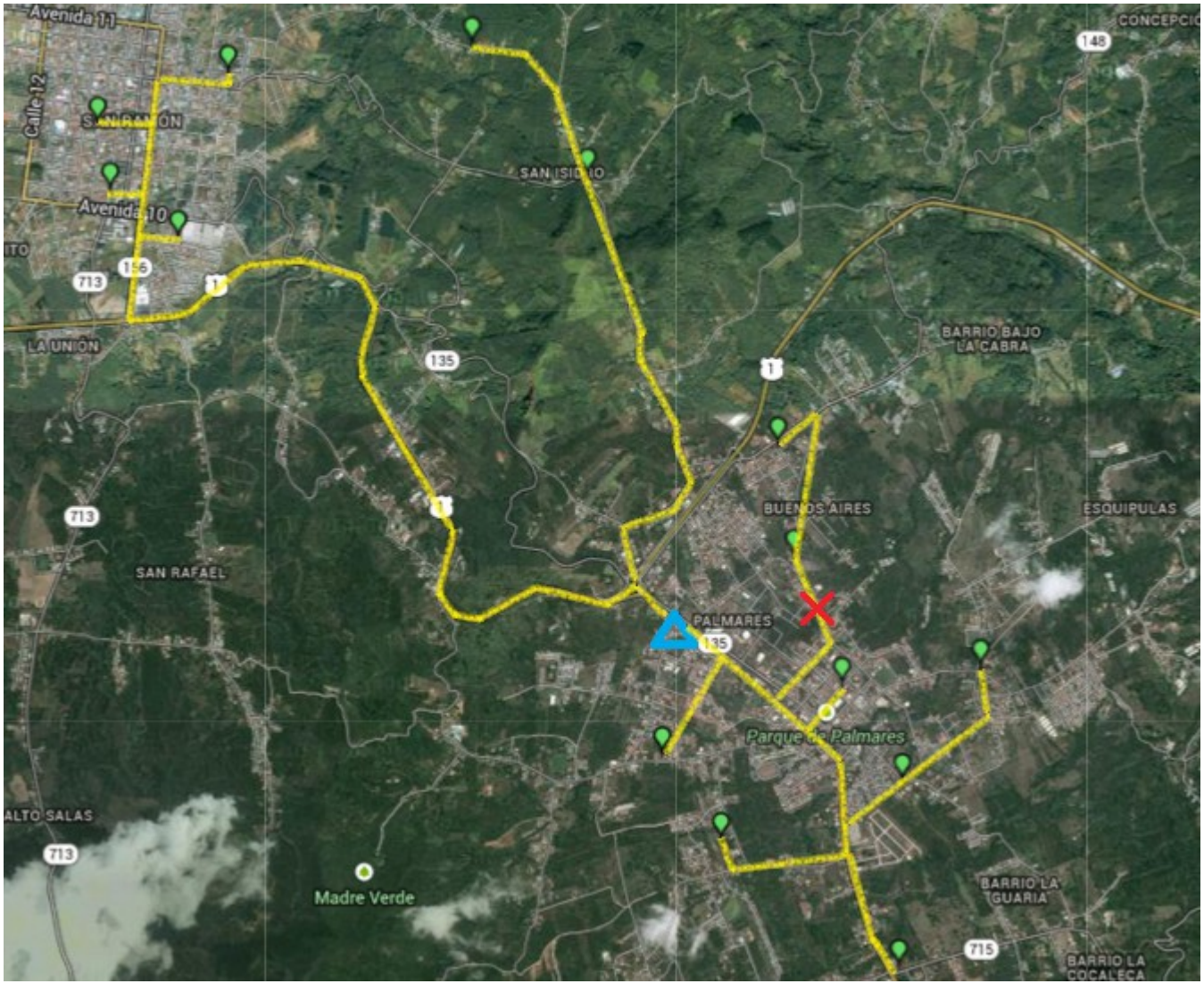

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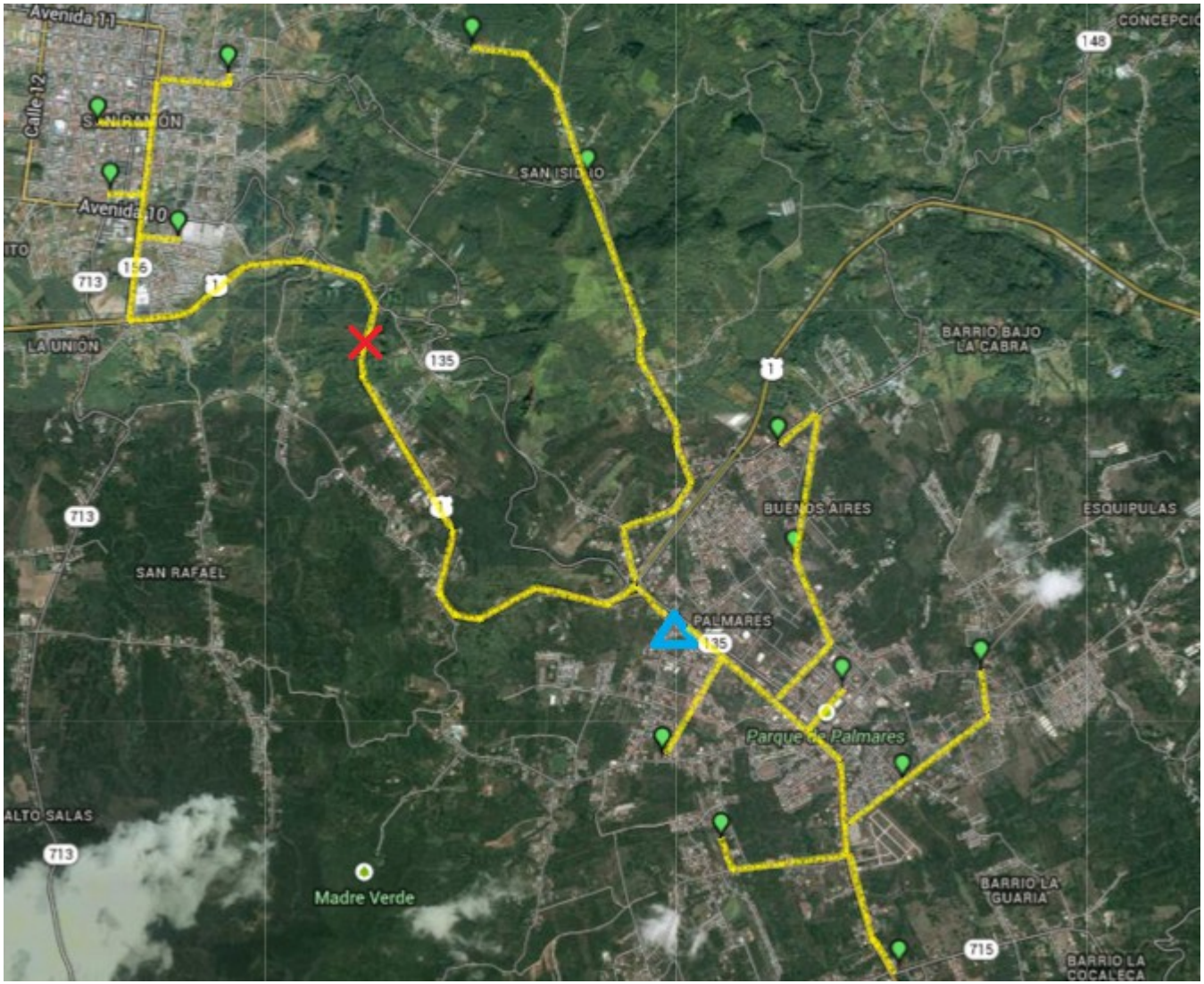


Issue Detection

What do I need to detect issues automatically?

1. Which clients are offline.

2. The time when the clients went offline.

3. The location of clients offline.

Issue Detection

What do I need to detect issues automatically?

1. Which clients are offline.
   CMTS gives us MAC ADDRESS of Cable Modems Offline.
2. The time when the clients went offline.
   CMTS can gives as the offline time.
3. The location of clients offline.
   CMTS gives the upstream to which the client is connected.

   Since an upstream is related to a node and a node is related to a geographic location we can relate an upstream to a geographic location.

Issue Detection

What do I need to detect issues automatically?

1. Obtain all Cable Modems from a CMTS
2. Group the users according to upstream.
3. Find offline users per upstream.
4. Get the offline time of the users.
5. Group the offline users that went offline in the same minute.
6. If the amount of users offline in the same minute exceed a threshold, consider the event as an issue.
7. If the amount of users offline is the same as the total amount of clients in a node, node is totally offline.
8. Report issues to a trouble ticket system and a local database.

