

LPA Training

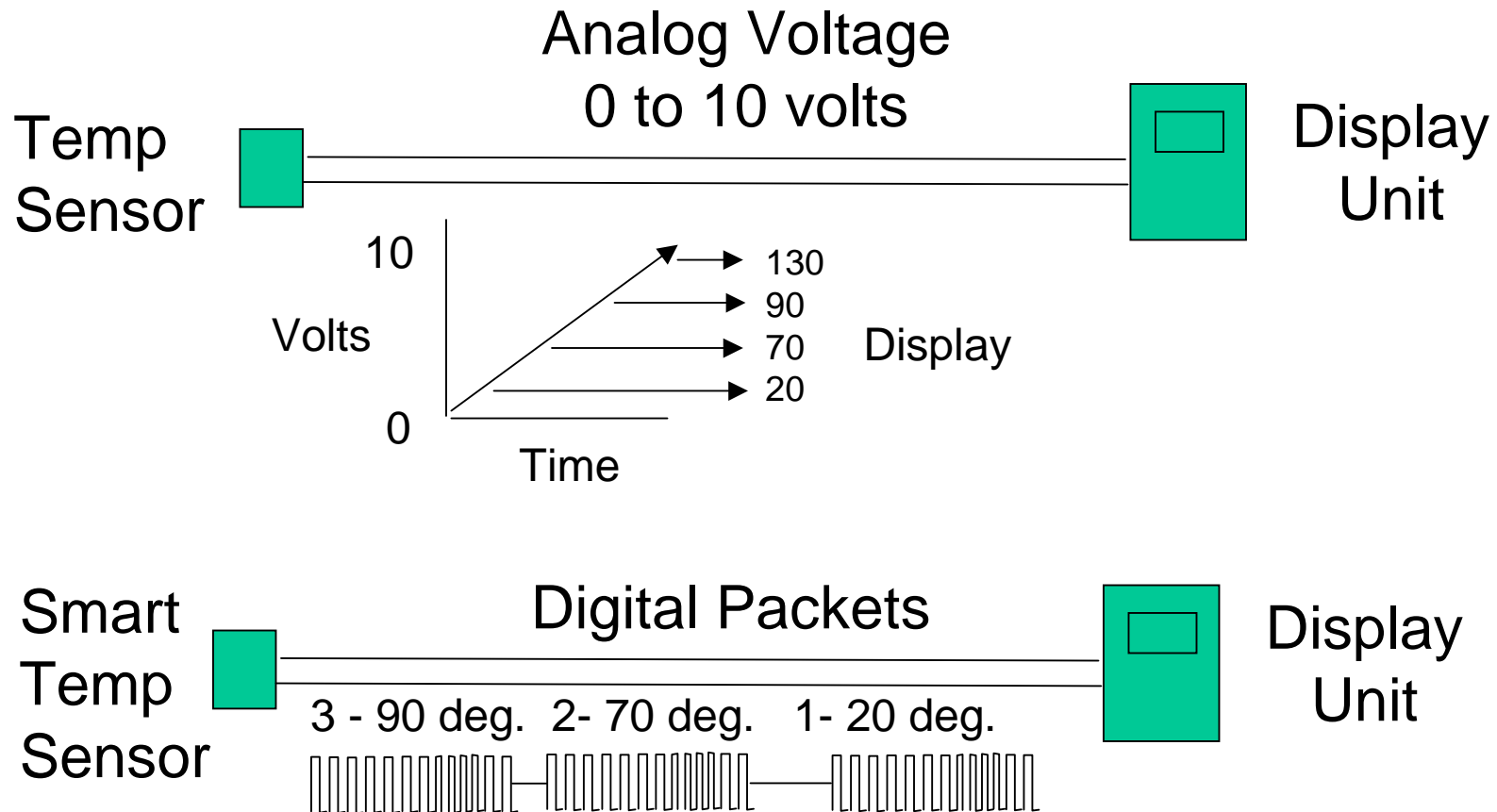
Al Mouton

President Loytec Americas

A Networking Company

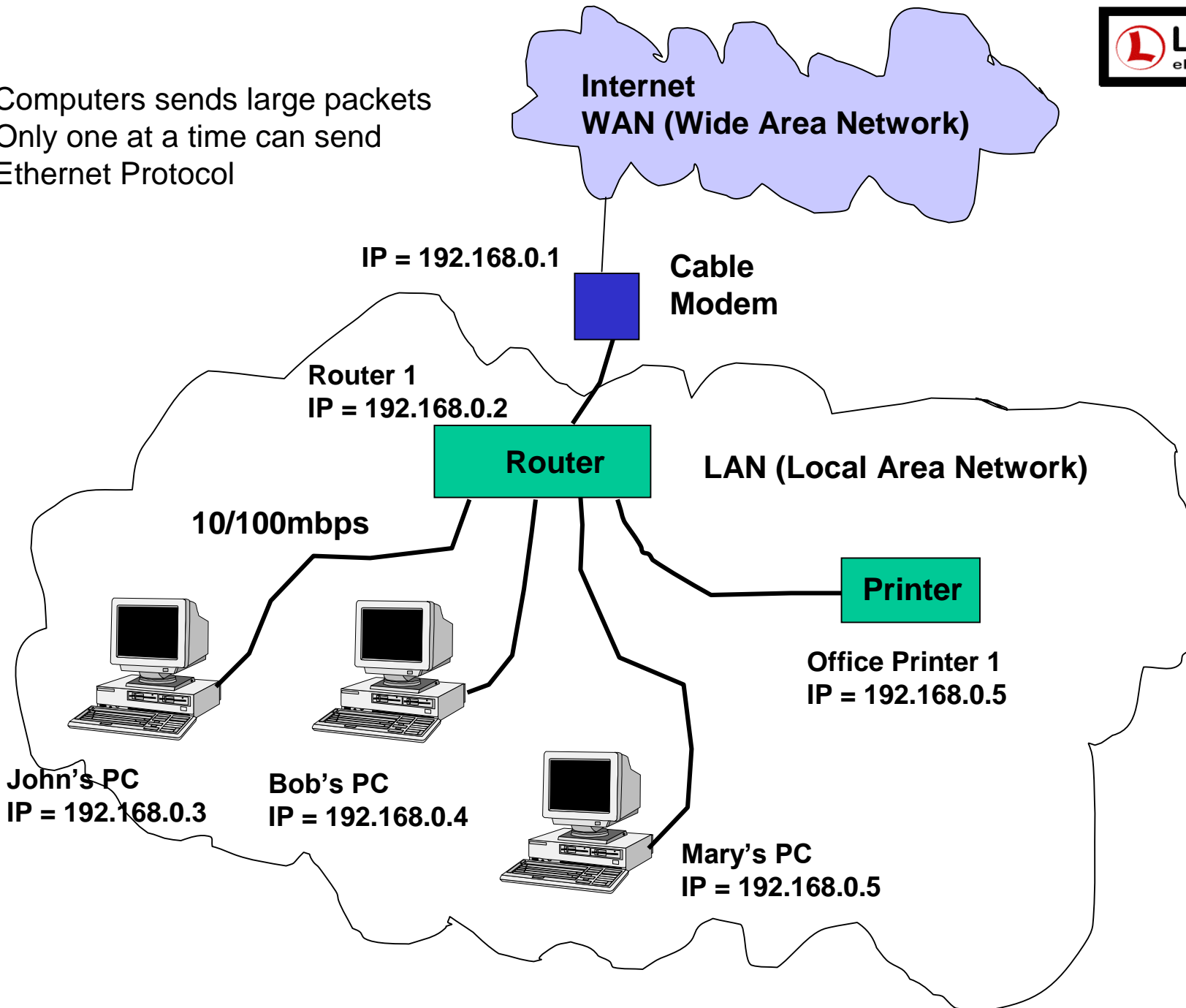
sales@loytec-americas.com

Analog vs Digital Systems



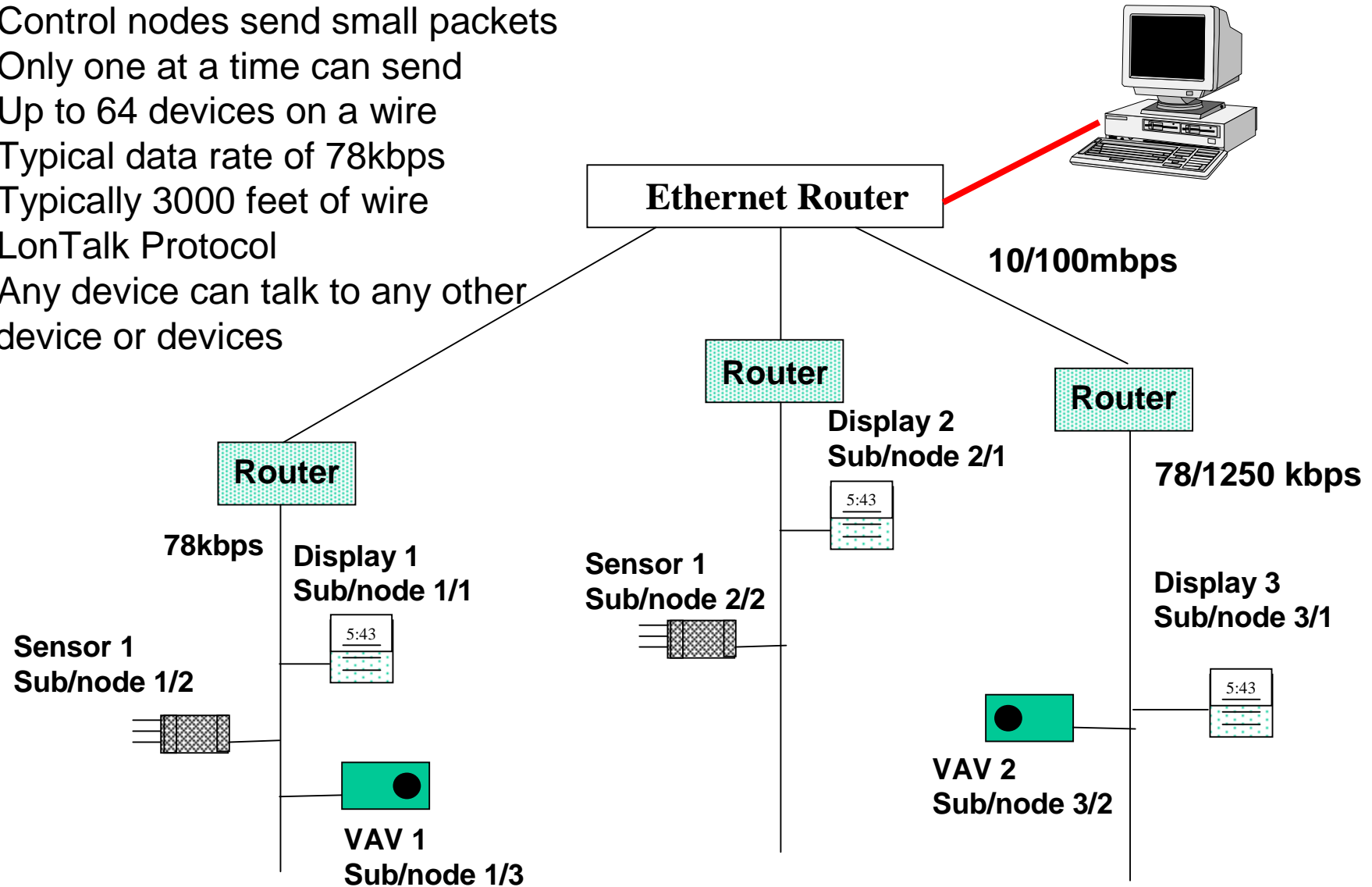
A packet contains a data field from a single word to many depending on packet size
 A packet contains a source and destination address, command, data, check sum

- Computers sends large packets
- Only one at a time can send
- Ethernet Protocol



Control Networks

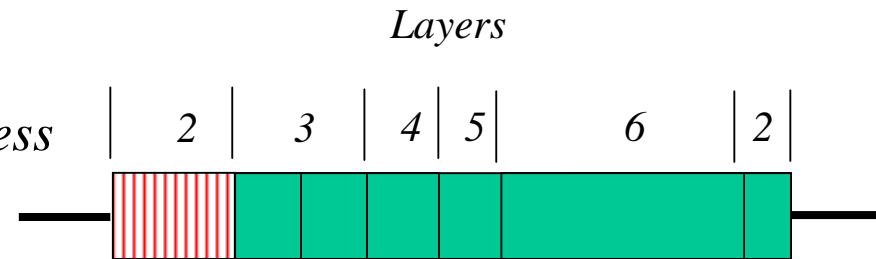
- Control nodes send small packets
- Only one at a time can send
- Up to 64 devices on a wire
- Typical data rate of 78kbps
- Typically 3000 feet of wire
- LonTalk Protocol
- Any device can talk to any other device or devices



LonWorks Packet

Packet contains:

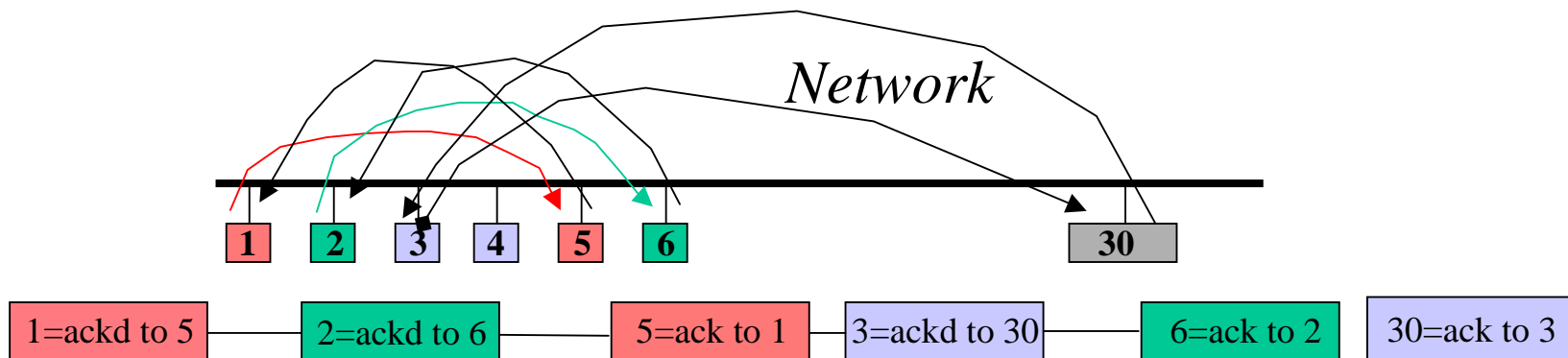
- (2) *Preable*
- (3) *Source address + destination address*
- (4) *Service type*
- (6) *Data*
- (2) *CRC error check byte*



*Packet length from
11 to 64 bytes
Or 1.6ms to 56ms*

CRC - cyclic redundancy checking

The originating product calculates a 2 byte CRC, then the receiving product Re-calculates and compares with the originating product's CRC

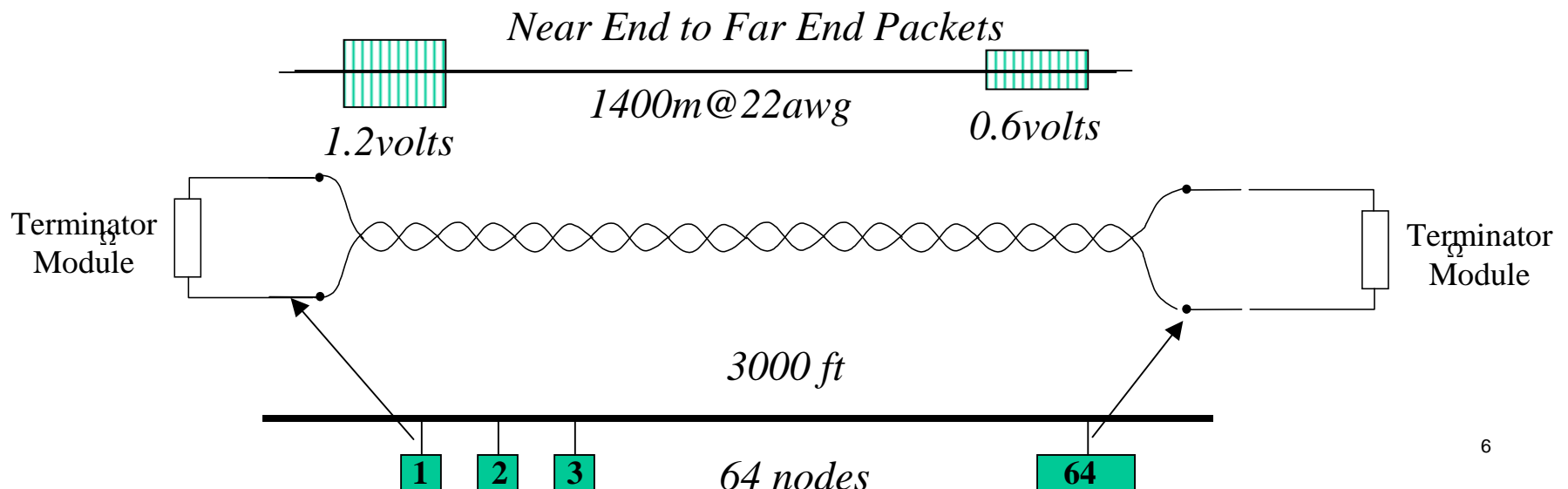


This all happens in less that .05 seconds or 50ms

Physical Layer

- **FT-10 network EIA-709.4 Straight multi-drop or Bus Topology**
- **Terminators lower the line impedance and reduce noise pickup**
- 78Kbps data rate or 2.5 ms per packet
- bus topology up to 64 devices distributed across the wire length
- terminated on both sides
- max stub length < 3m or 10 feet
- max bus length < 2700 m (8858 feet) 16 AWG suggest 4500 ft (Belden 85102)
- max bus length < 1400 m (4500 feet) 22 AWG suggest 3000 ft (Belden 8205)
- max bus length < 900 m (2400 feet) 24 AWG suggest 1200 ft

