Which powering solution is the best for my network upgrade?

DTS Thought Snippet

Problem statement

A cable operator is planning to use Extended Spectrum DOCSIS (ESD) technology to upgrade their access network. They are considering two network powering options - central powering vs distributed powering. Which powering model would be best suited for their future network upgrades?

Which powering solution is best for my network upgrade?

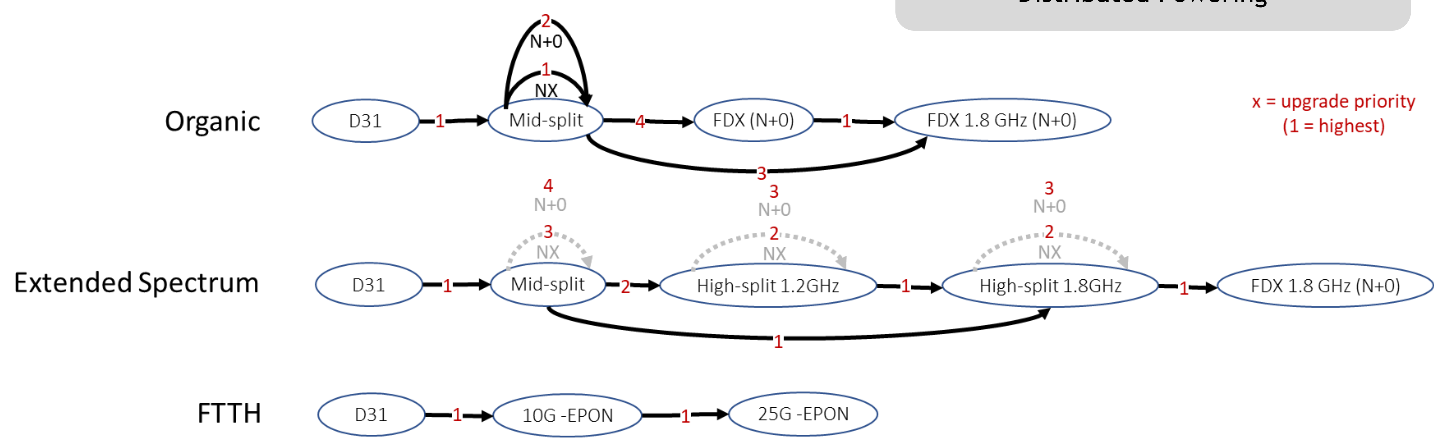
Evaluate the impact of the following powering options on a network evolving to Extended Spectrum DOCSIS (ESD):

- Central Powering
- Distributed Powering

DTS approach

This is a broad challenge on many fronts, the solution of which clearly depends on many factors - the major ones being the operator's current network state and their future upgrade plans. In this thought snippet, we present a methodology on how to analyze such a scenario based on the framework presented in the SCTE energy journal [1].

In an earlier article [2], we had looked at various technology upgrade paths network operators could take in order to meet the growing demand with a goal of delivering 10G services in the future. The figure below shows the three paths that were evaluated.



In this DTS thought snippet, we dig deeper into the above Extended Spectrum upgrade scenario with a view on powering the access network. We will evaluate this upgrade path using both the centralized and the distributed powering approaches. Also, in [1] we analyzed network powering needs for the various upgrade paths including the Extended Spectrum case over a 10-year period using the AP-Jibe planning tool. We will leverage the ESD power projection outcome presented in that paper for our analysis here.

Finally, we had outlined a comprehensive framework for evaluating powering options along three major dimensions - architecture, operations, and financial - in the same paper [1]. We will apply that framework for our comparative analysis between the powering options here.

Understanding the basics

In order to understand the basics of this analysis we took a sample node configuration as follows:

- A 500-HHP DOCSIS 3.0 N+x Node with 5 coax miles
- 4-legs with 125 HHP each
- 5 Amplifiers per mile
- 3 N+0 fiber-deep pockets per leg
- Assuming Central power supply at the node location
- Assuming 4 Distributed power supplies - one for each leg

Later we extended the analysis to a facility level analysis using AP-Jibe with the following configuration:

- One sample facility with 50K HHP across 100 N+x nodes running DOCSIS 3.1
- Demand Growth: 40% downstream / 30% upstream
- Nodes in the facility are assumed to have the same density characteristics

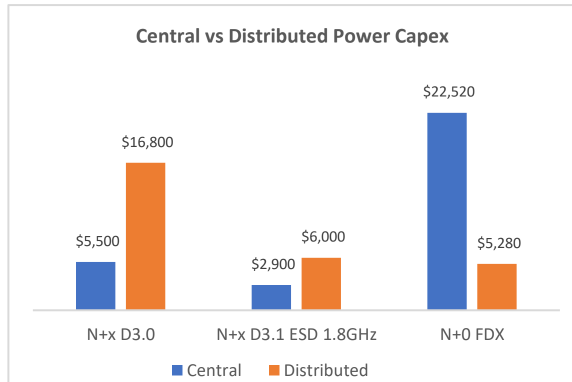
We compiled the power supply requirements for the Central and Distributed cases. We then took the node through ESD upgrade followed by Fiber Deep (N+0) upgrade, as shown in the figure above. The power supplies are upgraded as needed.

