MPoE Specifications

Current, Voltage, Unit Loads

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Motivation

- Three previous multi-pair PoE standards demonstrate that success will bring more applications, with the added ask for more power
- We should specify the maximum power possible to prevent a similar experience with MPoE
- Multi-pair PoE has significant margin in, specifically in the cable
- Experience has shown that this worst-case dissipation NEVER happens in real installs
- This is multiplied in multidrop systems, so a new approach is desired to not ”leave power on the table”

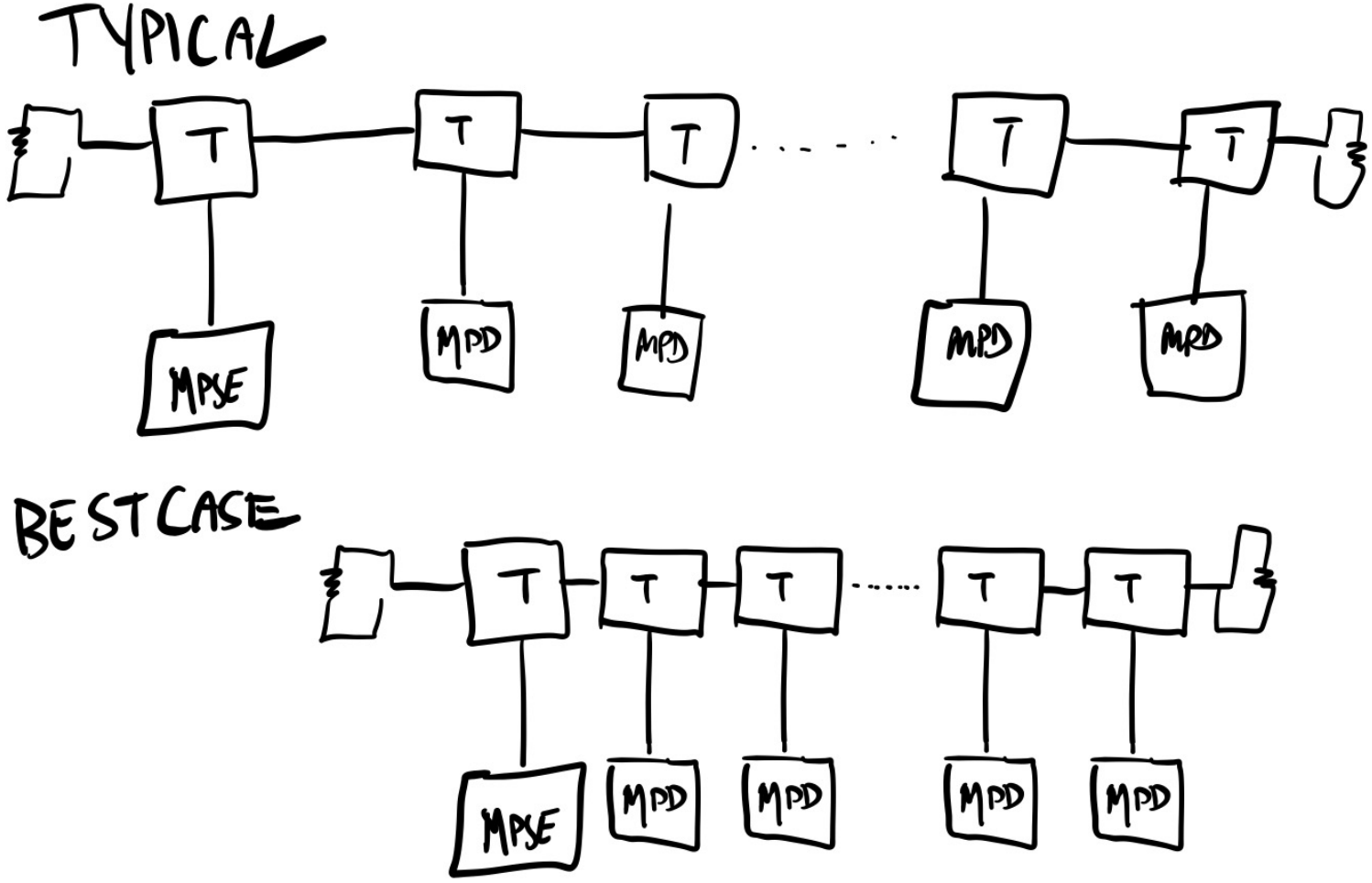
Process

- Use Excel to iteratively calculate the operating points for each PD in a multidrop system
- Spreadsheet is not “user friendly” (brute force that requires a little intuition) but the author is happy to share with anyone that wants to poke around in it