Enters Nagios

Thanks to the flexibility of Nagios we can change the paradigm of host/service

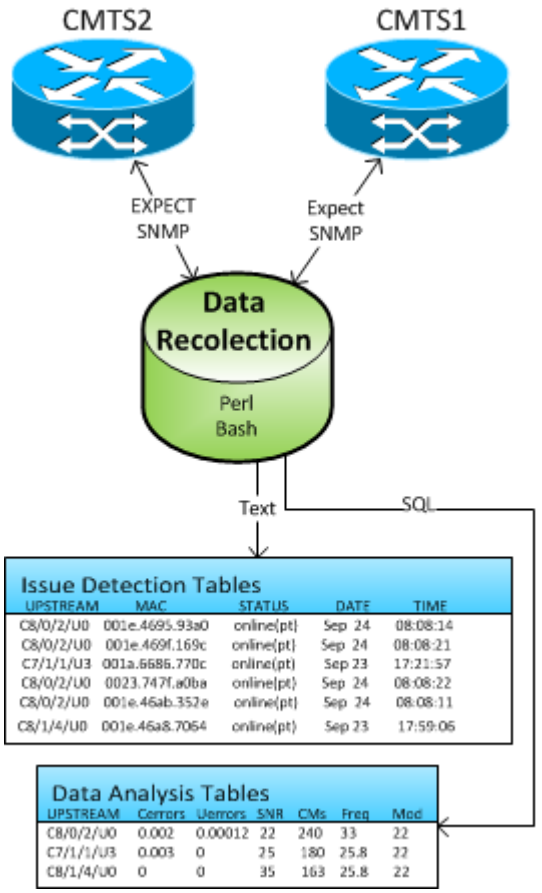
- A Host can be considered as a Node.
- The address of the host is defined by the CMTS and the Cable Interface.
- The Services of the Host (Node), gather information from the specific Node.
- Is easier to manage Issues by Host than to consider CMTS as a Host by itself (regular way)

Enters Nagios

Data Recollection

A script gathers information from all CMTS of the network and stores it as a cache in the Nagios Server. It gathers:

- Online Cable Modems.
- Offline Cable Modems.
- Offline Times.
- Connection Upstream.
- RF variables



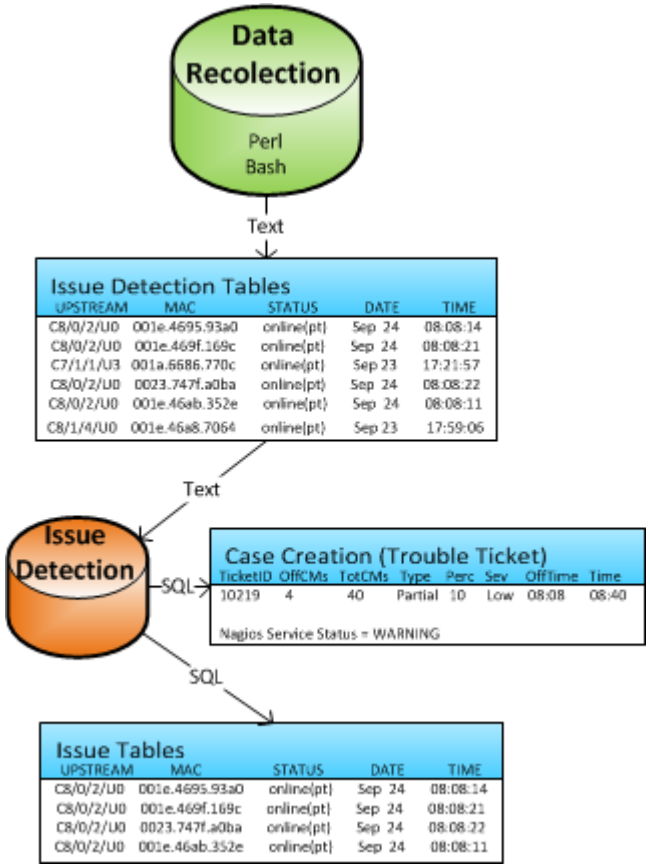
Enters Nagios

Issue Detection

A Nagios plugin we analyzes the offline information and determines per each node:

- Amount of users that went offline at the same time (issue).
- Total users connected to a node.
- The type of issue (partial or total).

