

802.3bn Bright House Networks per-node SNR Downstream Characterization

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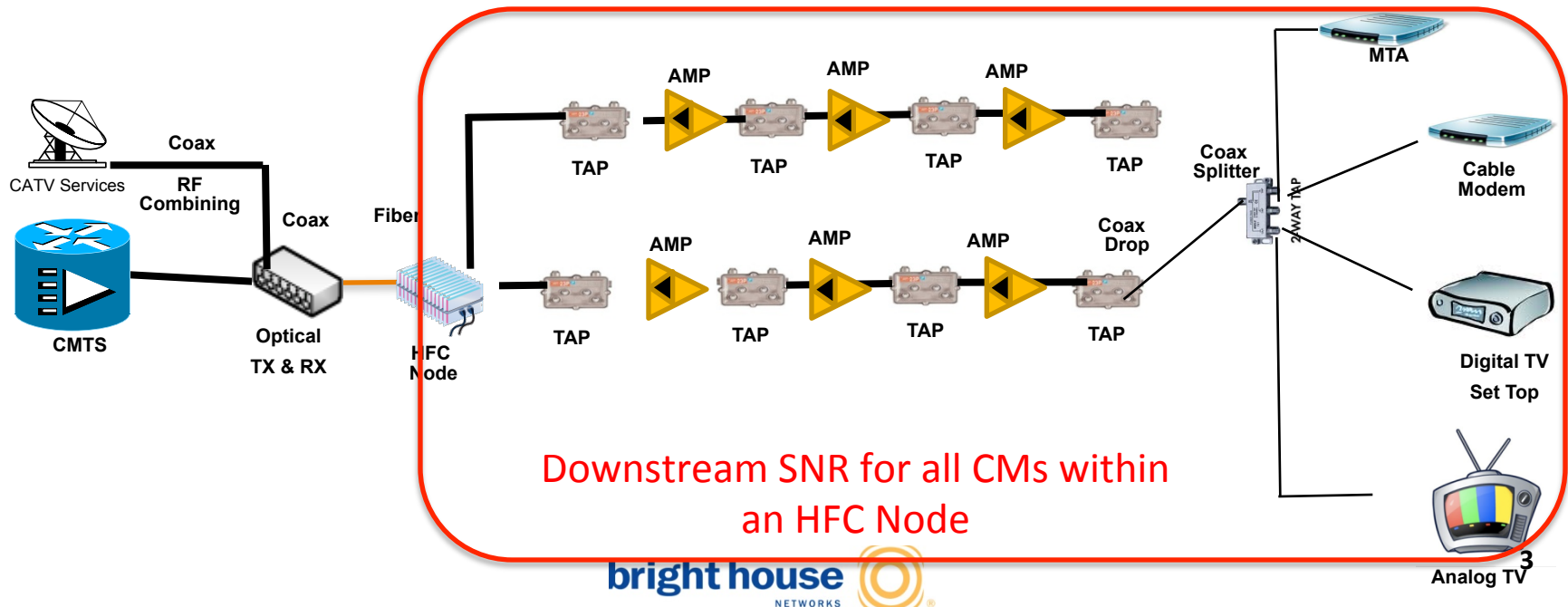
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Introduction

- © We've had a lot of discussion about this topic of "multiple simultaneous Modulation and Coding Schemes."
- © We've even seen some average receive Signal to Noise Ratio values in some contributions.
- © This contribution goes a little deeper to depict the average SNR values at a per-HFC-Node grouping.
- © This presentation intends to provide the distribution of SNR for stations on a many coax cable distribution network (CCDN) – HFC Node Serving Groups.