In addition to the basic power supply capacity upgrade, the fiber-deep (N+0) upgrade requires the coax feeder section to be reinforced for handling higher power. This is particularly significant in the Central power feeding model. For our analysis we assumed 20% feeder reinforcement for Central powering and 5% for Distributed powering.

Results and conclusions

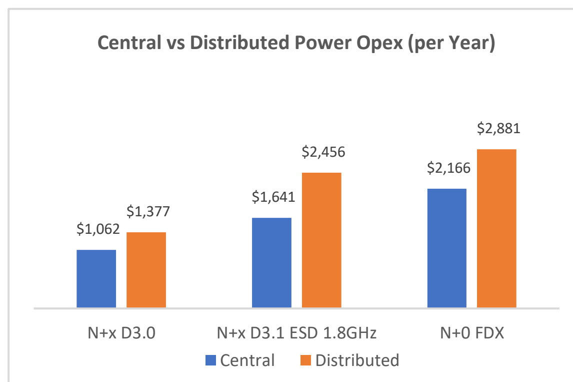
Caution: These results are based on our high-level assumptions for illustrative purposes only. Actual results may vary based on each operator’s environment.

Appendix A: Power solution comparison metrics, which is an excerpt from [1], provides a framework for the analysis of the powering solutions. We use this framework to analyze the current scenario.



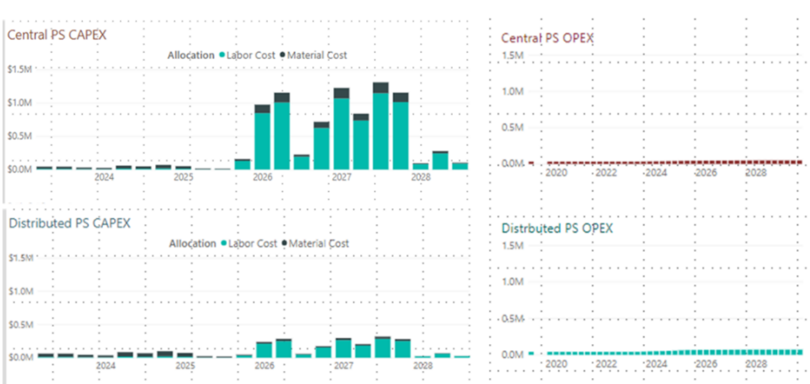
Financial Analysis

Based on the above sample node model we analyzed the powering Capex and Opex requirements for the Central and Distributed scenarios. The charts on the side show high level costs either at the time of incur (Capex) or over a year (Opex).



The above charts show the clear benefit of the Central powering approach in all cases except the significantly higher Capex cost associated with coax feeder upgrade when upgrading to a fiber-deep (N+0) configuration.

We subsequently extended this analysis to a similar upgrade of a facility level network, as mentioned before, using AP-Jibe. The AP-Jibe analysis provided a detailed view of power supply Capex and Opex needs over a 10-year period for both the scenarios. Our preliminary results are shown in the charts below.



Architectural Analysis

Architectural analysis mainly drives the upgrade strategies. Being a non-quantitative factor, we give a comparative score of 1 – 5, 1 as the least favorable and 5 as the most favorable option. When comparing the Central and Distributed powering models against the key architectural metrics outlined in Appendix A: Power solution comparison metrics, we made the following observations:

- **Feasibility**: While both Central and Distributed powering models are always feasible, it is easier to deploy the Central model as only one power supply location must be built (we scored it a 5). In the Distributed case there can be challenges with easy grid power availability in all locations (we scored it a 4).
- **Upgradeability**: Once again, no significant upgrade issues are seen in either case. However, upgrade of the Central powering solution is much easier as only one location needs to be managed. On the flip side, for a large node we could see capacity issues with a single large power supply (we scored both options a 4).
- **Frequency of Upgrade**: In this case we observed that the Central power supply needed upgrades more frequently (thus we scored it a 4) compared to the Distributed power supplies (which received a score of 5) since they had to deal with significant capacity increase each time.