And creates a new case

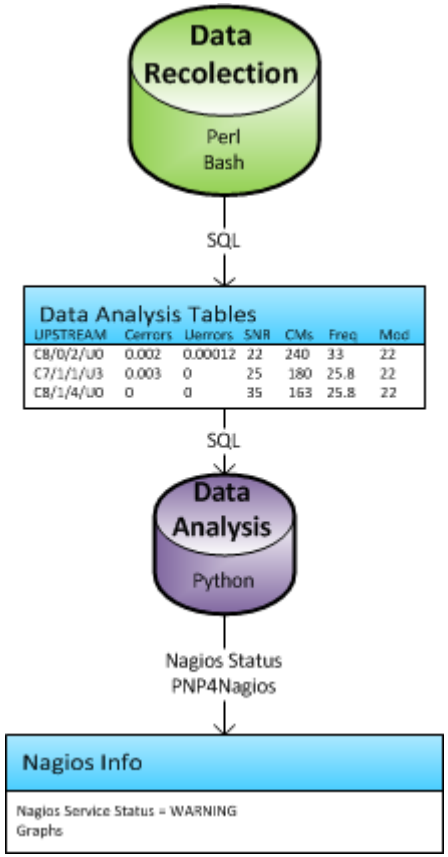


Enters Nagios

Data Analysis

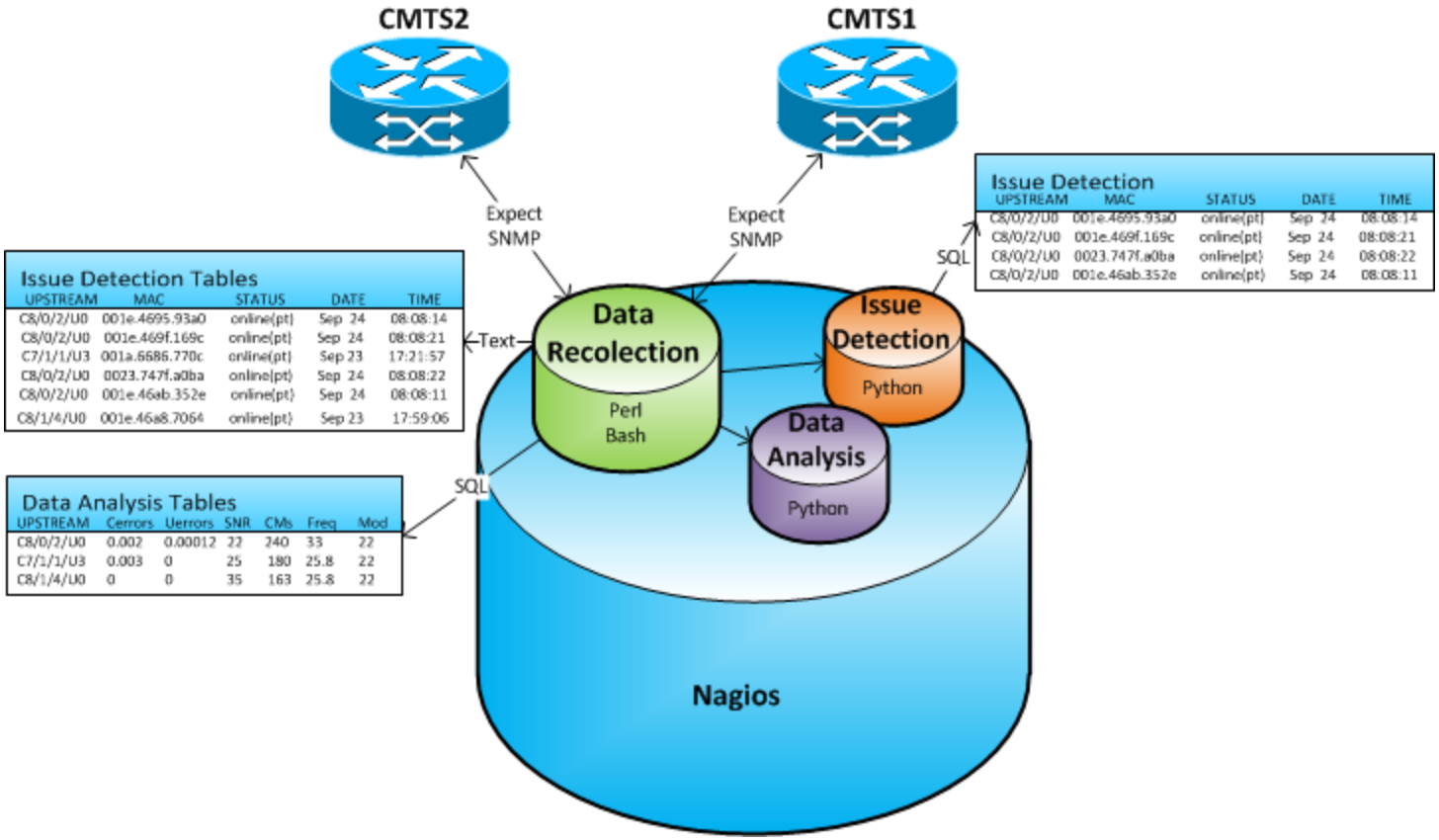
Another nagios plugin reads the information gathered from a whole CMTS and, for a single node, recollects:

- Correctable/Uncorrectable errors.
- Signal to Noise Ratio.
- Frequency.
- Modulation Profile.
- Total Cable Modems.
- Among others.



Enters Nagios

Nagios



Enters Nagios

Issue Detection Results

After Nagios has detected issues, the information is used to:

- Create a prefilled ticket in a Trouble Ticket System.
- Inform third party software (Contact Center, IVR)
- Alert in Nagios.
- Alert in Nagmap (Nagios Map Interface).
- Graph all issues in a CMTS (wide area).
- Graph a summary of issues (pnp4nagios special templates)

Enters Nagios

Issue Detection Results

Prefilled Ticket

- Saves time from tech team (no need to write ticket fields)
- Reduces error (no human writing ticket fields = no errors)
- Facilitates Statistics (no error = automatic statistics)

Enters Nagios

Issue Detection Results

Alerts in Nagios and Nagmap

- Alerts can be analyzed individually for more detail.
- With alerts in Nagios it is possible to summarize alerts per CMTS
- Nagios flapping detection can be used to find Nodes with recurrent problems.
- Nagmap helps to reduce location time of the issue.
- With geographic location technicians can relate a group of issues and find the problem faster

Enters Nagios

Alerts in Nagios

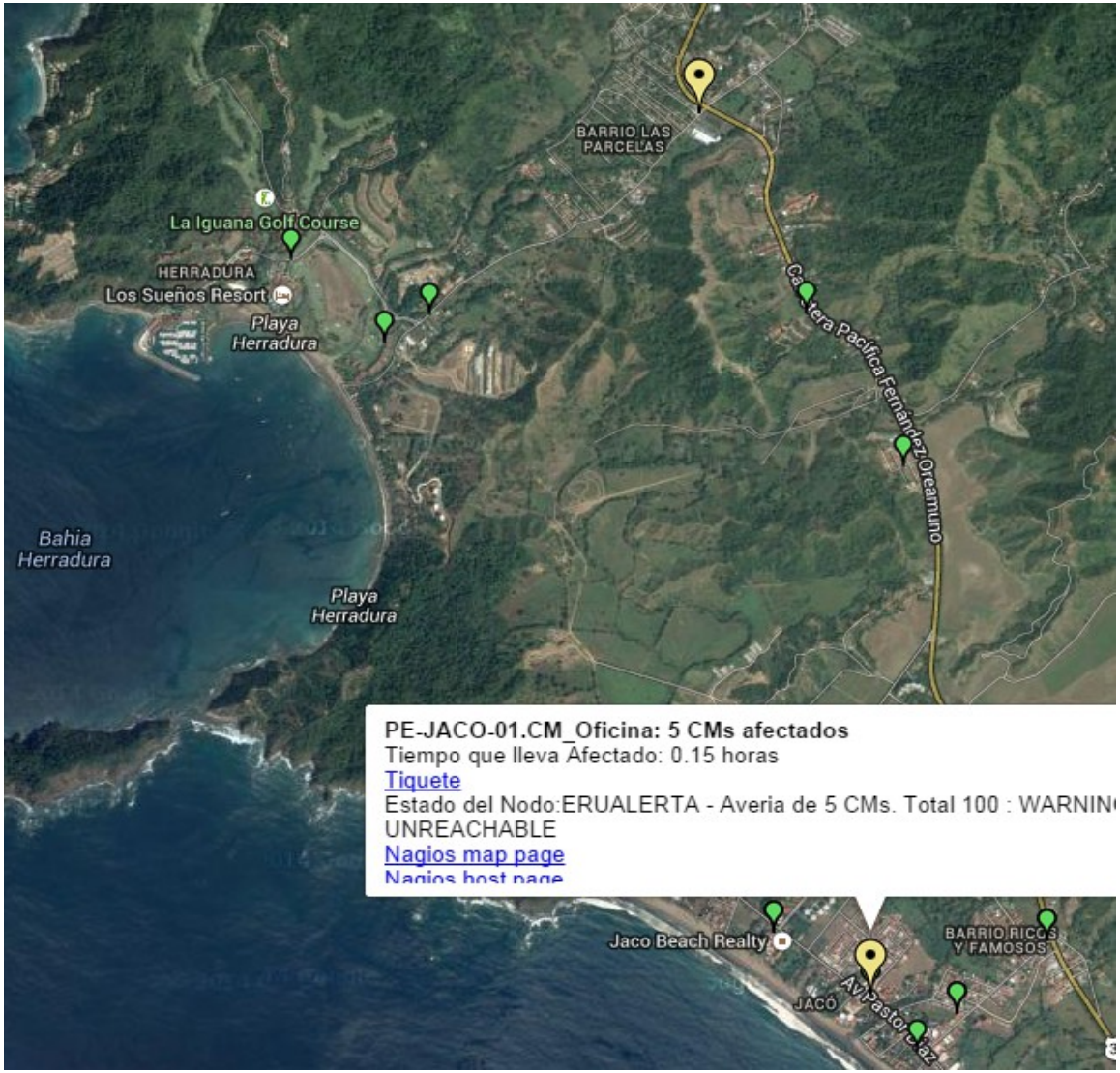
	ERU	OK	09-24-2014 14:34:01	0d 11h 26m 51s	1/2	OK - Total: 138 . Offline: 8
	SNR	OK	09-24-2014 14:32:46	1d 11h 24m 26s	1/1	OK Cable7/1/3-upstream3 35 db, cms= 138
	ERU	OK	09-24-2014 14:34:01	0d 20h 52m 25s	1/2	OK - Total: 94 . Offline: 2
	SNR	WARNING	09-24-2014 14:30:38	0d 0h 33m 48s	1/1	ALERTA - Errores corregibles 5.35629734848 Cable6/1/1-upstream1 32db, cms= 94
	ERU	OK	09-24-2014 14:32:26	0d 6h 28m 35s	1/2	OK - Total: 104 . Offline: 2
	SNR	OK	09-24-2014 14:32:46	0d 11h 23m 45s	1/1	OK Cable8/0/0-upstream0 36 db, cms= 104
	ERU	OK	09-24-2014 14:32:27	0d 7h 33m 11s	1/2	OK - Total: 260 . Offline: 17
	SNR	OK	09-24-2014 14:33:37	2d 0h 29m 29s	1/1	OK Cable8/1/1-upstream0 35 db, cms= 260

Host Group	Host Status Summary	Service Status Summary
CMTS (CMTS)	20 UP	58 OK 2 WARNING : 2 Unhandled
	78 UP	156 OK
	28 UP	53 OK 1 WARNING : 1 Unhandled 2 CRITICAL : 2 Unhandled
	114 UP	224 OK 1 WARNING : 1 Unhandled 3 CRITICAL : 3 Unhandled

Host	Status	Services	Actions
	UP	2 OK	
	UP	2 OK	
	UP	2 OK	
	UP	1 OK 1 WARNING	
	UP	2 OK	