Hybrid Fiber Coax: A Review

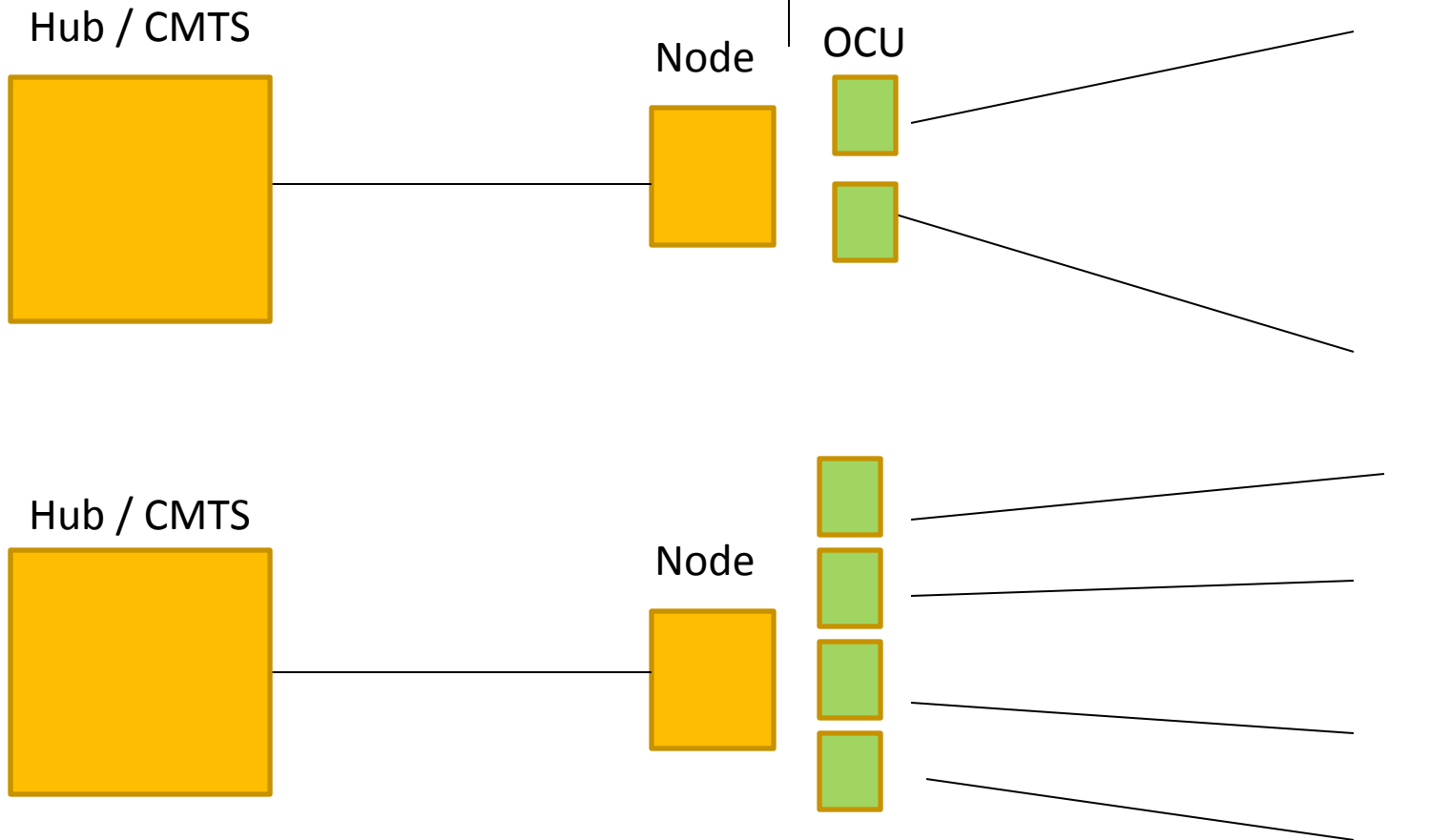
- ◎ Fiber to HFC Node, AM modulation, then active coax network past the node.
- ◎ CCDN extends from the node to the connected station.
- ◎ The data in this presentation only includes the average SNR (reported by the Cable Modem) on the DOCSIS downstream carriers.
- ◎ The per-node grouping allows a discussion about the distribution of stations on the CCDN.