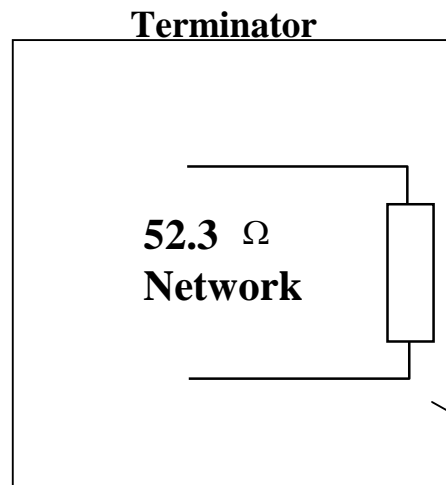
22awg = 25pf/ft 10 ohms/1000ft)



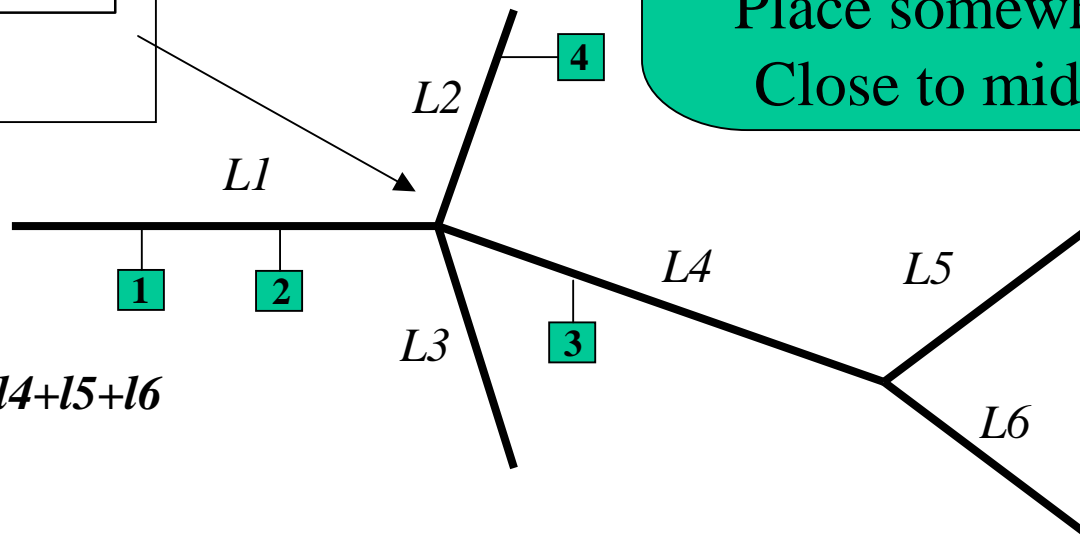
Physical Layer

- FT-10 network, free topology

- terminated at one location near the middle
- max total cable length <500 m (1600 feet) (Belden 85102) 16 AWG
- max total cable length <400 m (1300 feet) (Belden 8205) 22 AWG



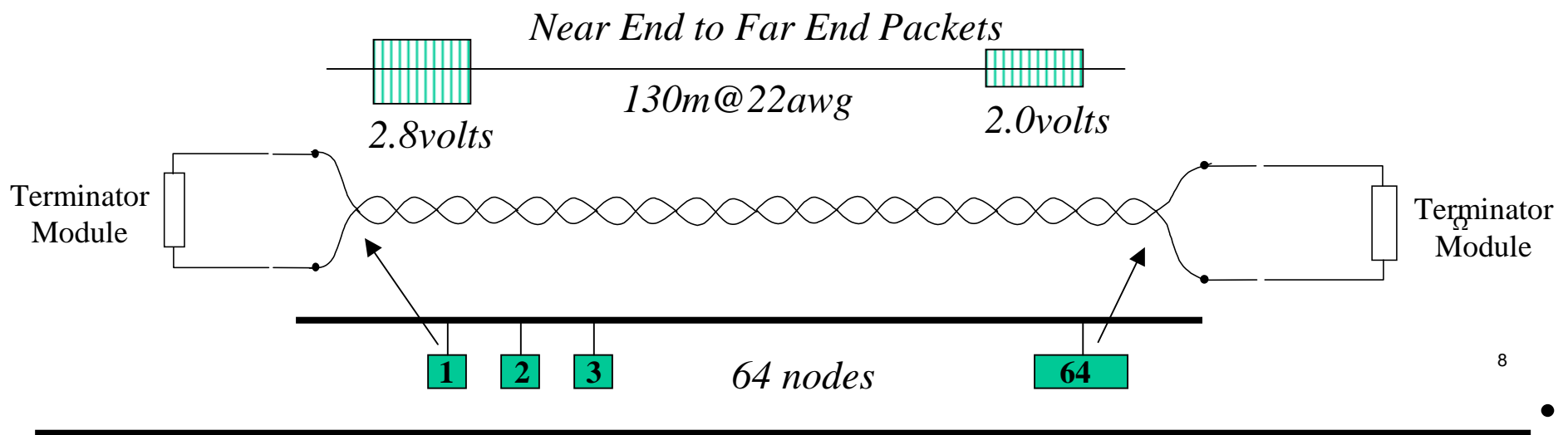
You cannot measure the terminator with an Ohm meter
Place somewhere Close to middle



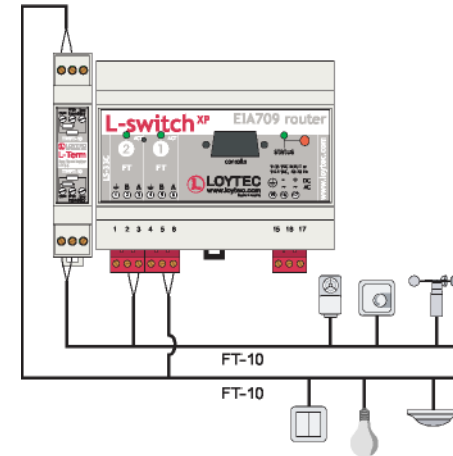
$$Max=L1+l2+l3+l4+l5+l6$$

Physical Layer

- **TP 1250 network**
- 1250 Kbps data rate or 250us per packet
- bus topology
- terminated on both sides
- max stub length < 1.5m or 4 feet
- max bus length < 300 m (750 feet) 16AWG
- max bus length < 130 m (400 feet) 22AWG
- No more than 8 devices within 16 m

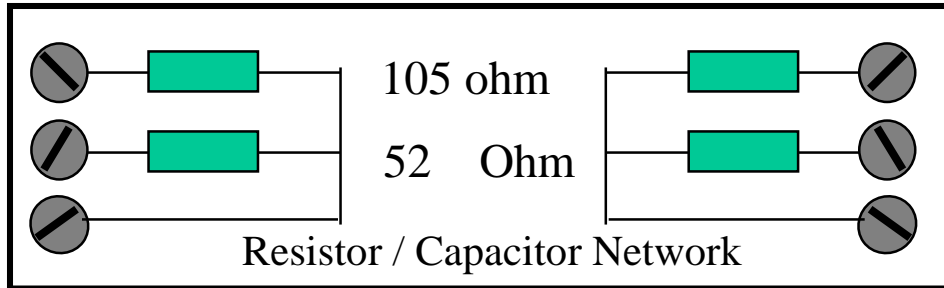


Terminator Devices



LT-33

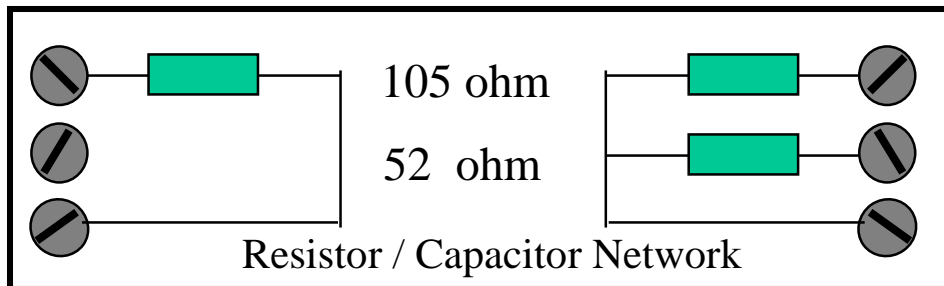
TP78 Bus
FT10 Free Top.



TP78 Bus
FT10 Free Top.

LT-13

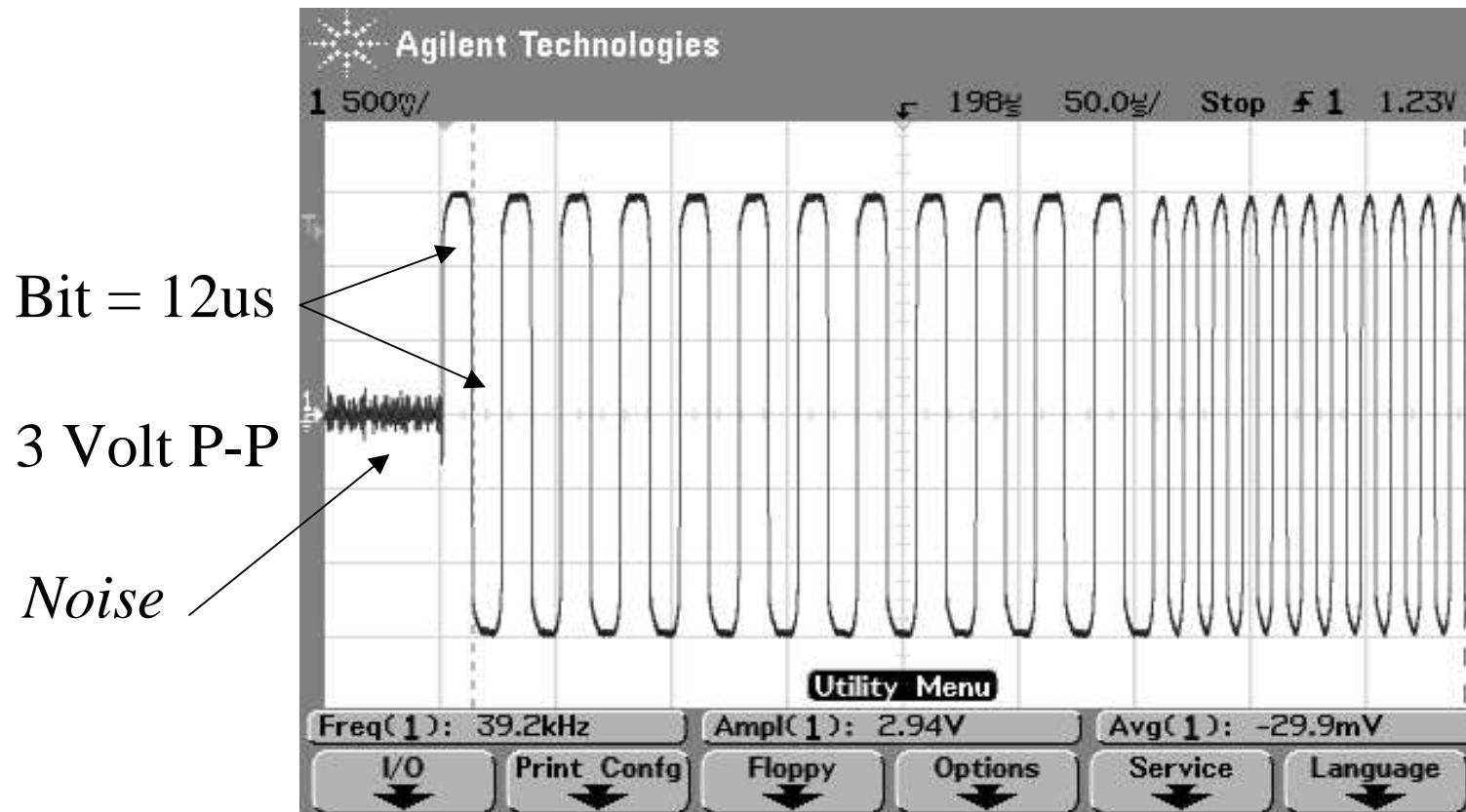
TP1250 Bus



TP78 Bus
FT10 Free Top.