Enters Nagios

Alerts in Nagmap



Enters Nagios

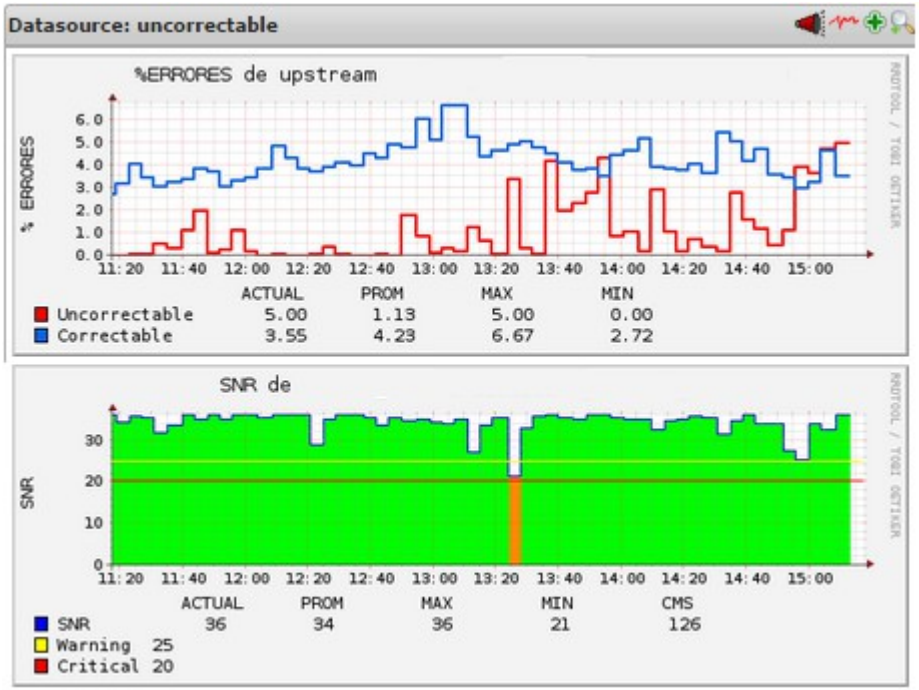
Issue Detection Results

Graph of Issues and Special Templates

- Graph of issues in a CMTS helps to find trends in issues.
- Makes prioritization of issues easier.
- Helps in the generation of reports for big events.
- Reduces the time it takes to generate statistical analysis.
- Reduces human error in statistics.