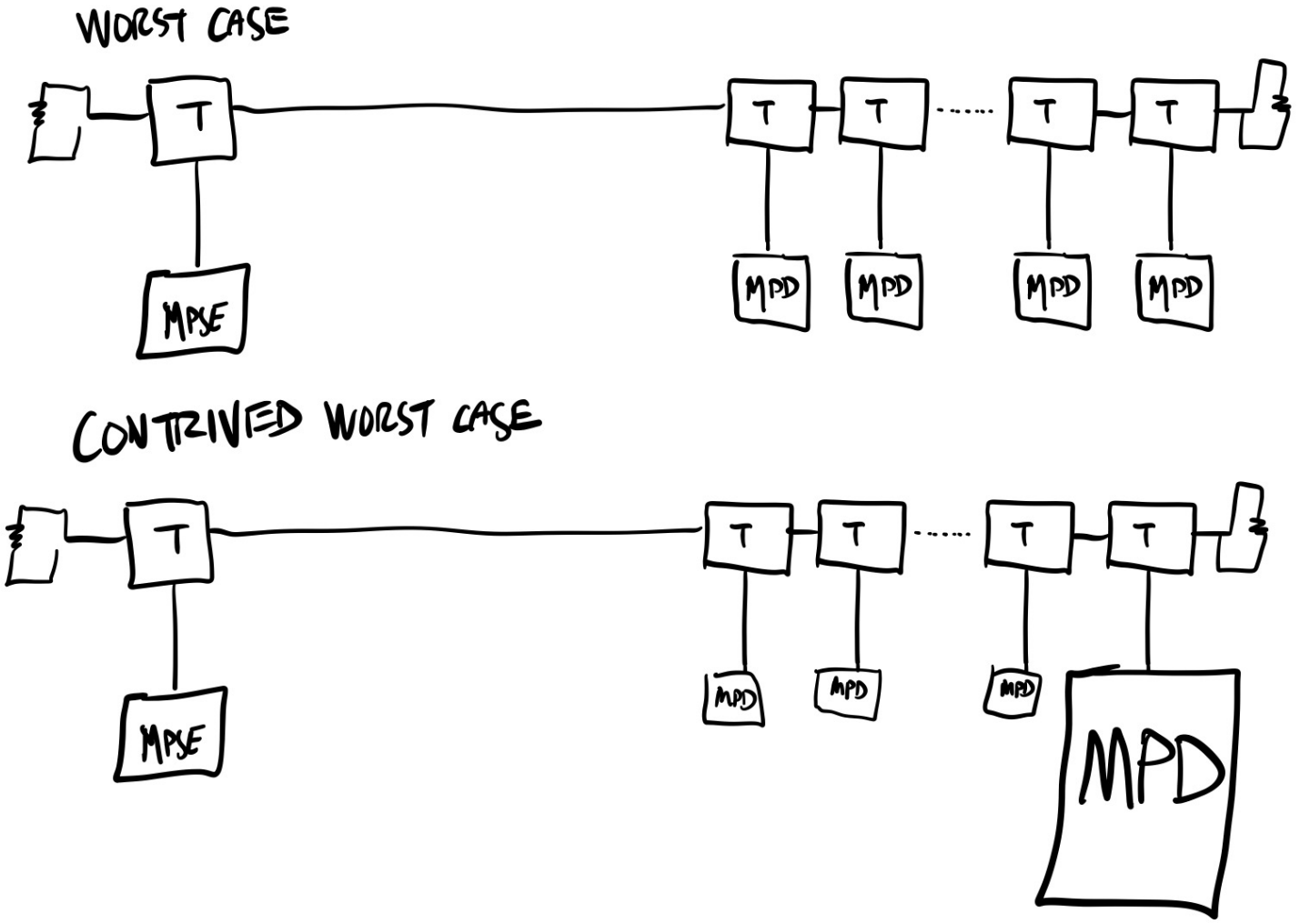
Description of Calculations

- Looked at 4 configurations:
  - Typical: equal spaced, equal power MPDs
  - Best Case: equal power MPDs all clumped at MPSE
  - Worst Case: Equal power MPDs all clumped at end of the mixing segment
  - Contrived Worst Case: 15 minimum power MPDs and one last MPD drawing the rest of the power, all clumped at the end of the mixing segment
- All T connectors were assumed 0.2 ohms
  - TC1->0.1 ohm->MPI->0.1 ohm->TC2
- Three voltages: 45 V, 26 V, 18 V
- Two currents: 1 A and 2 A
- Two loop resistances: 12 ohms for 1 A, 6 ohms for 2 A

Typical and Best-Case Diagram



Worst Case and Contrived Diagram



Calculation Method

- Spreadsheet made with MPSE at one end, 16 MPDs on the mixing segment
- Calculated the voltage at and current for each TC1, TC2, and MPI
- Used “Goal Seek” function in Excel to find the MPD power that resulted in the last TC2 current equaling zero.