Physical Layer

FT-10 signal, unterminated bus



Scopes

Tenma 20mhz \$750

Fluke 20mhz \$1200

Velleman

HPS10 10mhz \$ 200

HPS40 40mhz \$ 400

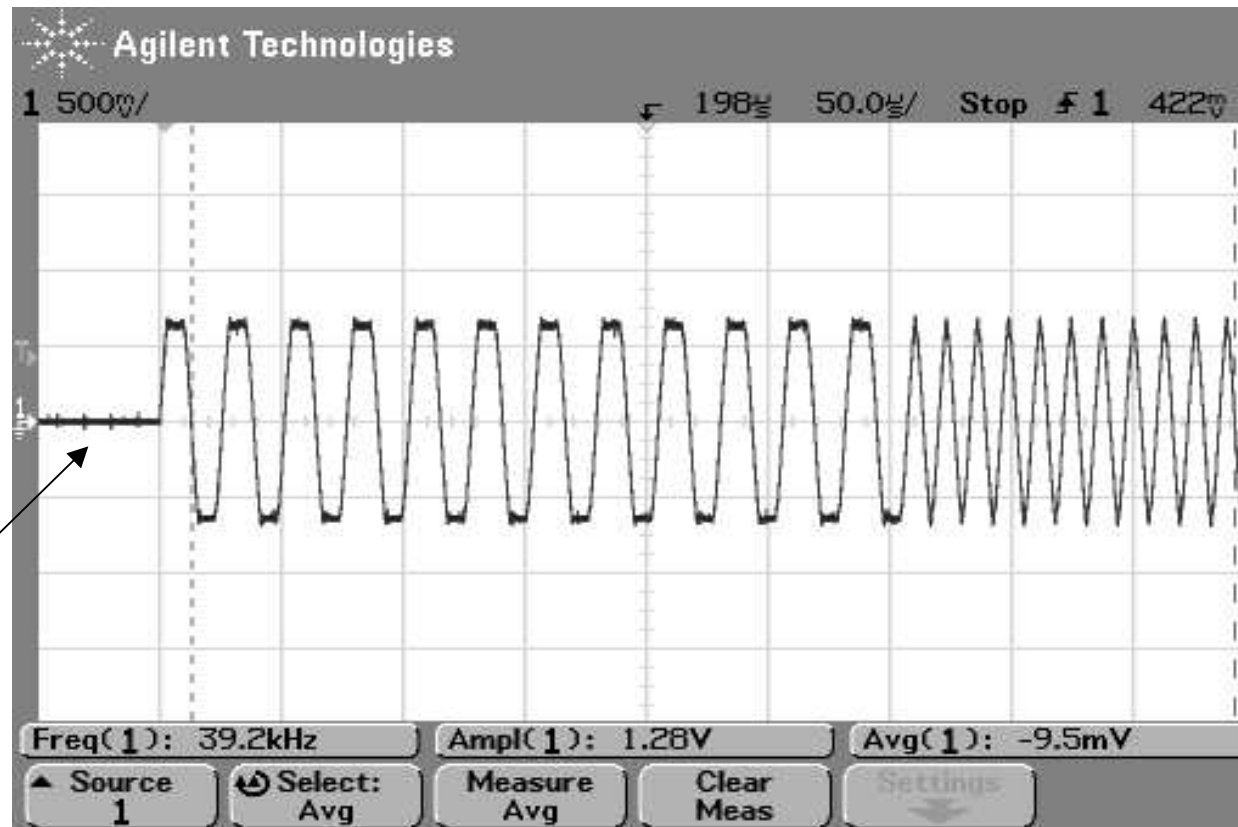
Physical Layer

FT-10 signal, terminated bus

1.2 Volt P-P

Reduces RF
Radiation

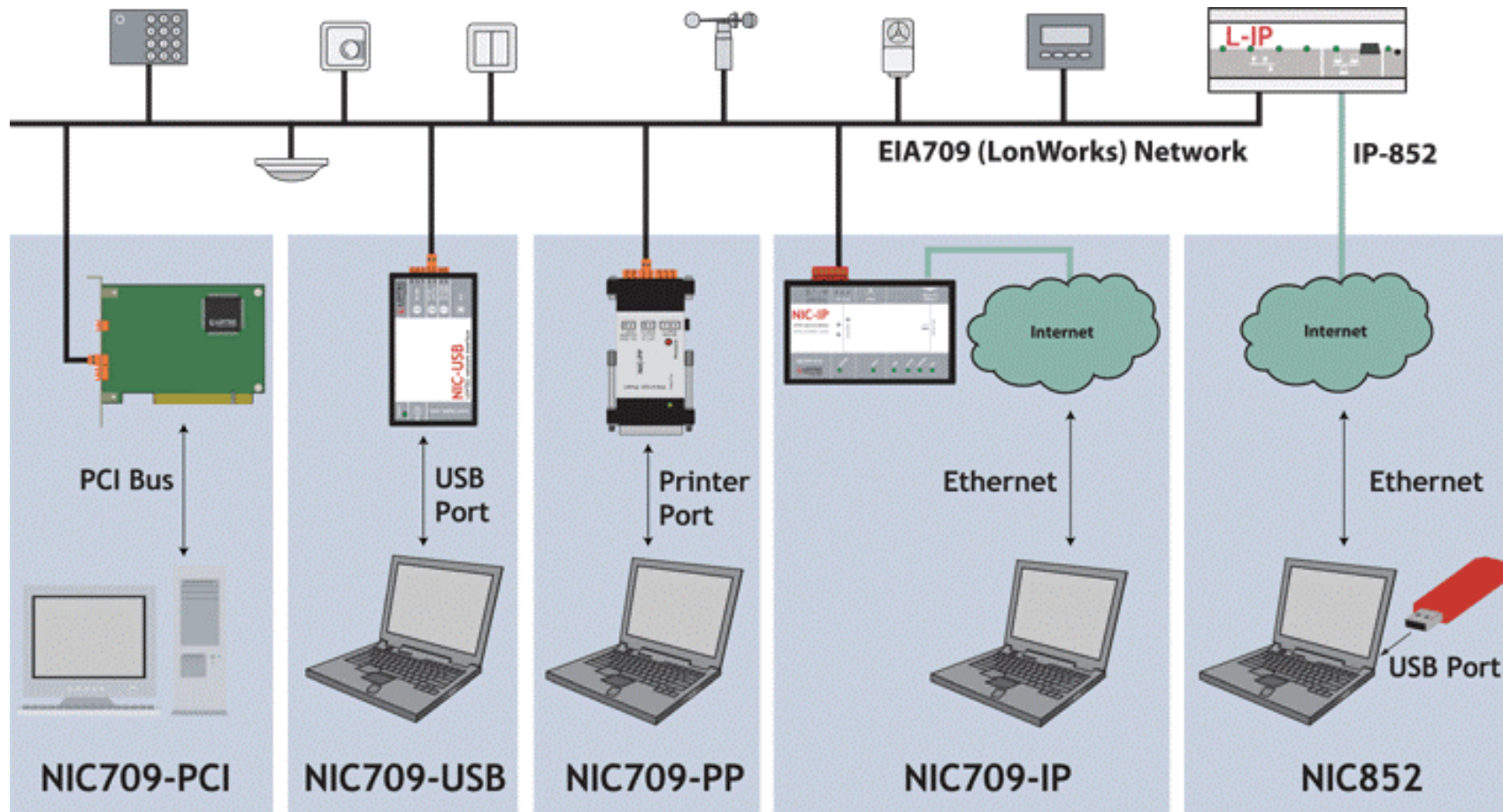
Lowers S/N



Network Errors

Loytec Protocol Analyzer (LPA) Network Interface Products (NIC)

LPA works with
LIP + NIC-852



Loytec is a Technology Company Hardware and Software

NIC Hardware Configurations

- LPA-PP (printer port), LPA-PCI , LPA-USB,
- All have Three Physical Layer Interfaces (FTT10/TP1250/RS485)
- Invensys WorkPlace Tech has technical updates on installing NIC products

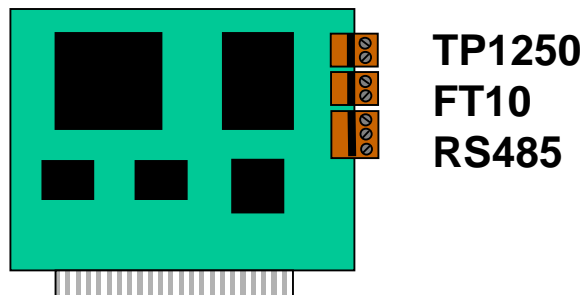
NIC-PP



NIC-USB



NIC-PCI



NIC-852



Turns your PC into a Network Interface over the IP network

How to Insure Good Network

- Most problems with a network are wire related. Either wrong wire, corroded wire, wire taps, frayed wire, opens, shorts, etc.
- When using the LPA always check signal quality in multiple locations along the network cable.
- Connect shield properly (ground on one side only.)
- Properly terminate the network to reduce induced noise.
- Keep routers out of heavy noisy areas.
- Use **switches** and **routers** instead of physical layer repeaters

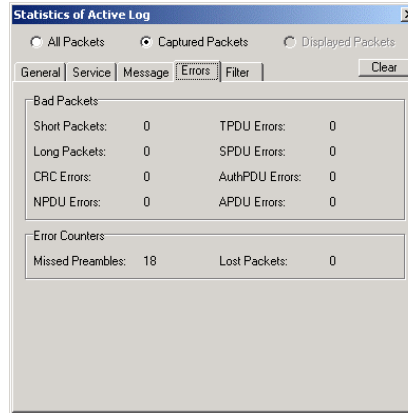
Layer 1 Errors

	<i>Noted Failures</i>	<i>Cause</i>
<u>Hardware problems</u>		
Cable too long, wrong type or has too many nodes	CRC	Random Failures
Bad cables (open, shorted)	AP	no ack or response
Terminations (no terminators)	CRC	Random Failures
Terminations (Wrong one – Free top.)	CRC	Random Failures
Cable contacts corroded	AP, CRC	no ack or response
Ground problems	CRC	Random Failures
Cable-shield connected on both sides	CRC	Random Failures
Power Supply bad or dead	AP	no ack or response
Product Input bad	AP	High Bandwidth
<u>Environmental problems</u>		
EMC problems (noise, emissions, ...)	CRC	Random Failures
Humidity	CRC	no ack or response
Lightning damage	AP	no ack or response

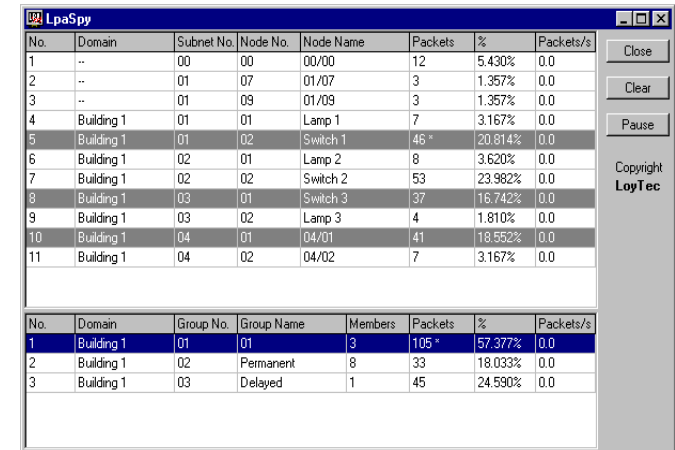
All these problems can cause one of the following
 LPA noted errors: CRC, Lost packet, short packets,
missed preamble or Alternate Path (AP) Flag (no Ack back)

LPA to Find the Problems

- 1) LPA Statistics will display error log
 - CRC
 - Bandwidth



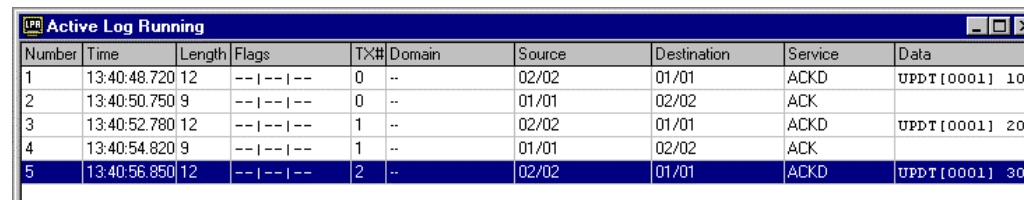
- 2) LPA Node report will list Nodes in the network sequentially by Domain, subnet, node number



No.	Domain	Subnet No.	Node No.	Node Name	Packets	%	Packets/s
1	--	00	00	00/00	12	5.430%	0.0
2	--	01	07	01/07	3	1.357%	0.0
3	--	01	09	01/09	3	1.357%	0.0
4	Building 1	01	01	Lamp 1	7	3.167%	0.0
5	Building 1	01	02	Switch 1	46	20.814%	0.0
6	Building 1	02	01	Lamp 2	8	3.620%	0.0
7	Building 1	02	02	Switch 2	53	23.982%	0.0
8	Building 1	03	01	Switch 3	37	16.742%	0.0
9	Building 1	03	02	Lamp 3	4	1.810%	0.0
10	Building 1	04	01	04/01	41	18.552%	0.0
11	Building 1	04	02	04/02	7	3.167%	0.0

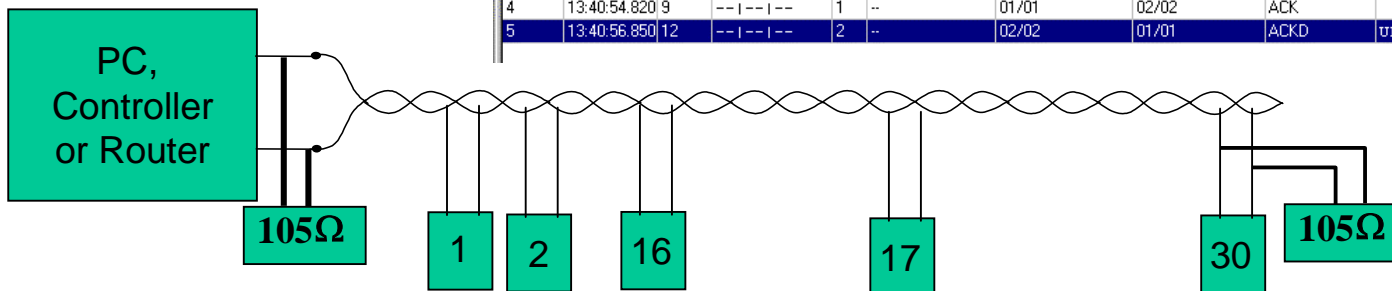
No.	Domain	Group No.	Group Name	Members	Packets	%	Packets/s
1	Building 1	01	01	3	105	57.377%	0.0
2	Building 1	02	Permanent	8	33	18.033%	0.0
3	Building 1	03	Delayed	1	45	24.590%	0.0

- 3) LPA will log packets showing all the details



Number	Time	Length	Flags	T×#	Domain	Source	Destination	Service	Data
1	13:40:48.720	12	-- -- --	0	--	02/02	01/01	ACKD	UPDT[0001] 10
2	13:40:50.750	9	-- -- --	0	--	01/01	02/02	ACK	
3	13:40:52.780	12	-- -- --	1	--	02/02	01/01	ACKD	UPDT[0001] 20
4	13:40:54.820	9	-- -- --	1	--	01/01	02/02	ACK	
5	13:40:56.850	12	-- -- --	2	--	02/02	01/01	ACKD	UPDT[0001] 30

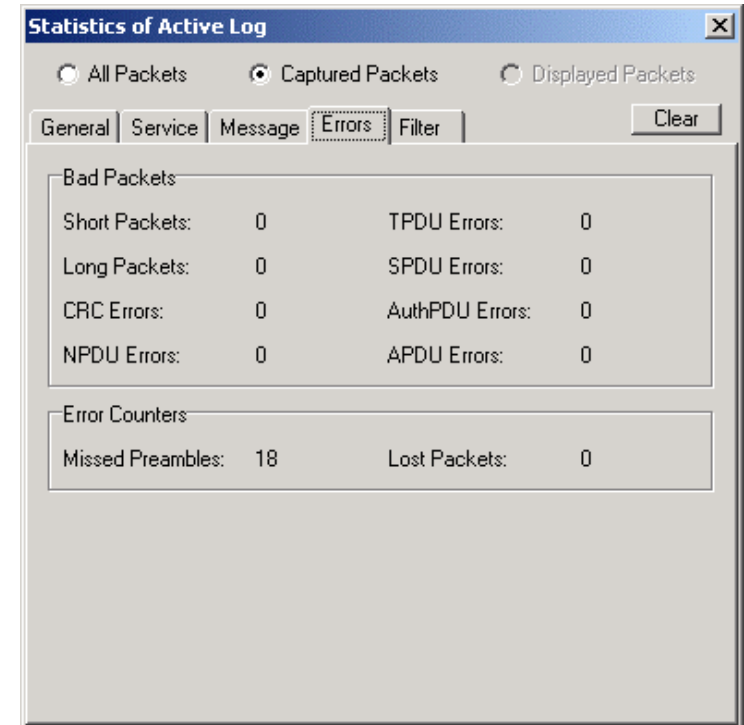
PC/Controller/Router



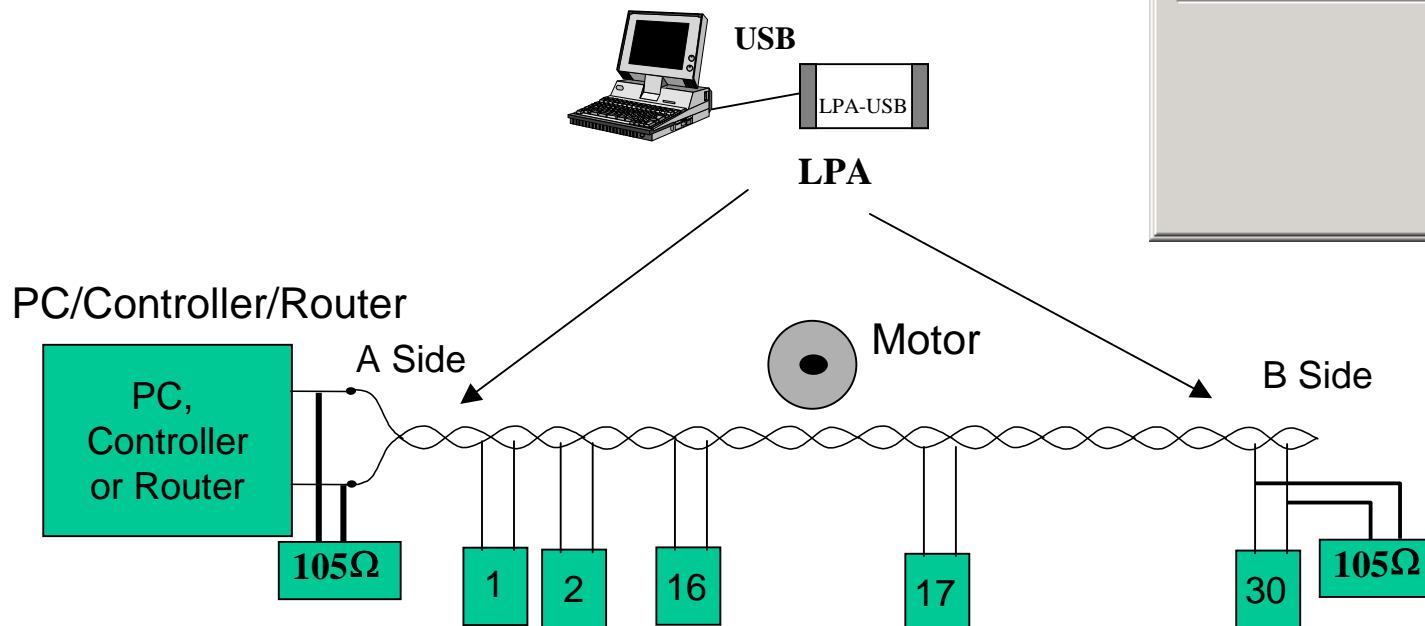
LPA Statistics Log

LPA Statistics will display error and bandwidth logs

1. CRC errors over 2% bad
2. Short Packets (typically caused by noise) >20% bad
3. Missed Preamble cause by packet collision
4. AP (Alternate Path) counting each time a ACK/ACKD or Request/Response does not get through
5. Bandwidth greater than 50% will start causing delays in response time and some loss of packets



