Multidrop PHY Simulation

David D. Brandt
Rockwell Automation

Purpose

- The purpose of this presentation is to:
  - Investigate multidrop with large node count to address industrial in-cabinet component applications

Link Topology

- Christoph Wechsler, Audi AG
  - http://www.ieee802.org/3/cg/public/May2017/wechsler_3cg_01a_0517.pdf
- Adopt conclusion that “passive linear topology with end-of-line terminators and limited stubs” was the best option
  - Feasible for at least 25 m and 8 nodes
- Results were based on parameters from:
  - TJA 1081 FlexRay node transceiver

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Pins BP and BM						
$R_{i(dif)(BP-BM)}$	differential input resistance between pin BP and pin BM	idle level; $R_{bus} = \infty\ \Omega$	20	37	80	kΩ

Could we achieve more nodes?

- FlexRay achieves:
  - 22 nodes @ 22 m (passive linear bus)

- RS485 increased node count by:
  - Making the termination external
  - High impedance transceivers
    - 3-state transmitters

Unit Loads	Nodes	Value
1	32	12k ohm
1/2	64	24k ohm
1/4	128	48k ohm
1/8	256	96k ohm

Source Impedance

- Assume 100 Ω line
- Center of long line:
  - Drive 2 parallel 100 Ω lines, one in each direction (50 Ω)
- Short line:
  - Drive 2 parallel 100 Ω terminators (50 Ω)
- Near one end of long line:
  - Drive 1 100 Ω terminator in parallel with a 100 Ω line (50 Ω)

Power Distribution

- Nodes are coupled by two 200 nF capacitors
- Termination is capacitive coupled with 200 nF each
- Power supply is decoupled by two 500 uH inductors

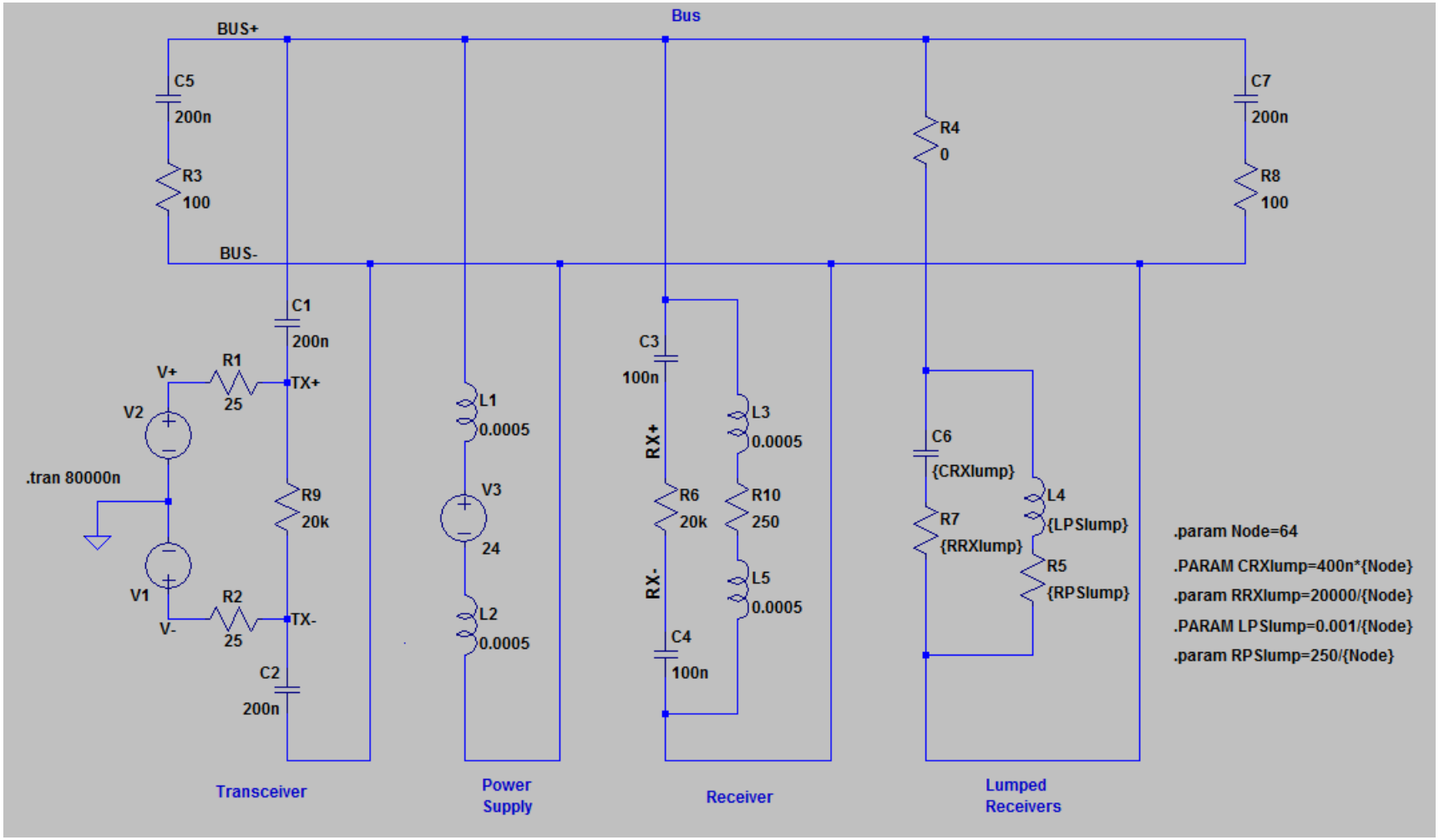
- 24 VDC, 4A, 64 nodes
  - 687 mW @ 11 VDC