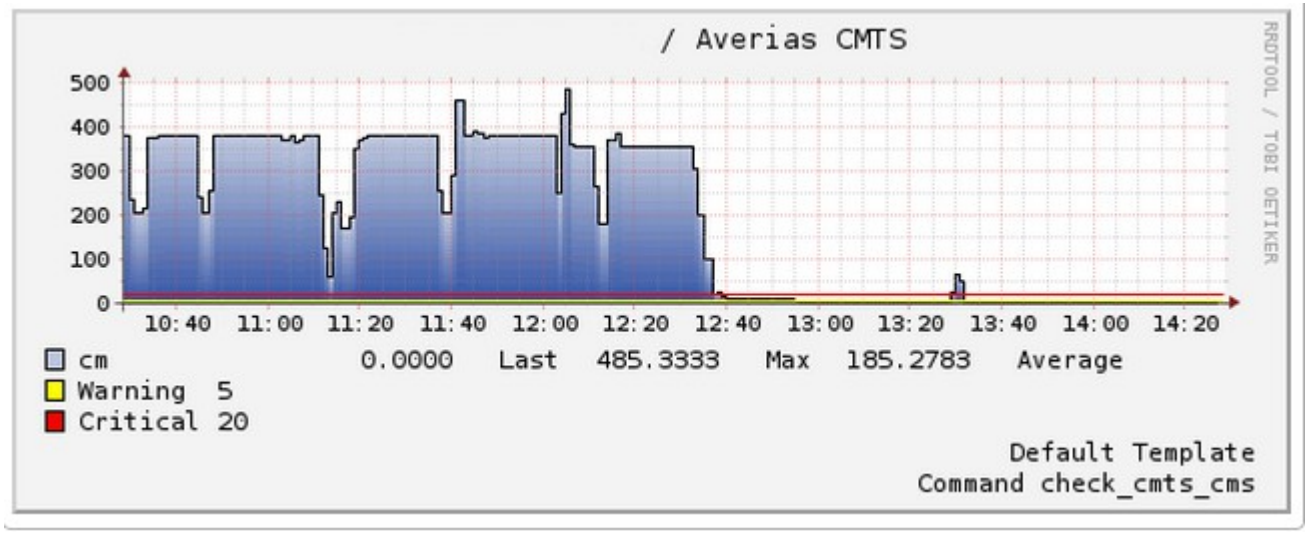
Enters Nagios

Node data graph



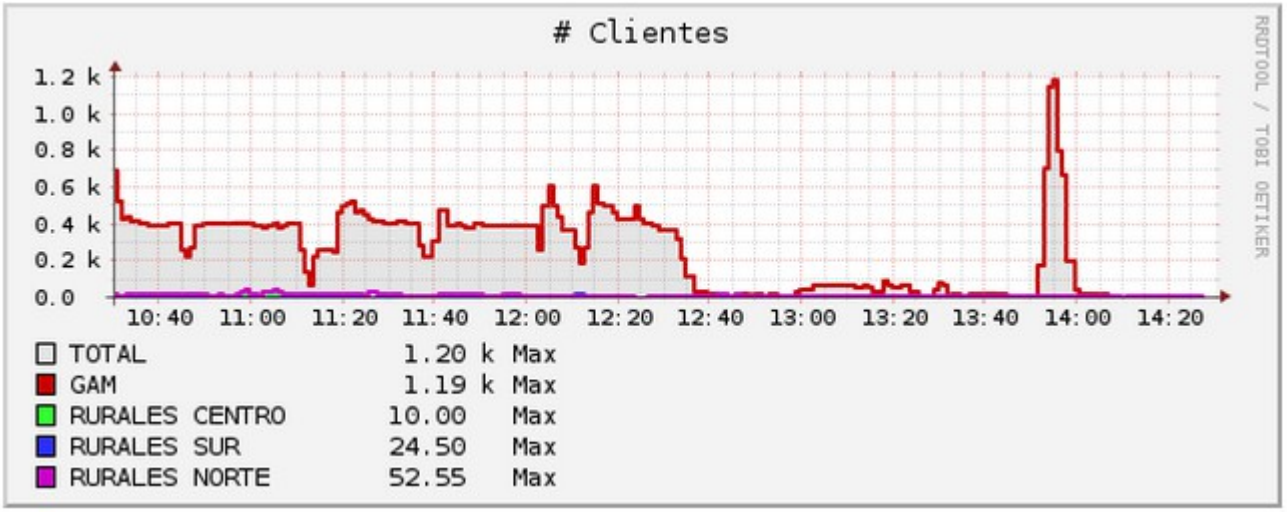
Enters Nagios

CMTS issues graph



Enters Nagios

Wide area graphs (PNP4Nagios Special Templates)