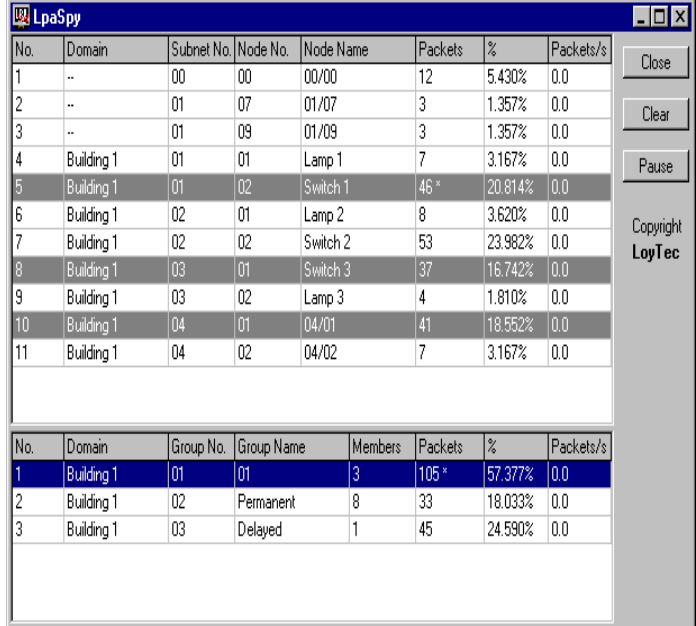
Statistics of Active Log			
<input type="radio"/> All Packets <input checked="" type="radio"/> Captured Packets <input type="radio"/> Displayed Packets			
General Service Message Errors Filter			Clear
Bad Packets:			
Short Packets:	0	TPDU Errors:	0
Long Packets:	0	SPDU Errors:	0
CRC Errors:	0	AuthPDU Errors:	0
NPDU Errors:	0	APDU Errors:	0
Error Counters:			
Missed Preambles:	18	Lost Packets:	0



LPA Node Log

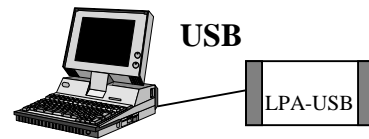
LPA Node log will list packet sequentially

- Will list the packet by Domain then nodes
- Will list the packet by subnet then nodes
- Will see nodes that are dead (not responding)
- Will see nodes that are high packet traffic (either pole rate to high or defective product)
- Will see shorts or opens



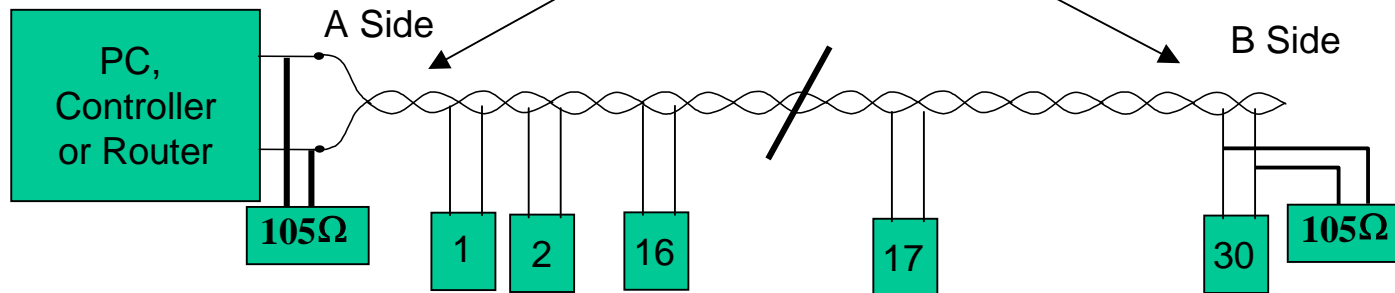
No.	Domain	Subnet No.	Node No.	Node Name	Packets	%	Packets/s
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LPA – Test Both Ends

PC/Controller/Router



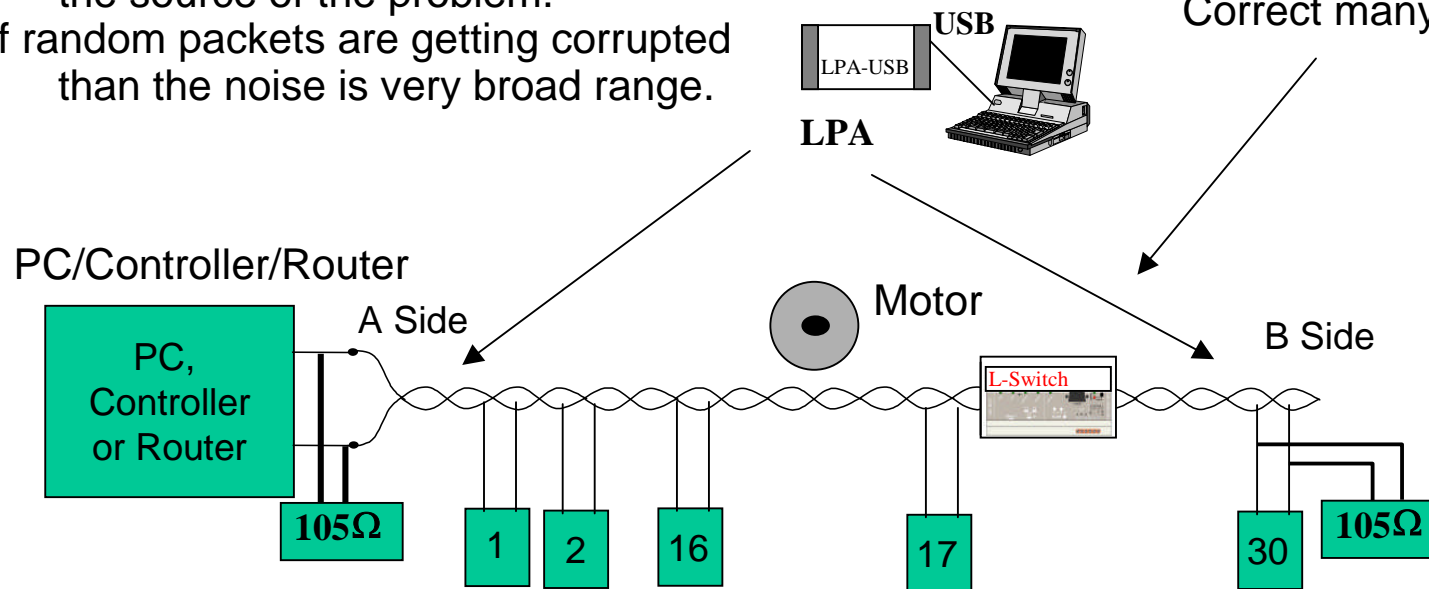
LPA Packets Analysis

LPA will log packets to identify which nodes are close to the noise source
 CRC errors will be displayed in red.
 List all nodes that are having CRC failures. If node 1 is talking to 3 probably no failure. If 1 is talking to 16 through 30, probably CRC failure.

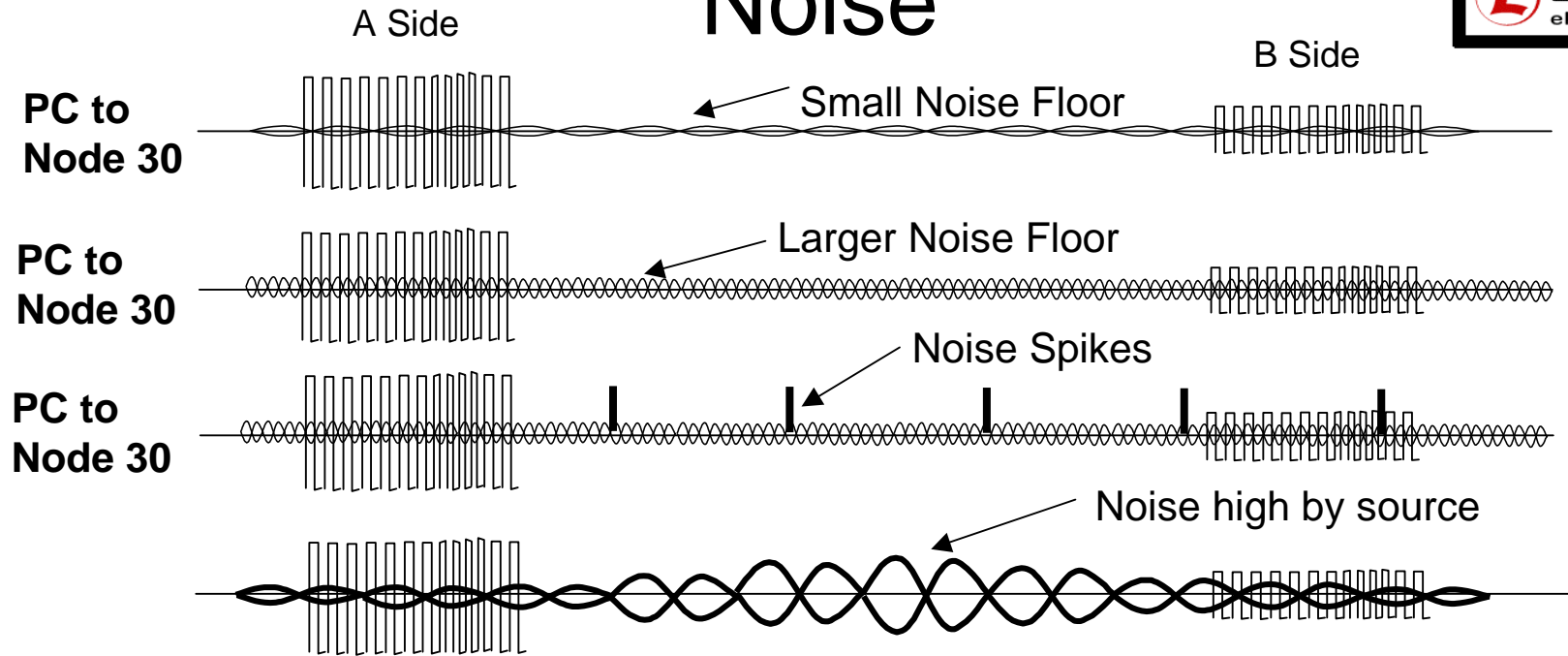
Number	Time	Length	Flags	TX#	Domain	Source	Destination	Service	Data
1	13:40:48.720	12	-- --- --	0	--	02/02	01/01	ACKD	UPDT [0001] 10
2	13:40:50.750	9	-- --- --	0	--	01/01	02/02	ACK	
3	13:40:52.780	12	-- --- --	1	--	02/02	01/01	ACKD	UPDT [0001] 20
4	13:40:54.820	9	-- --- --	1	--	01/01	02/02	ACK	
5	13:40:56.850	12	-- --- --	2	--	02/02	01/01	ACKD	UPDT [0001] 30

So if a few packets with the same address are corrupted that indicates the source of the problem.
 If random packets are getting corrupted than the noise is very broad range.

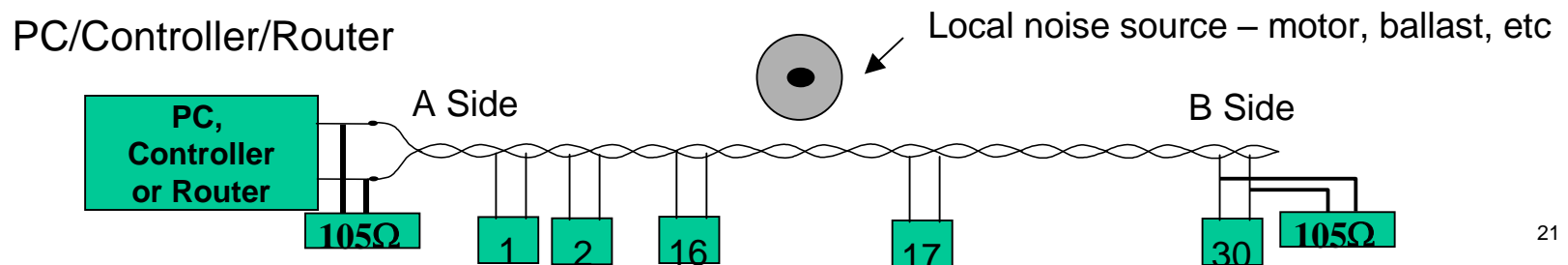
Add L-Switch in Smart Mode to Correct many problems



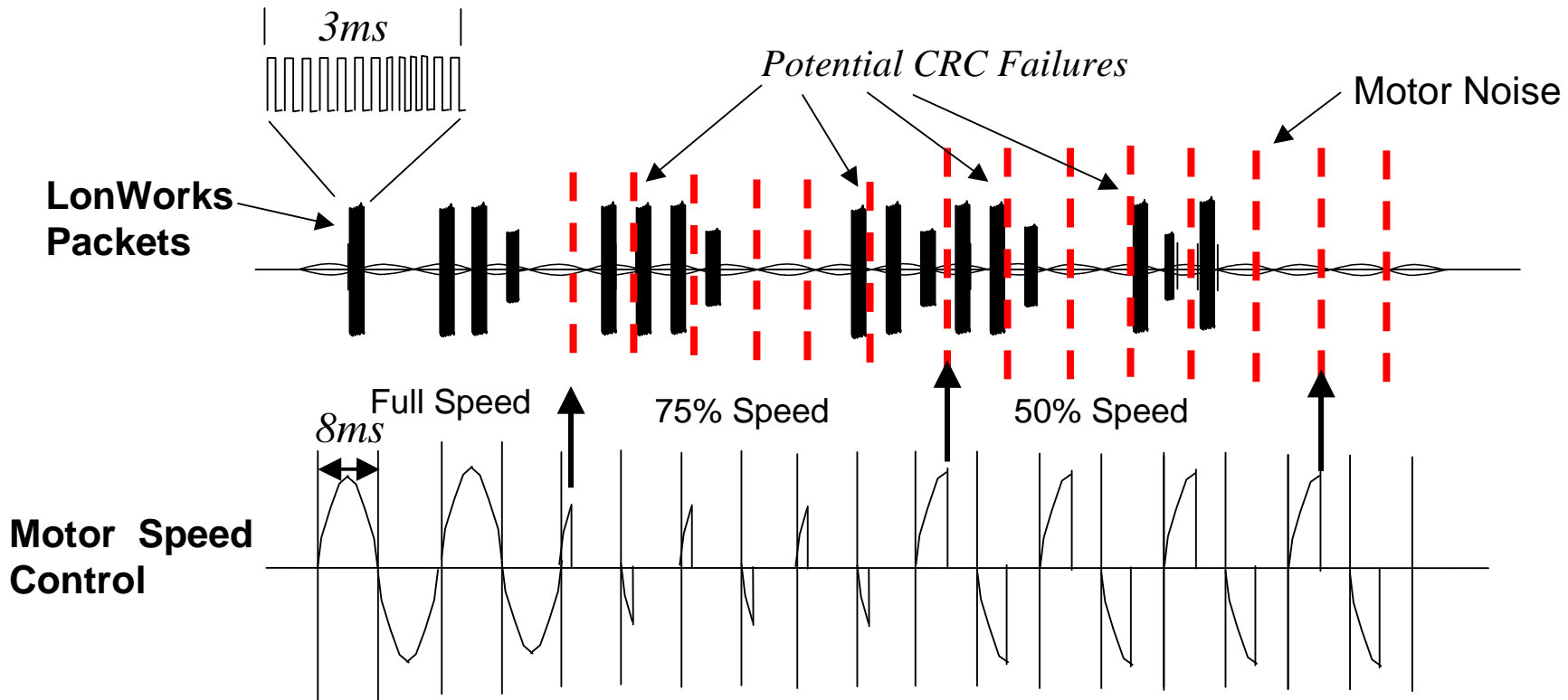
Noise



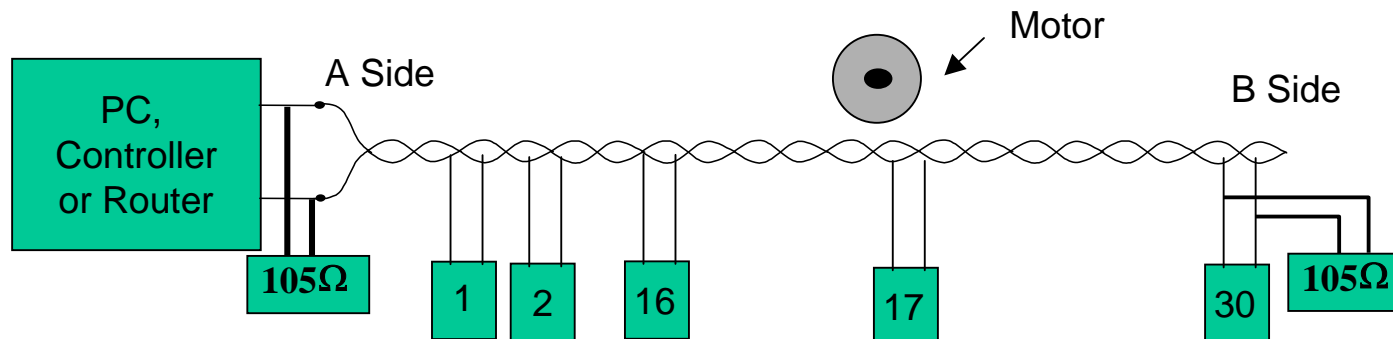
Noise – is measured as a ratio between signal-to-noise level. If the signal is 1 volt and the noise is .1 volt than the ration is 10:1. As the signal is attenuated due to: wire length to long, to many devices (loads <64) or wrong wire types (higher capacitance), and the noise stays the same, then the signal-to-noise ratio gets worst. Noise Source – Radio's Cell Phones, Solenoides, Electrical Vehicles, Electronic Ballast, corroded wire contacts, Electric Heaters, Motors and Motor Controllers



AC Noise 60 Hz / Motor Controllers

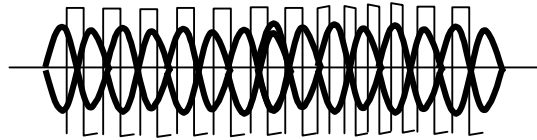


AC signal is not as much of a noise problem because the LonWorks packets are only 2-3 ms in length compared to 8ms AC time cycle. Motor speed controls are a problem because they chop the AC signal causing major spikes that are both RF radiated and coupled on the AC line.