Example of One Result (45 V, 1 A)

Vpsemin	45
Itci	1
Rchan	12
Tresistance	0.2
# of PDs	16

TYPICAL - EQUAL SPACED PDs

	VTC1	ITC1	VPD	PPD	IPD	ITC2	VTC2	R to next T	Tpower	cable power	
PSE			45.00			1.000	44.90	0.55	0.100	0.55	
PD1	44.35	1.000	44.25	2.53	0.057	0.943	44.16	0.55	0.189	0.49	
PD2	43.64	0.943	43.54	2.53	0.058	0.885	43.45	0.55	0.167	0.43	
PD3	42.97	0.885	42.88	2.53	0.059	0.826	42.80	0.55	0.146	0.38	
PD4	42.34	0.826	42.26	2.53	0.060	0.766	42.18	0.55	0.127	0.32	
PD5	41.76	0.766	41.69	2.53	0.061	0.705	41.61	0.55	0.108	0.27	
PD6	41.23	0.705	41.16	2.53	0.061	0.644	41.09	0.55	0.091	0.23	
PD7	40.74	0.644	40.67	2.53	0.062	0.582	40.62	0.55	0.075	0.19	
PD8	40.30	0.582	40.24	2.53	0.063	0.519	40.19	0.55	0.061	0.15	
PD9	39.90	0.519	39.85	2.53	0.063	0.456	39.80	0.55	0.048	0.11	
PD10	39.55	0.456	39.51	2.53	0.064	0.392	39.47	0.55	0.036	0.08	
PD11	39.25	0.392	39.21	2.53	0.064	0.327	39.18	0.55	0.026	0.06	
PD12	39.00	0.327	38.97	2.53	0.065	0.262	38.94	0.55	0.018	0.04	
PD13	38.80	0.262	38.77	2.53	0.065	0.197	38.75	0.55	0.011	0.02	
PD14	38.64	0.197	38.62	2.53	0.065	0.132	38.61	0.55	0.006	0.01	
PD15	38.54	0.132	38.52	2.53	0.066	0.066	38.52	0.55	0.002	0.00	
PD16	38.48	0.066	38.47	2.53	0.066	0.000	38.47		0.000	0.00	
				40.45					1.21	3.332	44.99

Summary of Results, 1 Amp Systems

		$P_{delivered}$ (W)	P_{cable} (W)	P_T (W)	P_{Tmax} (W)	P_{PDavg} (W)
45 V, 1 A	Typical	40.45	3.33	1.21	0.189	2.53
	Best	43.81	0	1.18	0.188	2.74
	Worst	35.01	8.8	1.18	0.188	2.19
	Contrived	33.27	8.8	2.93	0.199	(30.27)*
26 V, 1 A	Typical	21.32	3.44	1.25	0.190	1.33
	Best	24.81	0	1.19	0.188	1.55
	Worst	16.01	8.8	1.20	0.189	1.00
	Contrived	14.56	8.8	2.64	0.198	(11.56)*
18 V, 1 A	Typical	13.11	3.59	1.30	0.191	0.82
	Best	16.82	0	1.20	0.189	1.05
	Worst	7.98	8.8	1.23	0.189	0.50
	Contrived	7.03	8.8	2.17	0.196	(4.03)*

*P_{PDavg} in the contrived case is the power to the last MPD

Summary of Results, 2 Amp Systems

		$P_{delivered}$ (W)	P_{cable} (W)	P_T (W)	P_{Tmax} (W)	P_{PDavg} (W)
45 V, 2 A	Typical	80.91	4.24	4.85	0.756	5.06
	Best	85.24	0	4.76	0.754	5.33
	Worst	74.03	11.20	4.77	0.754	4.63
	Contrived	66.51	11.20	12.29	0.798	(63.51)*
26 V, 2 A	Typical	42.64	4.38	5.00	0.759	2.66
	Best	47.17	0	4.83	0.755	2.95
	Worst	35.93	11.20	4.88	0.756	2.25
	Contrived	29.03	11.20	11.77	0.796	(26.03)*
18 V, 2 A	Typical	26.23	4.56	5.21	0.763	1.64
	Best	31.09	0	4.91	0.757	1.94
	Worst	19.75	11.20	5.05	0.760	1.23
	Contrived	13.81	11.20	10.99	0.793	(10.81)*

*P_{PDavg} in the contrived case is the power to the last MPD

Recommendations

- Lower Unit Load to something that allows finer tuning, enabling more useable power
- Use the typical power consumption numbers for power reserved for the cable, rounding to the nearest unit load
- Add more MPSE and MPD Types; at least 2 (18 V, 1 A and 45V, 2A) or 4 more (additionally, 26V and 18 V @ 2 A)
- Change name of Types to be descriptive of the operating conditions, e.g Type 45-1, 26-1, 18-1, 45-2, 26-2, 18-2
- Write an informative section in assumptions made for “plug and play” warning of pitfalls that could break this