CMTS vs EPOC SNR

CMTS data provides Total SNR end to end on a Node basis

EPOC may operate only on the Coax segment
SNR on a Coax Segment basis

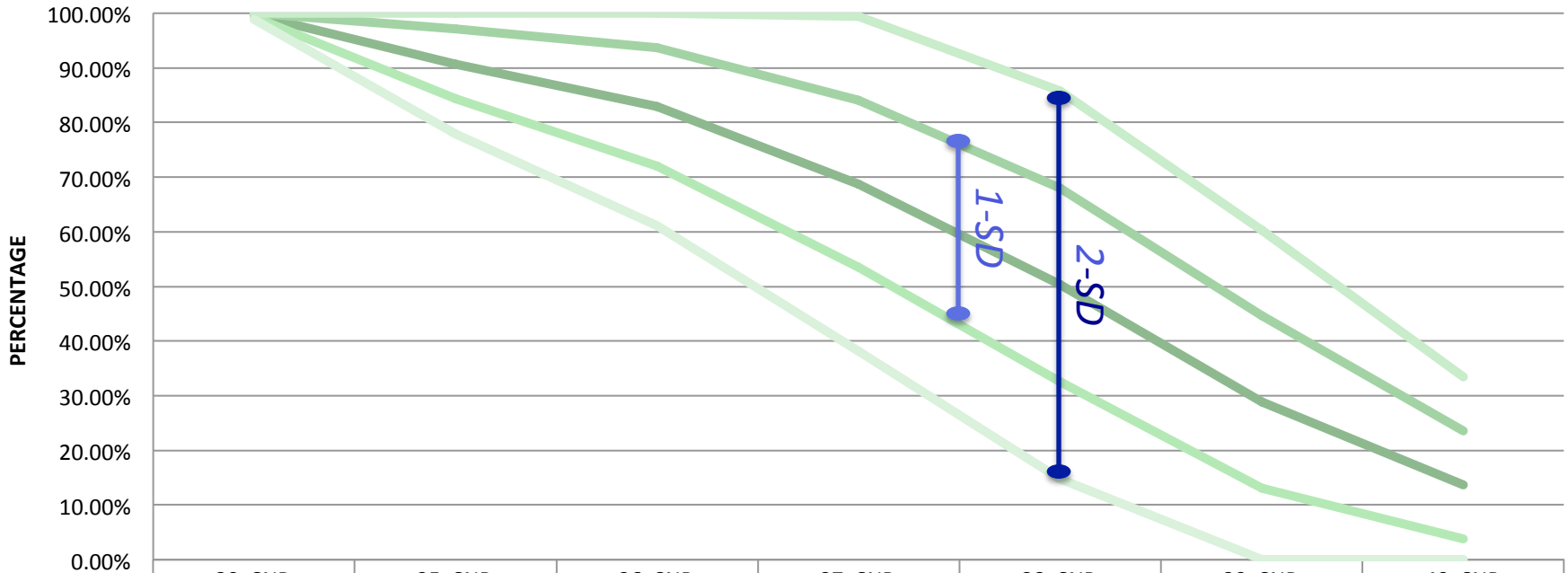


Procedure

- ◎ We have a tool that periodically queries cable-modems for many performance values including downstream SNR.
- ◎ We took several polled intervals over a one-week period.
- ◎ We calculated the number of cable-modems within an HFC node grouping that reported an SNR values...
 - E.G. 30+SNR, 35+SNR, 36+SNR, etc.
- ◎ We found that the number of modems within a node grouping reporting a given SNR value varied very little.
- ◎ As a result the SNR values reported come from a single polling cycle (as opposed to per-modem average SNR over some period.)
- ◎ The reported CMs include all in the population – DSGs, MTAs, DOCSIS1.1, 2.0 and 3.0 CMs.