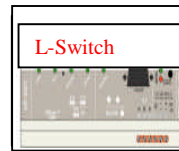
Noise Improvement Options

Before



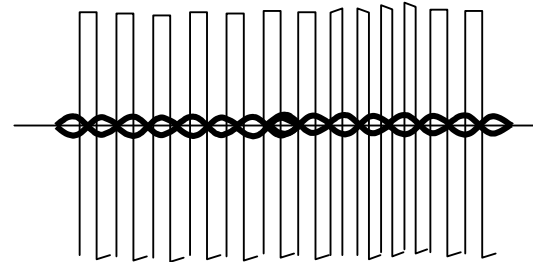
and

LS33

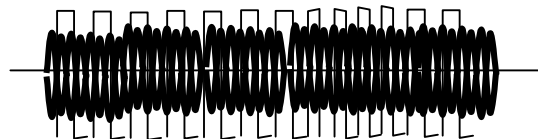


**Digital
Repeater/Router**

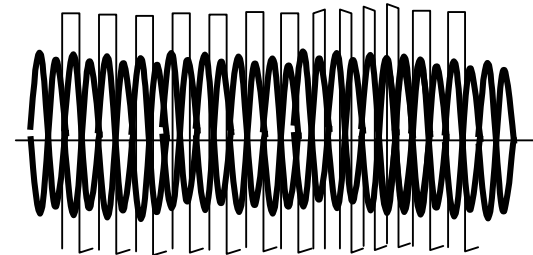
After



Receives packet, discards if corrupt, only retransmits good packets without any noise



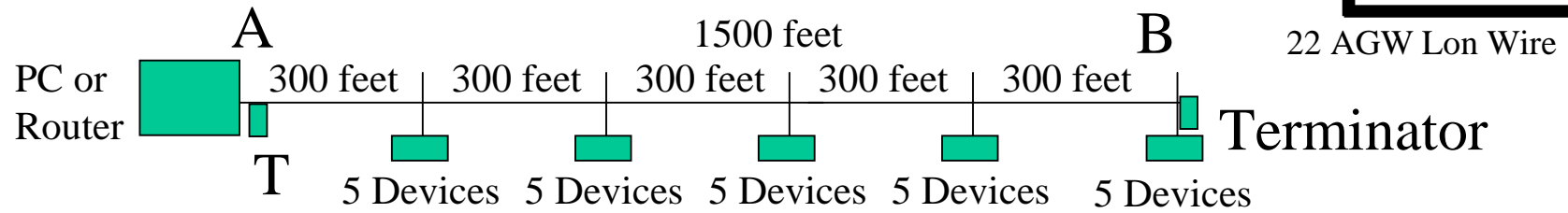
**Analog
Physical Layer Repeater**



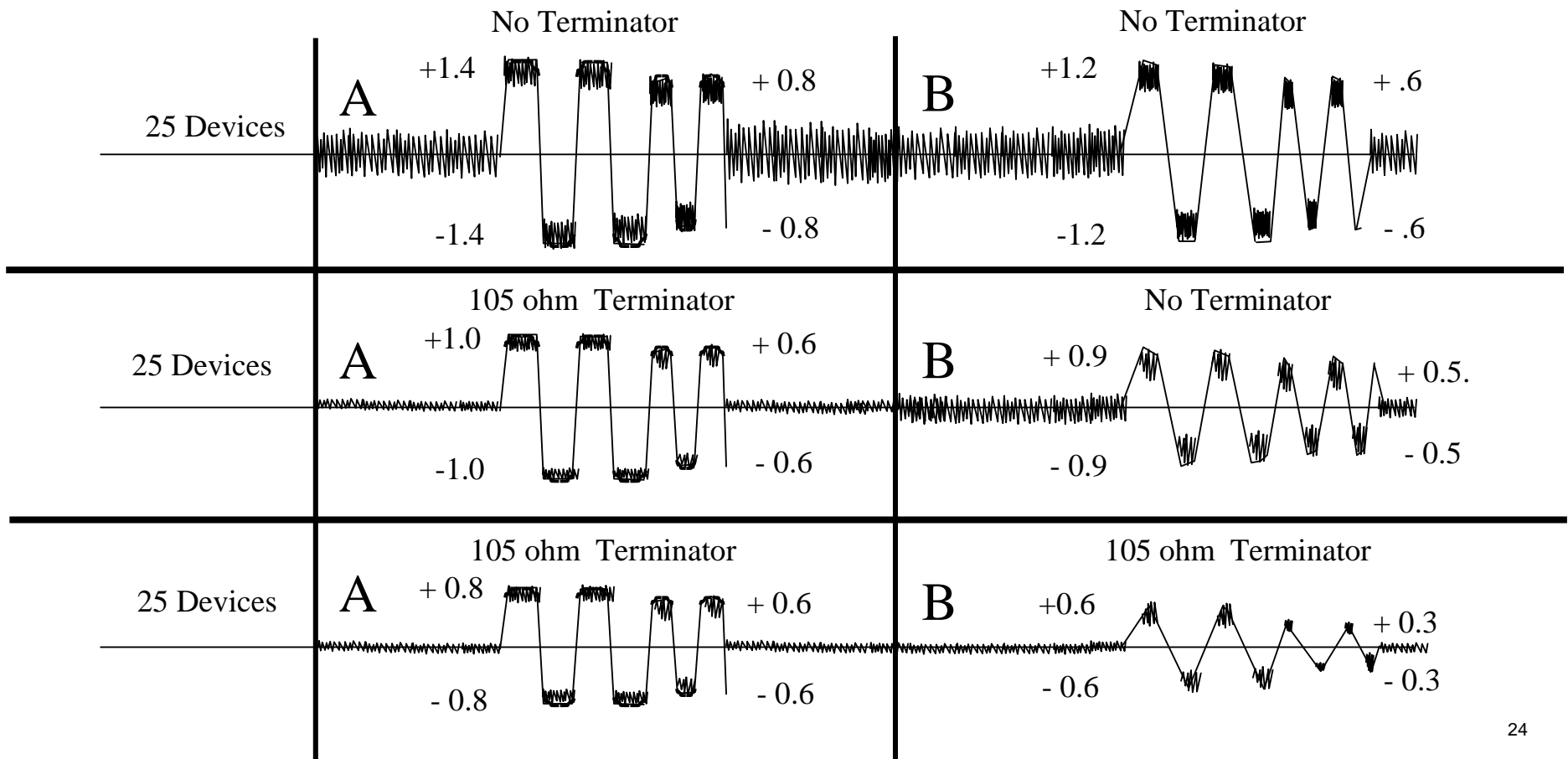
Receives packets, then Amplifies both the signal and noise, then retransmits both

For best results at improving network performance always use a Digital Router/Repeater

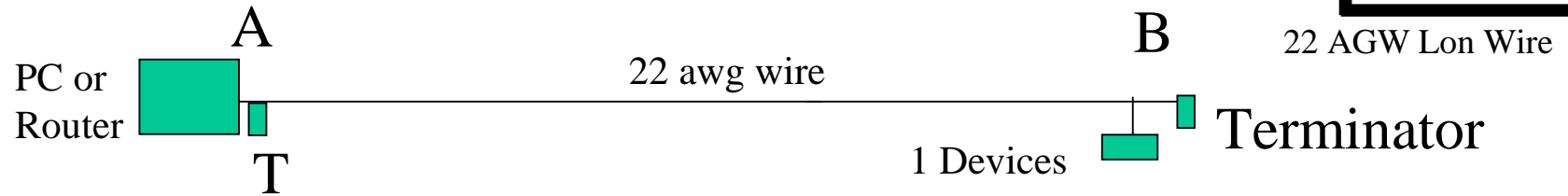
Signal Attenuation with Noise



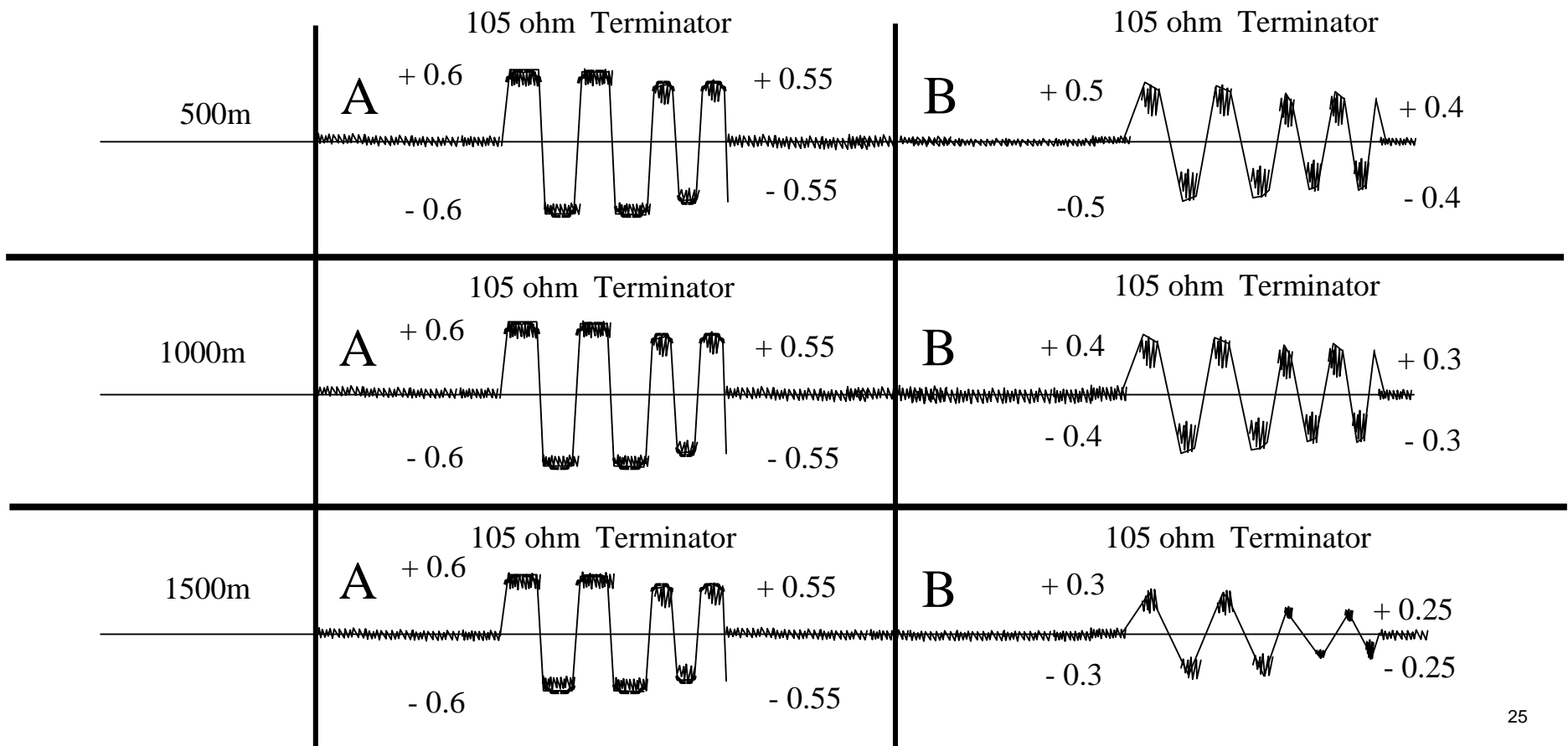
- Terminators reduce noise in-between pulses and reduce signal reflection.
- Signal Attenuation resulting from terminators, device and wrong wire(high capacitance)



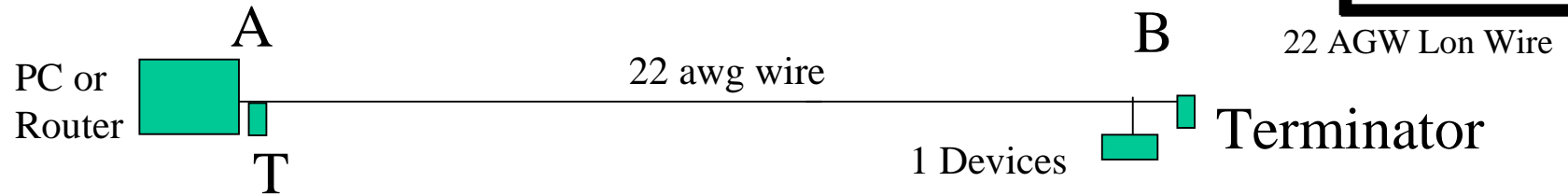
FT10 Signal Attenuation with Noise



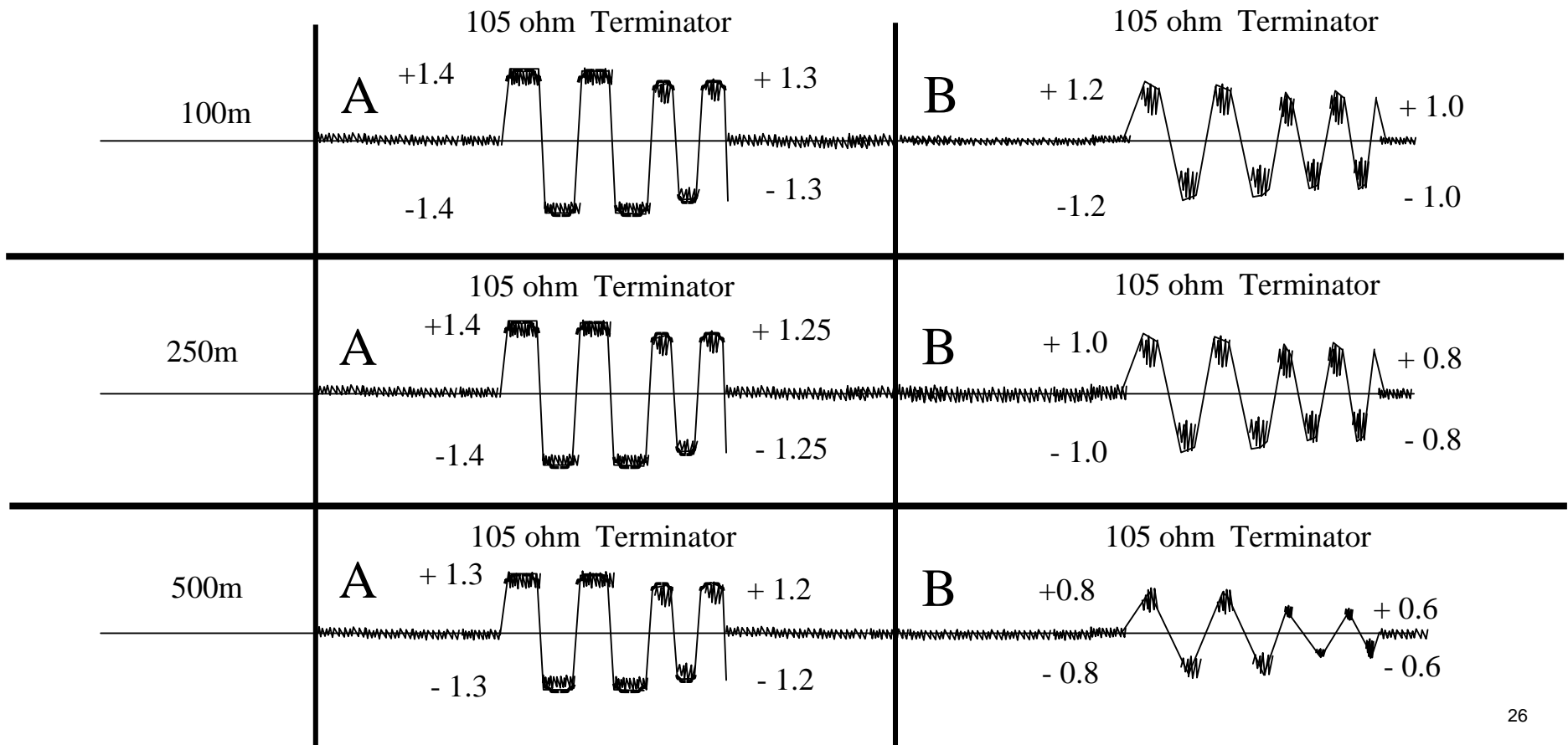
- Terminators reduce noise in-between pulses and reduce signal reflection.