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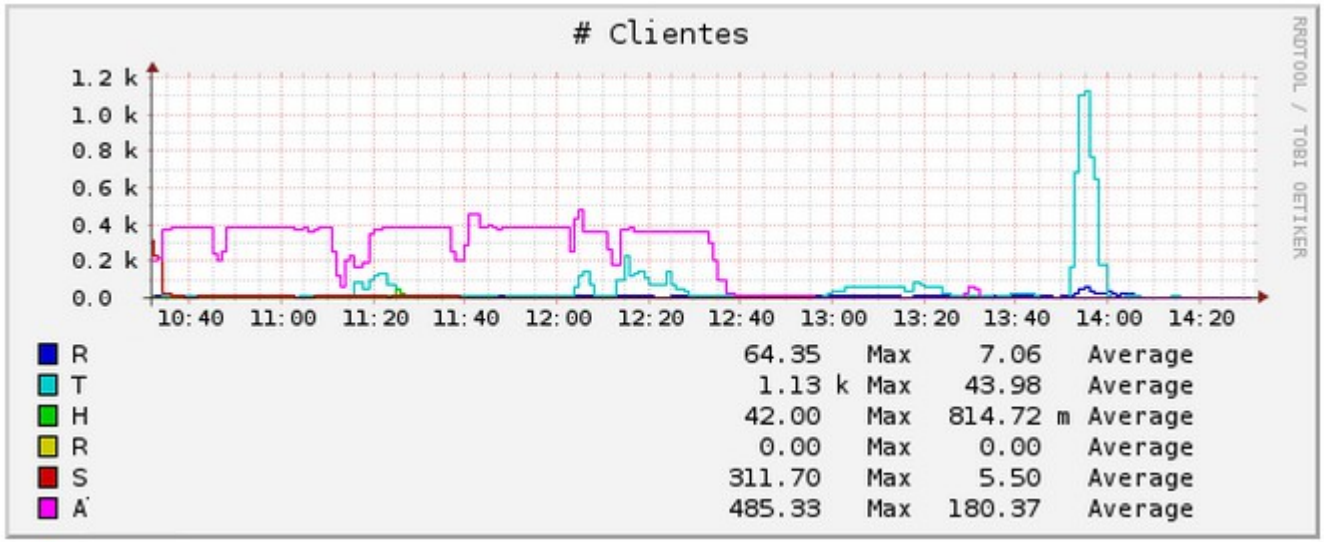

Questions?

Any questions?

Thanks!

The End

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