Average SNR with 2 Standard Deviations

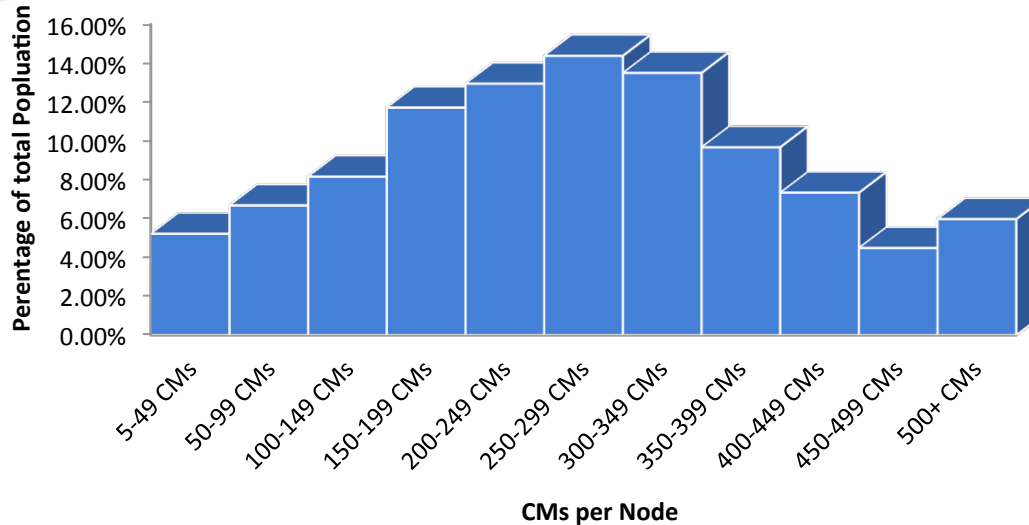
CABLE MODEM POPULATION - DOWNSTREAM SNR



	30+SNR	35+SNR	36+SNR	37+SNR	38+SNR	39+SNR	40+SNR
— AVG	99.76%	90.71%	82.86%	68.78%	50.32%	28.83%	13.69%
— 1SD(+)	100.00%	97.09%	93.72%	84.11%	68.05%	44.57%	23.57%
— 1SD(-)	99.32%	84.32%	72.01%	53.45%	32.59%	13.10%	3.81%
— 2SD(+)	100.00%	100.00%	100.00%	99.44%	85.77%	60.31%	33.45%
— 2SD(-)	98.88%	77.94%	61.15%	38.12%	14.86%	0.00%	0.00%