TP1250 Signal Attenuation with Noise



- Terminators reduce noise in-between pulses and reduce signal reflection.



LPA Bandwidth Analysis

Low Traffic with minimal problems.

Alternate Path count 0.

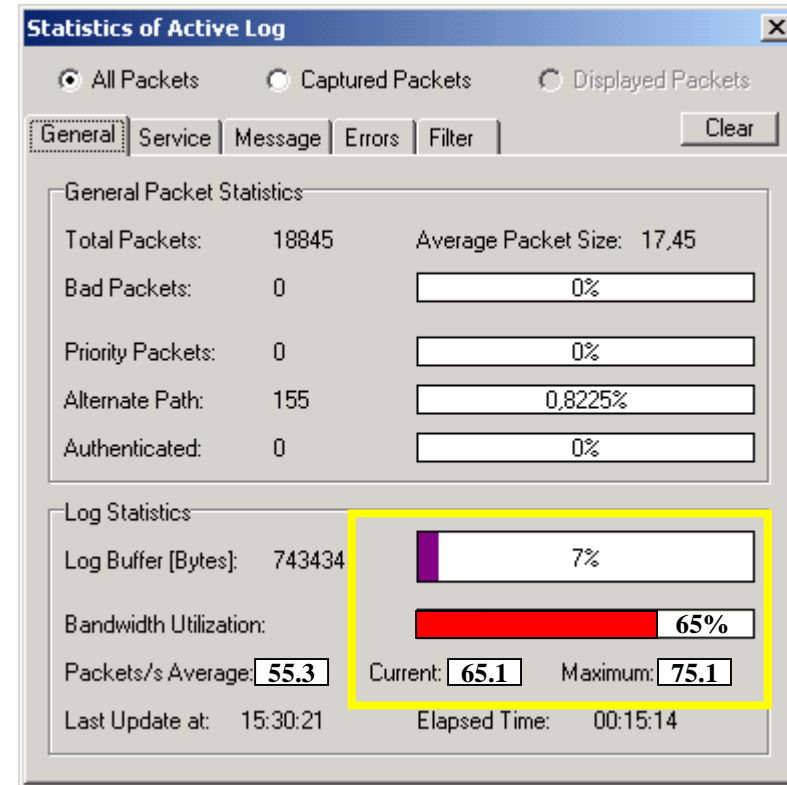
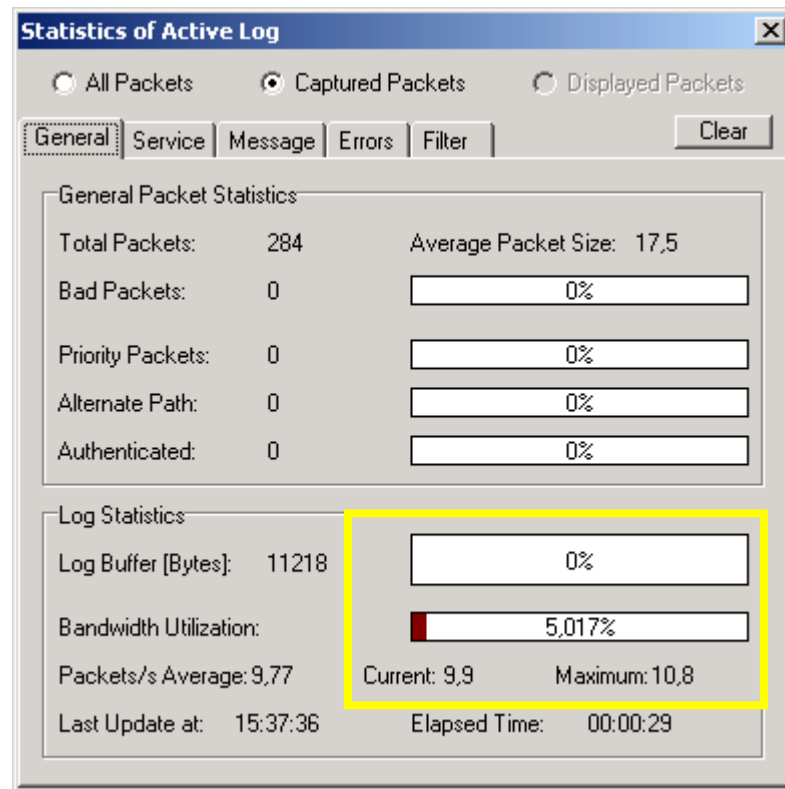
Bandwidth 5% or 10pps

Alternate Path count 155

Devices not responding back to

ACK/ACKD or Request/Response

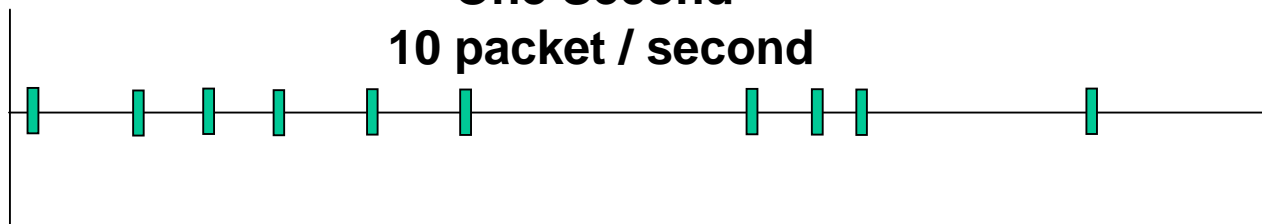
Failure due to Higher traffic



Bandwidth

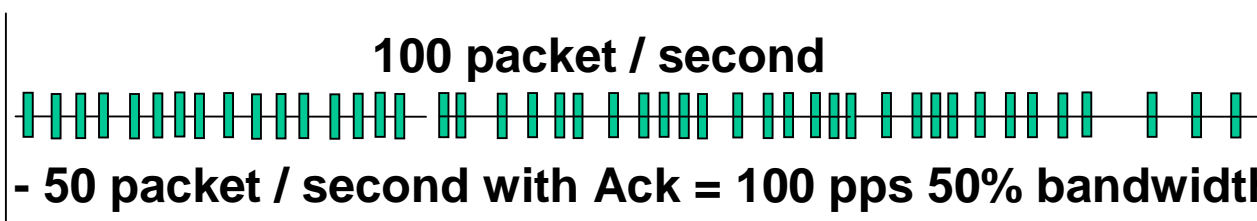
One Second

10 packet / second



$3\text{ms} * 100 = 300\text{ms}$ interpacket time $2\text{ms} * 100 = 200\text{ms}$ leaves 500ms

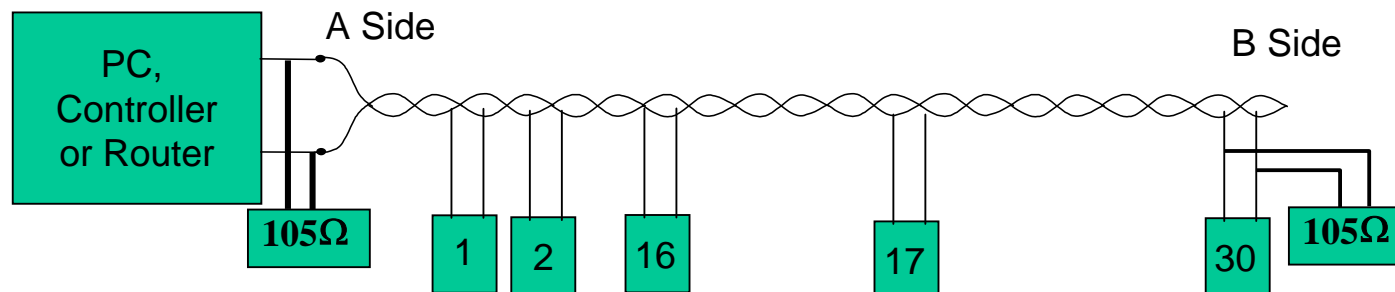
100 packet / second



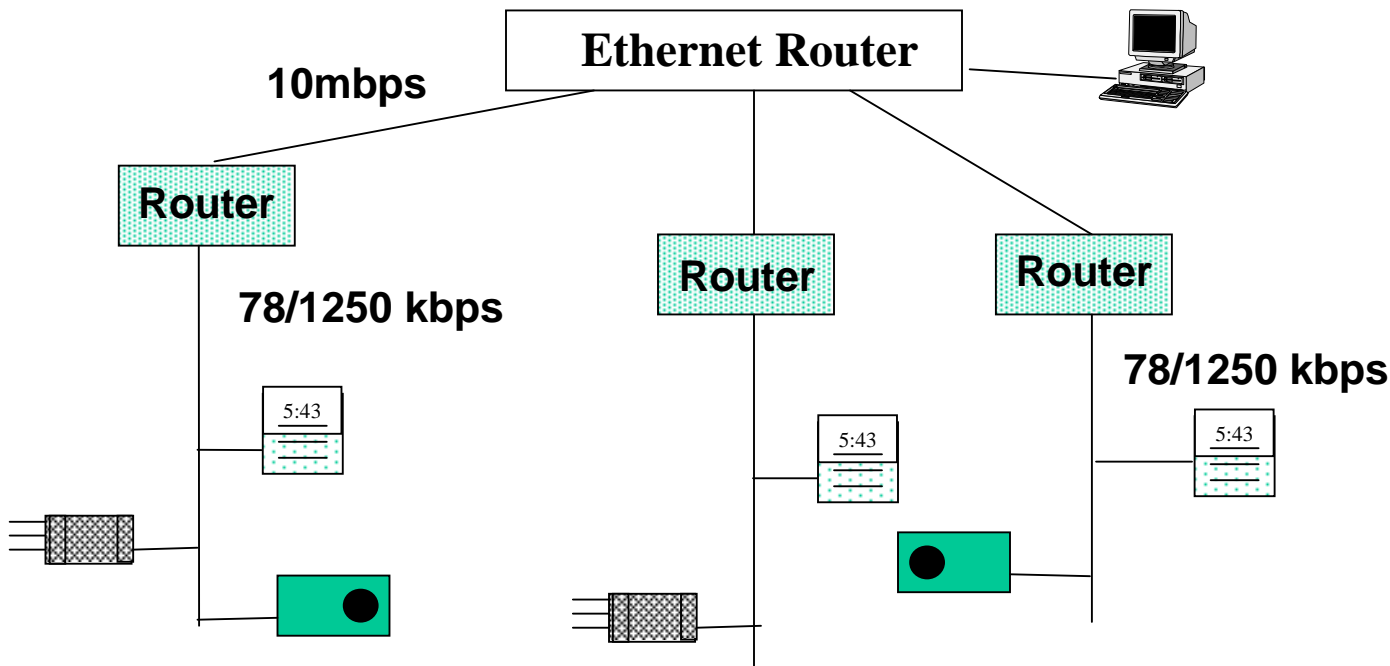
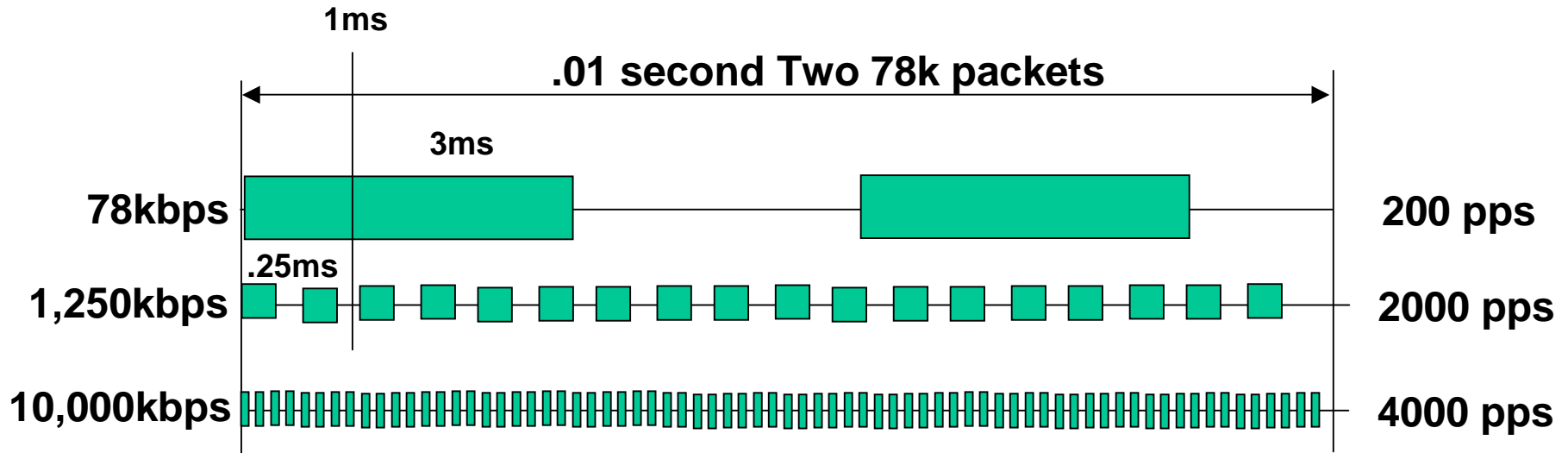
- 50 packet / second with Ack = 100 pps 50% bandwidth
- 100 pps with Ack = 200 pps 100% bandwidth

- Ackd/Ack and Req/Resp takes up 2 times Bandwidth
- High pole rate or monitoring rate causes high Bandwidth
- A device with a bad input port could cause high traffic
- Good practice is to keep bandwidth below 50% or 100pps

PC/Controller/Router



Bandwidth



The Higher the speed
The more packets can
Be transmitted.