DRAFT Recommendations for Power Specifications

Channel Resistance	MPSE Current	MPSE Voltage	P_{MPSE} (W)	P_{MPD} (W)	P_{Cable} (W)
12 Ohms	1 Amp	45 V	45	40.5	4.5
		26 V	26	21.3	4.7
		18 V	18	13.1	4.9
6 Ohms	2 Amps	45 V	90	80.9	9.1
		26 V	52	42.6	9.4
		18 V	36	26.2	9.8

Cautionary Text

- The clause will have to include informative text, informing of the pitfalls of misuse of the power architecture.
- Specifically, warning against using MPoE in a point-to-point, worst case channel and single PD configuration.
- The next page shows the table from the previous page with an added column for ultra-contrived worst case single PD.
- Note that the available PD power is MUCH less than what a typical multi-drop system can deliver, hence the need for the warning.

Single PD

- After doing all this work, the author realized that the real worst case is one PD drawing all the available power at the end of the worst-case channel.
- These values are straight forward to calculate, and are included on the next slide.
- One thing to note, the 18V modes are not stable – meaning the available PD power is less than half of the PSE power, meaning the cable consumes more power than the PD. And the 26V modes are only 53.8% efficient.

Adding Single PD Data

Channel Resistance	MPSE Current	MPSE Voltage	P_{MPSE} (W)	P_{MPD} (W)	P_{Cable} (W)	Single PD Power (W)
12 Ohms	1 Amp	45 V	45	40.5	4.5	33
		26 V	26	21.3	4.7	14
		18 V	18	13.1	4.9	6
6 Ohms	2 Amps	45 V	90	80.9	9.1	66
		26 V	52	42.6	9.4	28
		18 V	36	26.2	9.8	12

Unit Loads

- The desire is to make the Unit Load small enough to use all the power, but not so small making the total U of a network huge
  - e.g. Unit Load of 0.1W would mean ~810 U for a Type 45-2
- Proposing a Unit Load of 0.5 W for all types of systems
- This would result in X U's for -1 systems and 2X U's for -2
- Next page summarizes the recommendations, with a 0.5 W UL, rounded to this value

FINAL Recommendations for Power Specifications

Each Unit Load is 0.5 W

Channel Resistance	MPSE Current	MPSE Voltage	P_{MPSE} (W)	P_{MPD} (W)	P_{Cable} (W)	Single PD Power (W)	Mixing Segment Unit Loads
12 Ohms	1 Amp	45 V	45	40.5	4.5	33	81
		26 V	26	21.5	4.5	14	43
		18 V	18	13.5	4.5	6	27
6 Ohms	2 Amps	45 V	90	81.0	9.0	66	162
		26 V	52	43.0	9.0	28	86
		18 V	36	27.0	9.0	12	54

Table 169-1

Table 169–1—System power types

Contact	30V Max MPSE	50V Max MPSE	Units
System type	**0**	**1**	
$V_{MPSE(max)}$	30	50	V
$V_{MPSE(min)}$	26	45	V
$V_{MPD(min)}$	16	34	V
$I_{TCI\_MSPE(min)}$	1000	**1000**	mA
P_{MPSE}	26	**45**	W
$P_{MPD\_1U(max)}$	1	2	W

Table 169-5

Table 169–5—PSE output requirements

Item	Parameter	Symbol	Unit	Min	Max	Type	Additional Information
1	DC output voltage during POW-ER_ON state	$V_{MPSE(PON)}$	V	26	30	0	
				45	50	1	
2	Continuous output capability in POWER_ON state	P_{MPSE}	W	26	100	0	
				45	100	1	
3	Output slew rate		dV/dt	TBD	TBD	ALL	
4	Output current - at	I_{LIM}	A	TBD	TBD	ALL	

Question: duplicate of Table 169-1. we don't want this in two spots. How can we clean this up?

Table 169-8

Table 169–8—MPD power supply limits

Item	Parameter	Symbol	Unit	Min	Max	Type	Additional Information
1	Input voltage	VPort_MPD	V	14	30	0	
				33	50	1	
2	Unit power	P_{MPD_1U}	W		1	0	1 unit load
					2	1	1 unit load
3	Unit loading	N_{unit}	-	1	16	ALL	Must be an integer
4	Input power	P_{MPD}	W	1	14	0	N_{unit} * P_{MPD_1U}
				2	33	1	
5	Inrush current	I_{Inrush_MPD}	A	-	.01	ALL	
6	MPD Type 0 Voltage threshold	V_{TYPE0_TH}	V	11.9	14	ALL	
7	MPD Type 1 Voltage threshold	V_{TYPE1_TH}	V	30.1	33	ALL	