SNR versus Node Size

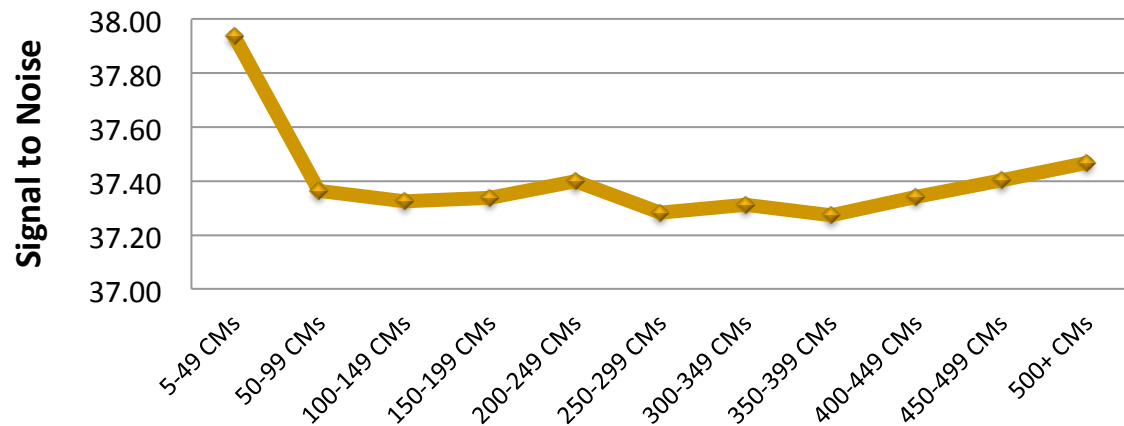
Distribution of Node Grouping Sizes



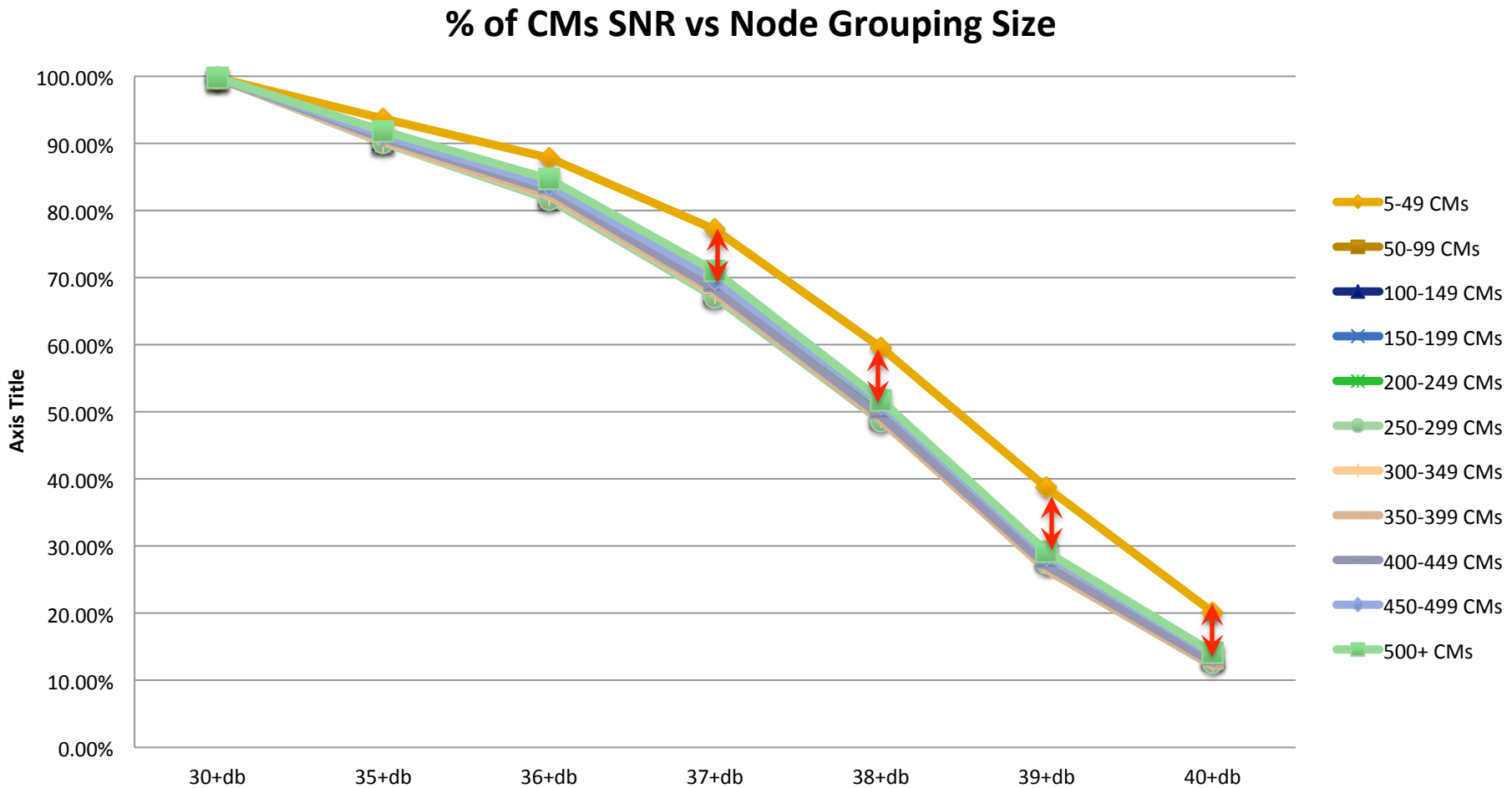
- © Distribution of Node Grouping Sizes forms a nice bell curve.
- © The outlier is the >500 CMs number which includes node grouping sizes between 500CMs and 848 CMs.