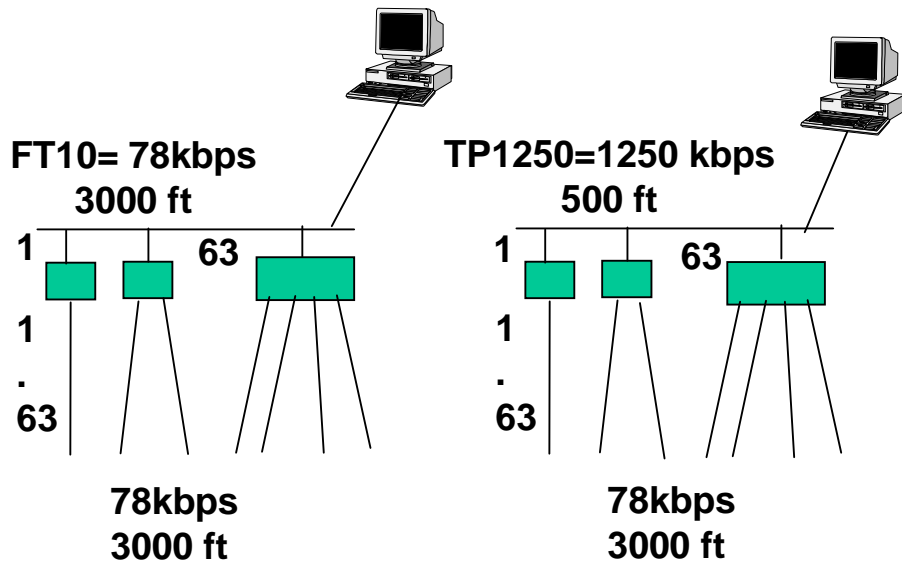
Bandwidth Router Issues

Bandwidth is determined by network speed

FT10 = 78kbps reliably @ 100pps

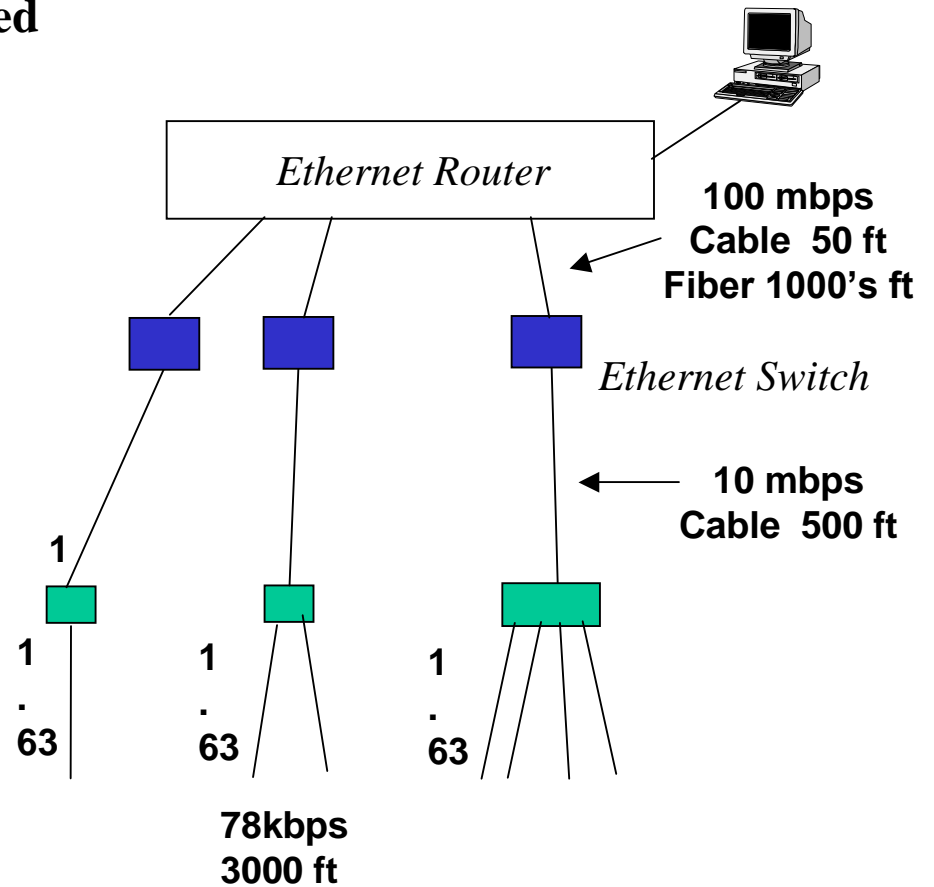
TP1250 = 1250kbps reliably @ 500pps

Ethernet = 10mbps reliably @ 2000pps



*FT10 to FT10
Lon Routers
100 pps*

*TP1250 to FT10
Lon Routers
500 pps*



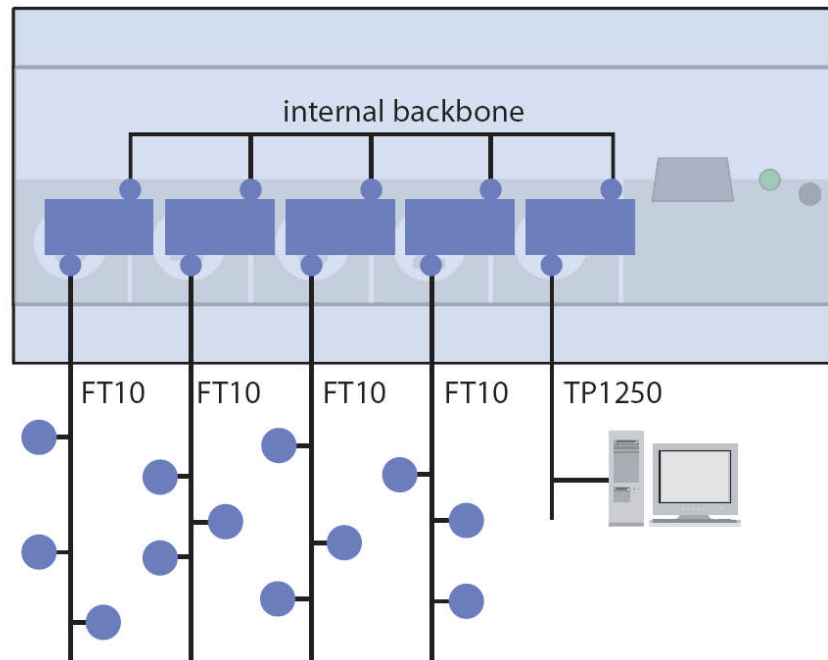
*Ethernet to FT10
Lon Routers
2000 pps*

Loytec Routers (L-Switches)

Multi-port Router



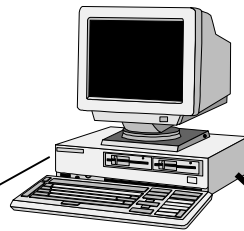
- ① **Communication between the FTT-10 Channels with internal 1250kbs backbone**
- ① **Reduces traffic on TP1250 Port**



Bandwidth Router Issues

Ch. 2 = 50pps $\frac{1}{2}$ up = 25pps
 Ch. 3 = 50pps $\frac{1}{2}$ up = 25pps
 Ch. 1 = down 50pps + up 50pps = 100pps
This network is past safe operation

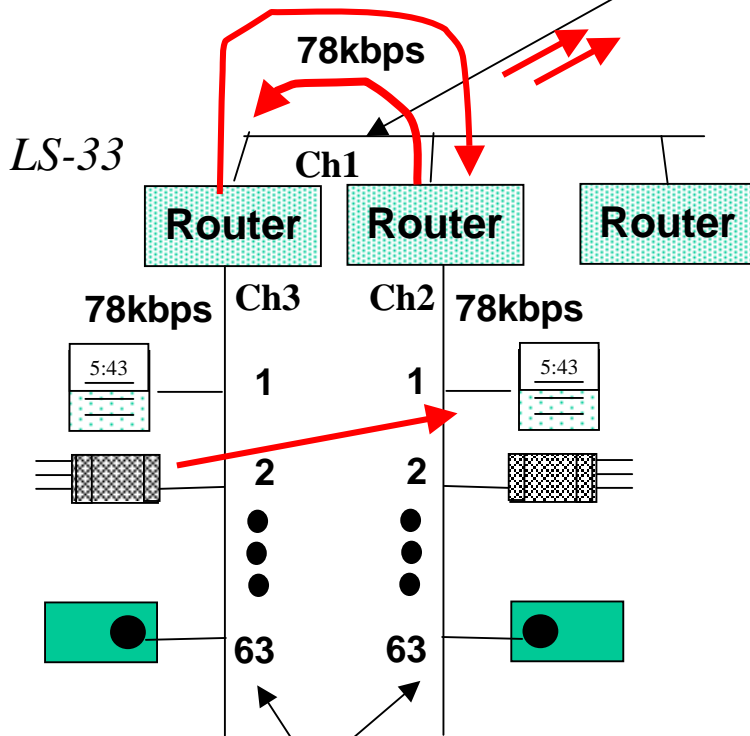
Ch. 3 = 50pps $\frac{1}{2}$ up = 25pps
 Ch. 4 = 50pps $\frac{1}{2}$ up = 25pps
 Ch. 2 = down 100pps + up 50pps = 150pps
This network has lots of extra bandwidth



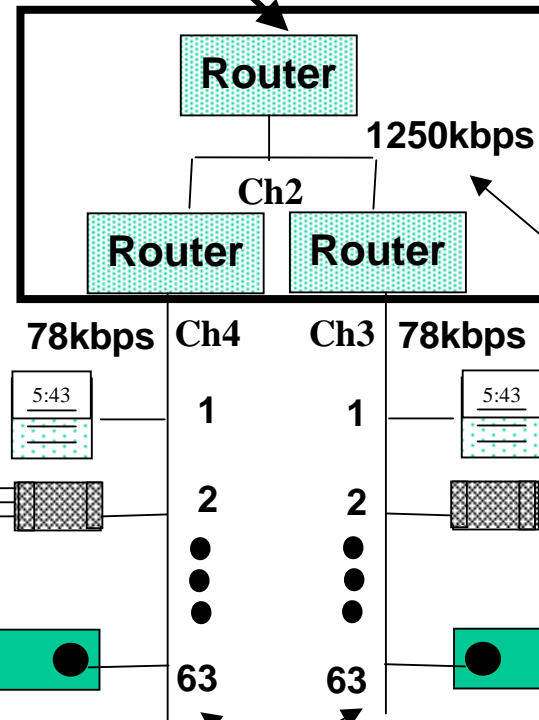
1250kbps

Ch1

LS-13300 multi Channel Router



FT10 = 78kbps
 50pps = 25%
 100pps = 50%
 200pps = 100%



FT10 = 78kbps
 50pps = 25%
 100pps = 50%
 200pps = 100%

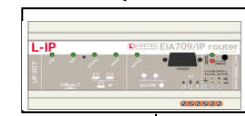
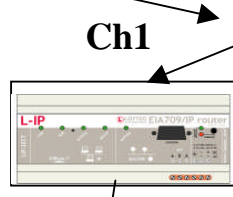
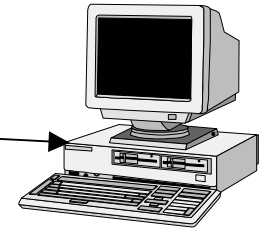
1250kbps
 500pps = 50%
 1000pps = 100%

Traffic going from Ch3 to Ch4 across Ch2 is not seen By Ch 1 and the PC

Bandwidth Router Issues

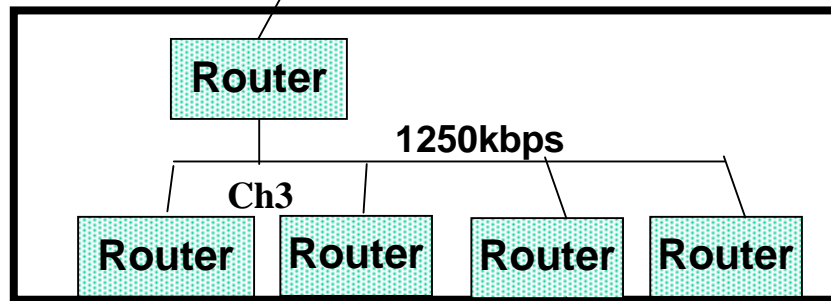
IP = Ethernet
10,000 kbps or 10Mbps
 2000pps = 50%
 4000pps = 100%

Ethernet Switch or Router

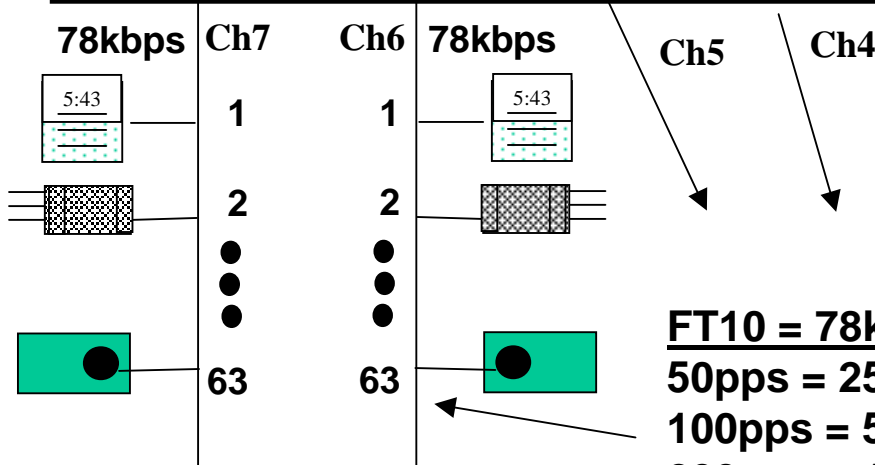


LIP-3ECT Router

1250kbps
 500pps = 50%
 1000pps = 100%

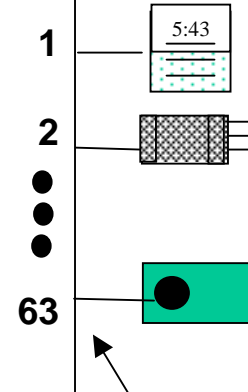


LS-13333 multi Channel Router



FT10 = 78kbps
 50pps = 25%
 100pps = 50% Optimum
 200pps = 100%

Ch9 78kbps



FT10 = 78kbps
 50pps = 25%
 100pps = 50%
 200pps = 100%

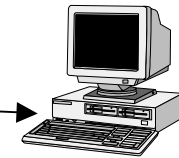
Bandwidth Router Issues

IP = Ethernet

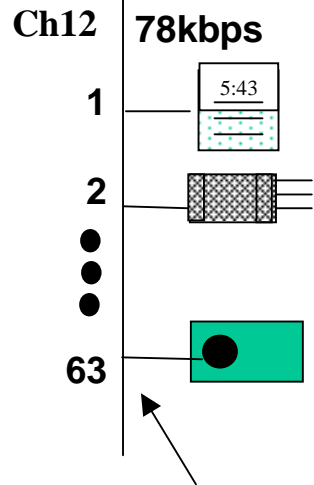
10,000 kbps or 10Mbps

2000pps = 50%

4000pps = 100%



LIP-3ECT
Router



FT10 = 78kbps

50pps = 25%

100pps = 50%

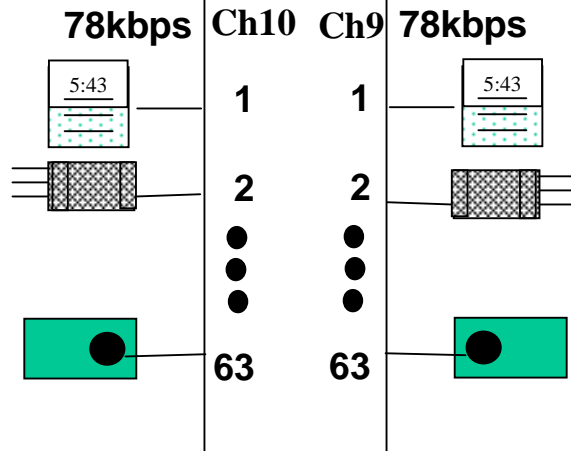
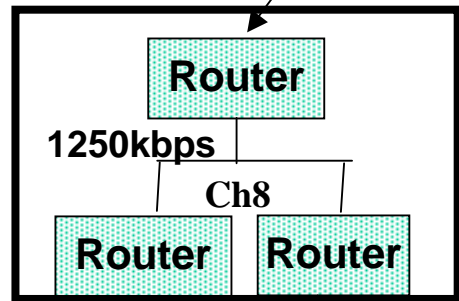
200pps = 100%

Ethernet Switch or Router

Ch11

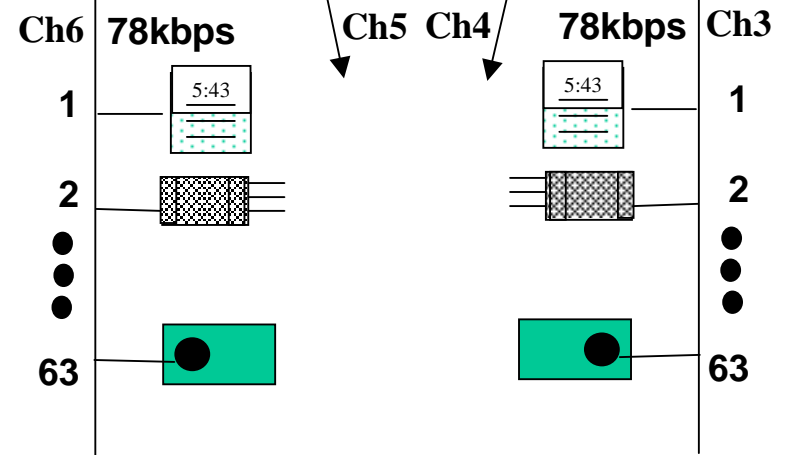
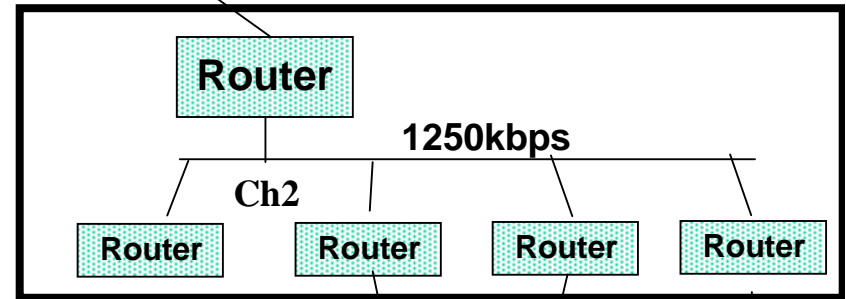
LIP-33ECT
Router