Operational Analysis

Like the architectural analysis, the operational analysis is also a qualitative factor. We use the same scoring criteria as used for the architectural analysis. When comparing the Central and Distributed powering models against the key operational metrics outlined in Appendix A: Power solution comparison metrics, we made the following observations:

- **Reliability**: When looking at the two solutions from a reliability point of view the Distributed model has an edge due to the distributed nature. Distributed power supplies can also provide backup capability (we therefore scored the Distributed option a 5 vs Centralized a 4 in this area).
- **Complexity**: The above advantage of the Distributed model turns into a disadvantage when looking at the complexity of the solution. The Central model is clearly simpler and less complex (we therefore scored the Centralized option a 5 compared to a 4 for Distributed option).
- **Failure Recovery Time**: Once again, from a failure recovery time point of view the Distributed model has a disadvantage due to multiple locations involved. These locations are also typically less accessible compared to the Central power supply location (we therefore scored the Centralized option a 5 compared to a 4 for Distributed option).

Summary and Conclusions

We summarize the results for all the metrics outlined above in the table below.

Metric	Centralized Powering	Distributed Powering
Architectural Metrics		
Feasibility	[5] Always feasible	[4] Requires easy access to power
Ease of Upgrade	[4] + All upgrade at one location - May have capacity issues	[4] - Multiple locations + Less capacity issues
Frequency of Upgrade	[4] - More likely to require upgrade	[5] + Less likely to require upgrade
Operational Metrics		
Reliability	[4] - Lower due to concentration	[5] + Higher due to distribution
Complexity	[5] + Lower - one location	[4] - Higher due to multiple units
Failure Recovery Time	[5] + Quicker – easy to fix	[4] - Slower – multiple & distributed
Financial Metrics		
10-Year Capex	$8.84 M	$2.63 M
10-Year Opex	$1.70 M	$2.33 M
Total Cost of Ownership NPV	$4.40 M	$2.29 M

Note: As mentioned before, these results are based on our assumptions for the sample node configuration.

Architecturally, both the solutions are at par. Operationally, the centralized solution has a slight advantage. Financially, the distributed solution is better in the long run. In this thought snippet, our intention is not to make a recommendation, but to showcase our methodology for tackling this problem.

References

[1] Rajesh Abbi, Sudheer Dharanikota, “Powering the Future 10G Access Networks,” SCTE ISBE Journal of Energy Management, Sept. 2019

[2] Luc Absillis, Rajesh Abbi, “How to reach 10G systematically?,” AP-Jibe Application Note

Appendix A: Power solution comparison metrics

Being a strategy consulting team (although we do have engineering degrees), we are often asked by our clients to compare multiple complex options. We have outlined below an analysis framework for evaluating powering solutions that takes into account architectural, operational and financial considerations. Other metrics related to the “greenness” of the solution can be included in these three dimensions. Keep in mind these metrics are not for the solutions at a point in time but for an access evolution path that your leadership has chosen. **All of these are measured on a scale of 1 - 5 (Low - High).**

Architectural measures: These measures evaluate a powering solution in the context of supporting the current access architecture and the future planned upgrades.

- *Feasibility*: How feasible is this upgrade in their current network?
- *Ease of upgrade*: How easy is it to extend to future needs?
- *Life time of the solution*: How often one needs to upgrade?

Operational measures: The operating metrics measure a powering solution’s ability to meet committed SLAs while providing a simple and maintainable solution.

- *Reliability*: What level of reliability needs to be considered to meet the SLAs?
- *Complexity*: What are the maintenance complexities?
- *Failure recovery*: How long does it take to recover from failure in the context of a most stringent SLA on the given network?

Financial measures: The financial measures provide the investment overlay (total and time-adjusted) views of the solution over a long-term transformation. *These are measured against the targets set by the operator*.

- *5/10 Yr. CapEx*: What is the 5/10-year capital expenditure of the solution?
- *5/10 Yr. OpEx*: What is the 5/10-year operating expense of the solution?
    - Including the obsolescence and disposal costs
- *TCO NPV*: What is the net present value (NPV) costs over 5/10 years?

What drives the cost of a powering solution?

Upgrades: In simple terms shelf life of a solution drives the upgrades and hence the cost. We need to consider how these solutions are upgraded in the context of the access transformation.

SLAs: We are carrying traffic with different SLAs. Need to keep them up and running. Hence, power solution reliability is one of the essential drivers.

Basic operating costs: End to end life time (5 or 10 year) operating cost of a solution in many times keeps us, the architects, at check in picking the solution.

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