- © On the surface it is questionable that there is a direct correlation between small node groupings and average SNR.
- © It is somewhat apparent that the very small (less than 50 CMs per node) does have a consistently better downstream SNR.

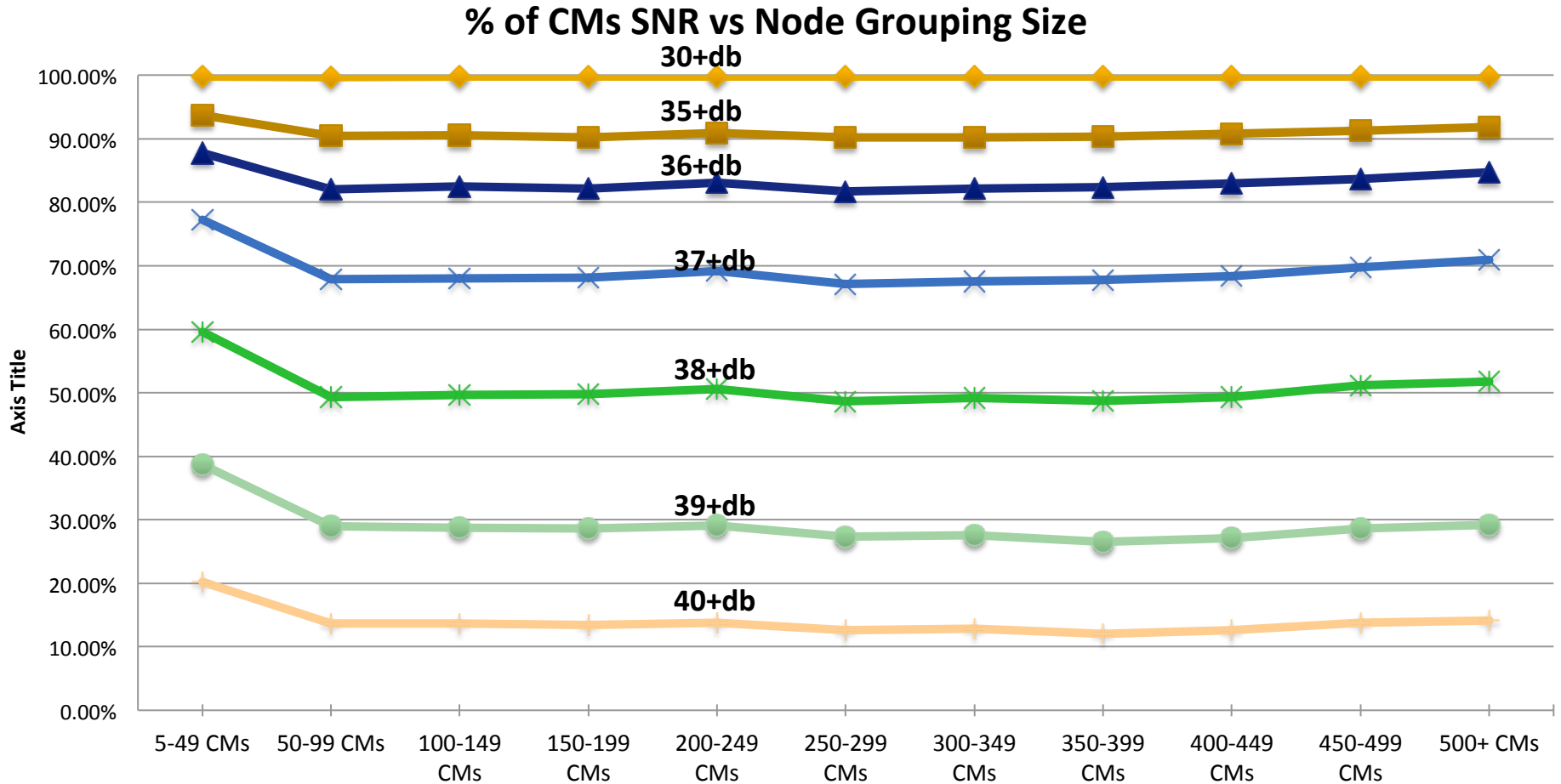
Distribution of Avg SNR to Node Grouping Size