Concepts

- FlexRay has 3 driven states, try PAM-3 @ 7.5 MS/s
  - Not successful with @ 10 of the same symbol with more than one node
    - Too much sag
  - Separate power was better
- DME @ 10 MS/s worked much better
  - Shorter periods, less sag
  - Twice the margin

Simulation Model

- Lumped load, 64 nodes

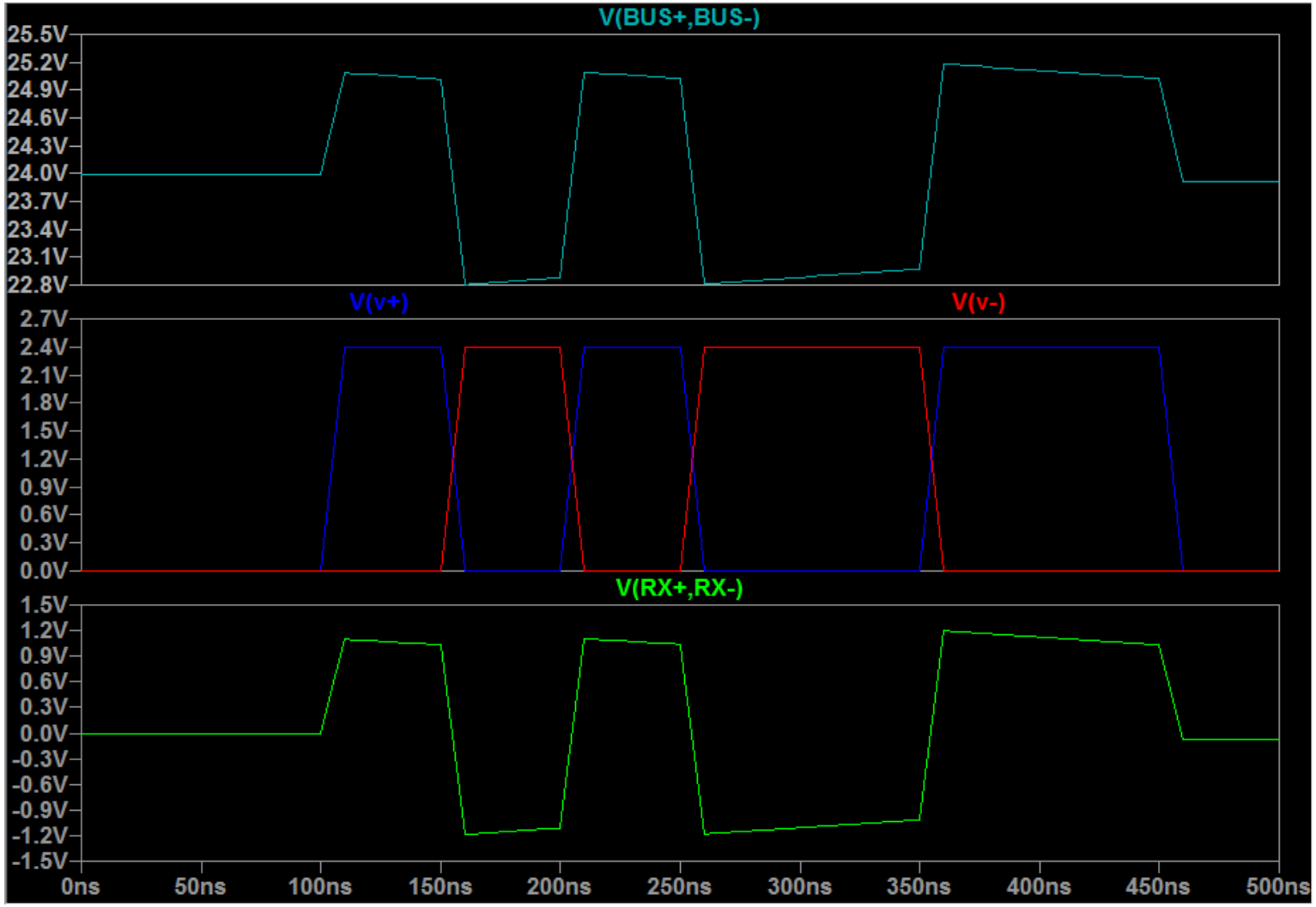


Simulation Waveforms

BUS

Transmitter

Receiver



Conclusions

- It appears feasible to achieve a larger node count
  - Single pair
  - Powered nodes
  - DME @ 10 MS/s