% of CMs SNR Capabilities vs Node Grouping Size



% of CMs SNR Capabilities vs Node Grouping Size



Further Analysis (SNR)

100% CMs	30db	35db
Percentage of Nodes	63.08%	2.53%
Average Node Size	241CMs/Node	18CMs/Node
Average SNR	37.54db	38.65db
>97.5 <100% CMs	30db	35db
Percentage of Nodes	36.33%	3.95%
Average Node Size	323CMs/Node	219CMs/Node
Average SNR	37.12db	38.42db
> 95 < 97.5 CMs	30db	35db
Percentage of Nodes	.03%	43.9%
Average Node Size	123CMs/Node	291CMs/Node
Average SNR	35.99db	37.54db

- © The first table is 100% of Cable Modems on that node that support 30db and 35db SNR.
- © The second table is of > 97.5% < 100% of Cable Modems that support 30db and 35db SNR.
- © The next table is of >95% but < 97.5% .
- © The last is of the worst 10% of nodes

Worst 10% of Nodes

Percentage <i>of CMs on a node</i> Capable of >35db	<84.06%
Average Node Size	254.36
Average SNR	35.93db

More Work to Come

- © With the small nodes, it's not clear (from our polling data) how large the CCDN is or how many passings we have on a node.
 - The nodes could have a small number of CMs but be far apart, for instance.
 - Alternatively we could have a large number of passings but an abnormally low penetration number in some cases.
- © Something we're looking at is the how far the cable-modems are from the CMTS.
 - Perhaps timing offset would help.
 - Or we could simply map the individual cable-modem locations to the plant (this is harder.)
- © Its also not clear what the impairments that reduce SNR for some CMs and not others.
 - It could be noise isolated to the home.
 - It could also be compound noise near the end of line.
- © We're also investigating what the downstream SNR would like if we provided digital lasers to a device past the node (SLIDE 4).
 - Does it improve ?
 - Significantly ?

Released Data

- © We're can release some samples of our node grouping data in excel if that would be helpful
- © This data would include:
 - 20 of our best performing nodes for SNR.
 - 20 of our nodes that are centered around the average SNR numbers.
 - 20 of our worst performing nodes for SNR.
- © Examples are below:

NodeNAME	TotalCMs	AvgSNR	15+ SNR	20+ SNR	25+ SNR	30+ SNR	33+ SNR	34+ SNR	35+ SNR	36+ SNR	37+ SNR	38+ SNR	39+ SNR	40+ SNR
BEST_1	12	40.4	12	12	12	12	12	12	12	12	12	12	11	8
BEST_2	13	40.2	13	13	13	13	13	13	12	12	12	12	11	8
BEST_3	20	40.2	20	20	20	20	20	20	20	20	19	19	17	9
BEST_4	56	39.8	56	56	56	56	55	55	54	54	50	45	44	38
BEST_5	59	39.8	59	59	59	59	58	58	57	57	53	49	44	31
BEST_6	168	39.8	168	168	168	168	167	166	166	164	152	146	120	96
BEST_7	10	39.7	10	10	10	10	10	10	10	10	9	8	8	7
BEST_8	13	39.7	13	13	13	13	13	13	13	13	13	13	11	5
BEST_9	31	39.7	31	31	31	31	31	31	31	31	30	29	25	19
BEST_10	54	39.7	54	54	54	54	54	54	54	51	49	45	36	27

Thank You!