Ch7

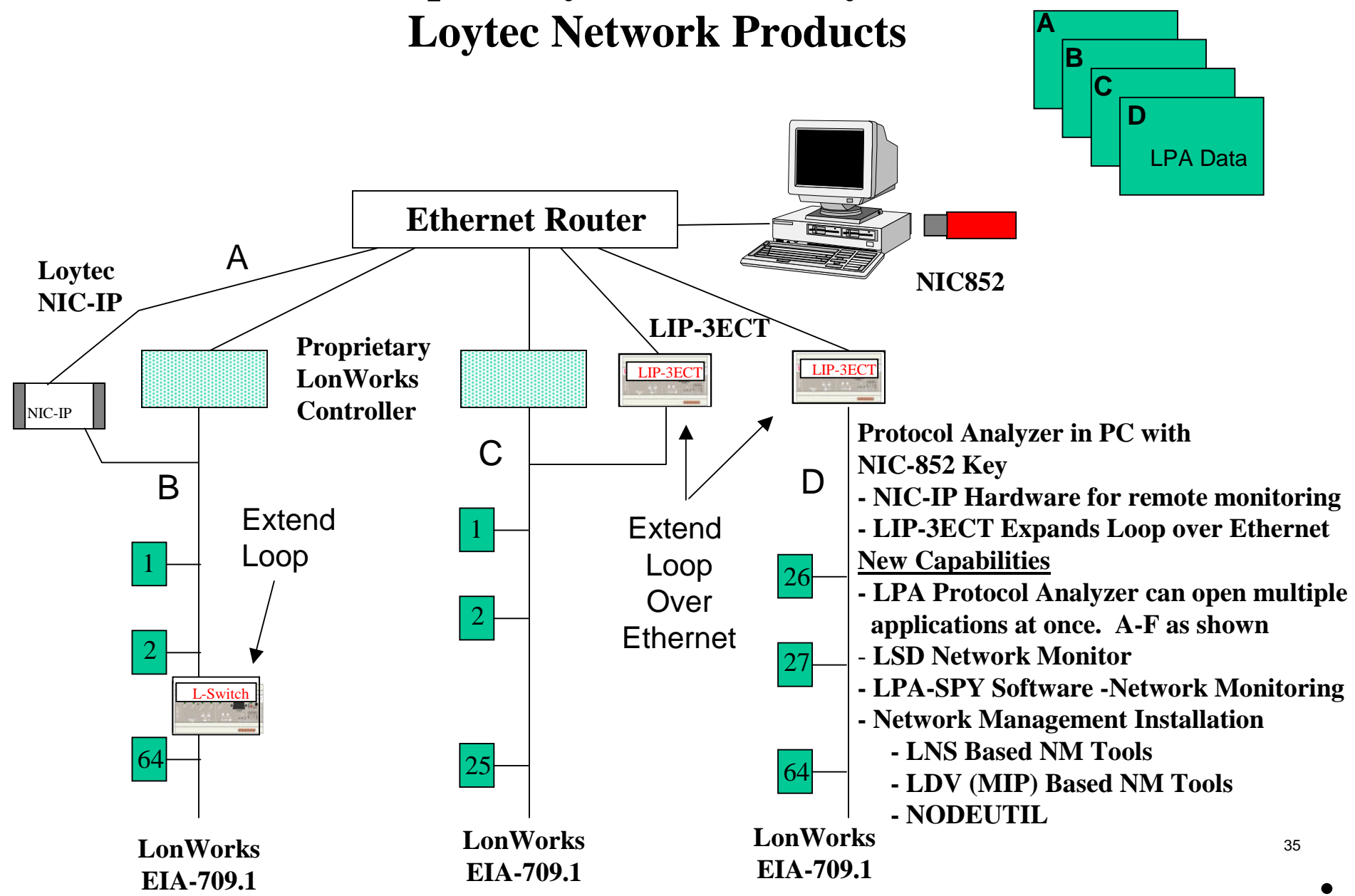


LIP-3333ECT
Router

Ch1

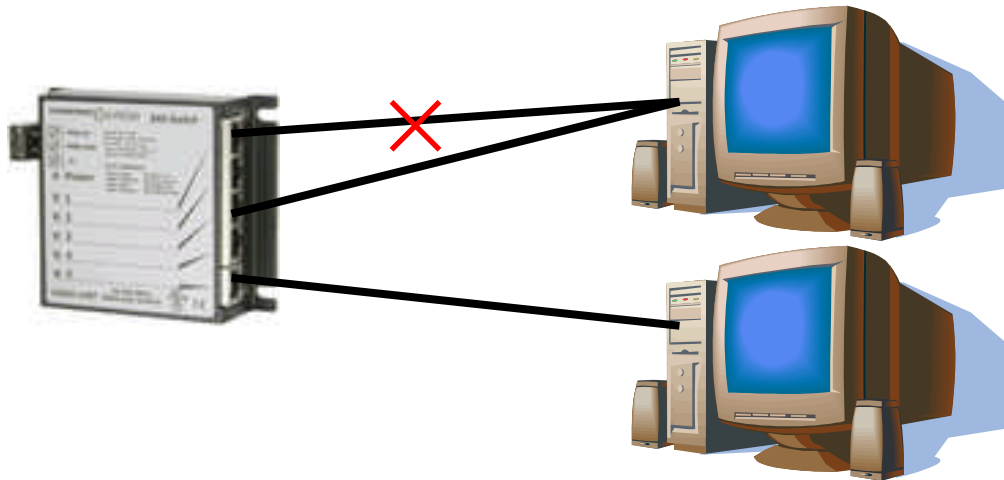


Proprietary LonWorks System Loytec Network Products



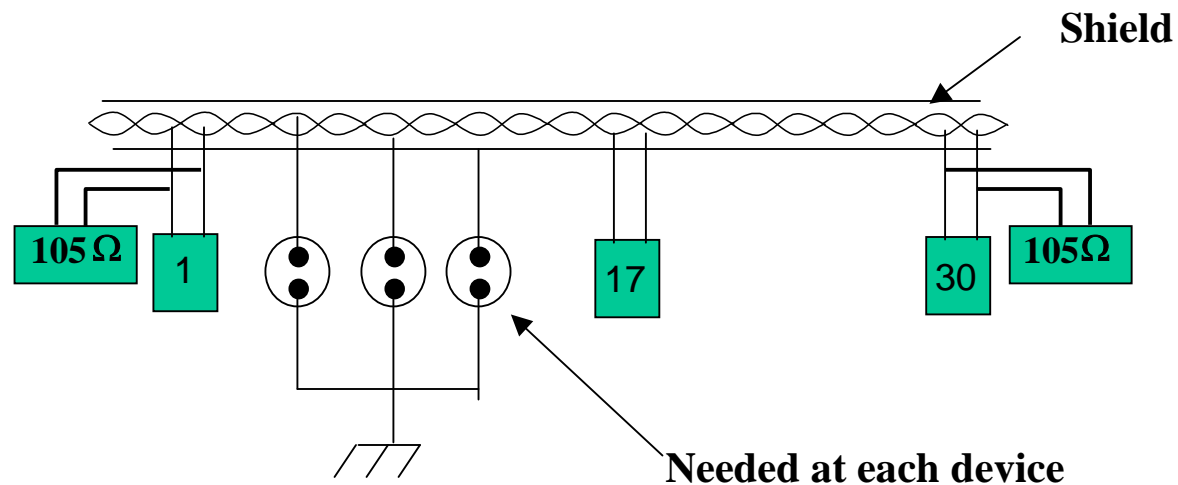
IP Networking Issues

- Switch Address Table
 - Switches learn where devices are located
 - They “forget” in 5 minutes
 - If you swap cables – power cycle switch



Lightning Protection

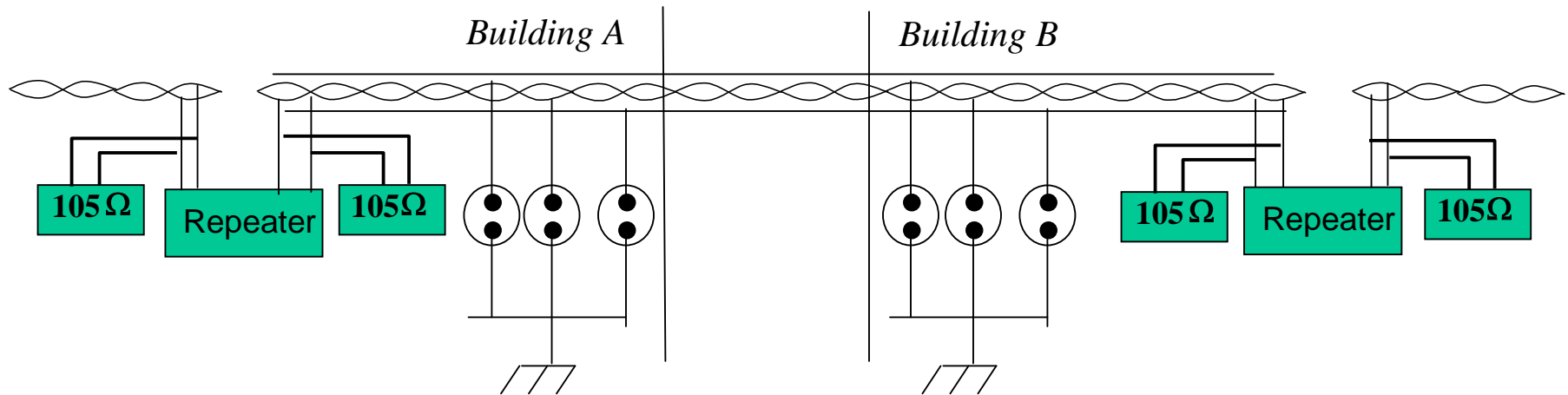
When the network data line extends outside of a building or grounded structure, every FTT10 and FT1250 device on the network segment whether located indoors or outdoors, must be equipped with surge protection circuitry. In addition, protection devices must be added to the network at every point where the network cable exits the building or structure



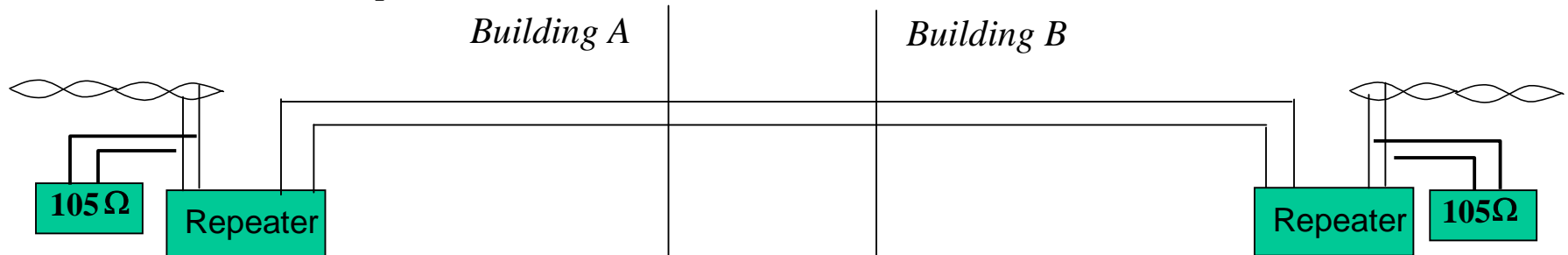
Lightning Protection

Since putting lightning protection at each device is impractical, there are two other Approaches. One is to add a Lon repeater at the each building site the other a Fiber Repeater

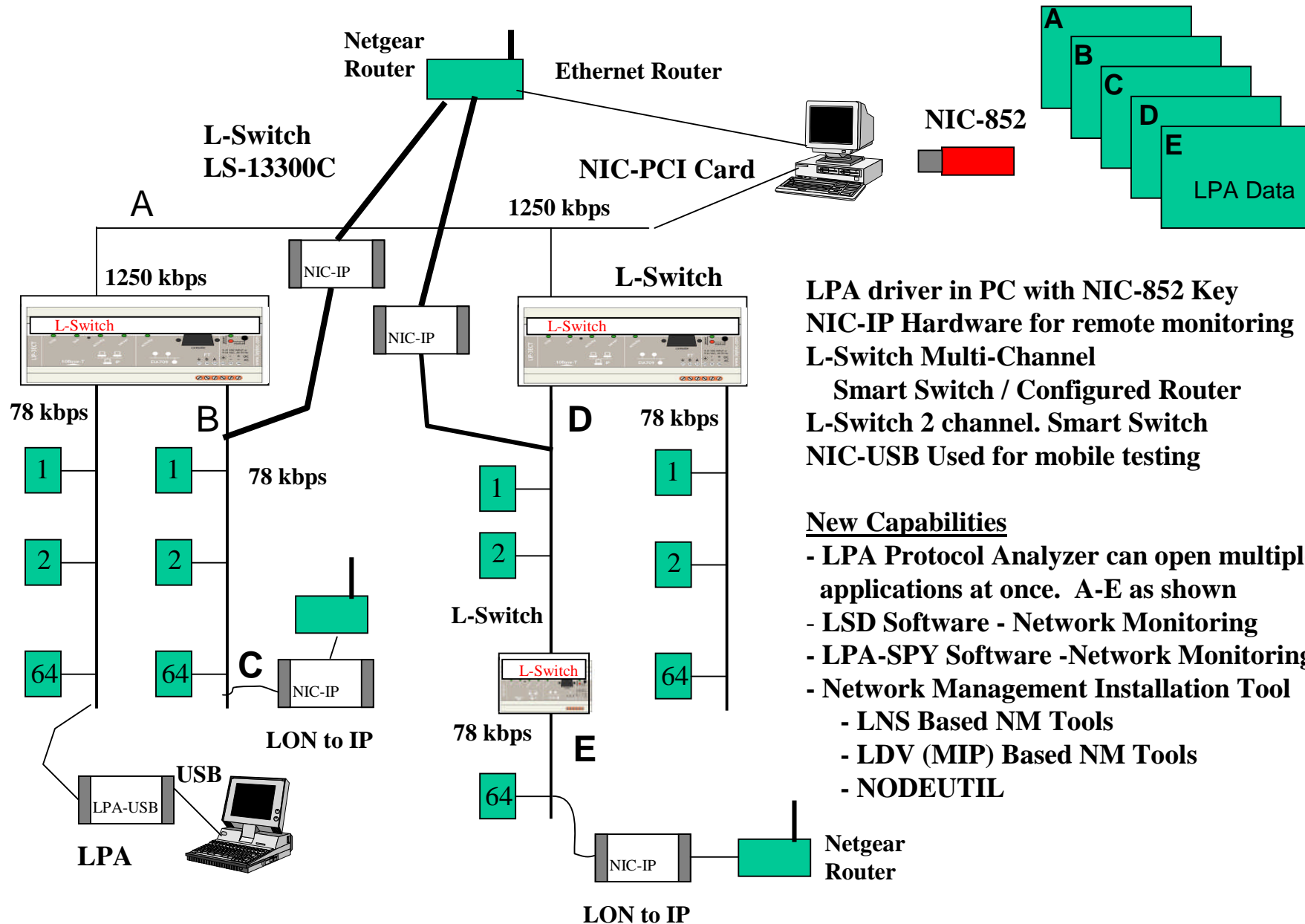
Lon Repeaters (LS-33)



Fiber Repeaters



Different LPA Solutions

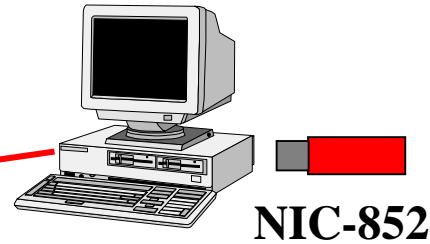
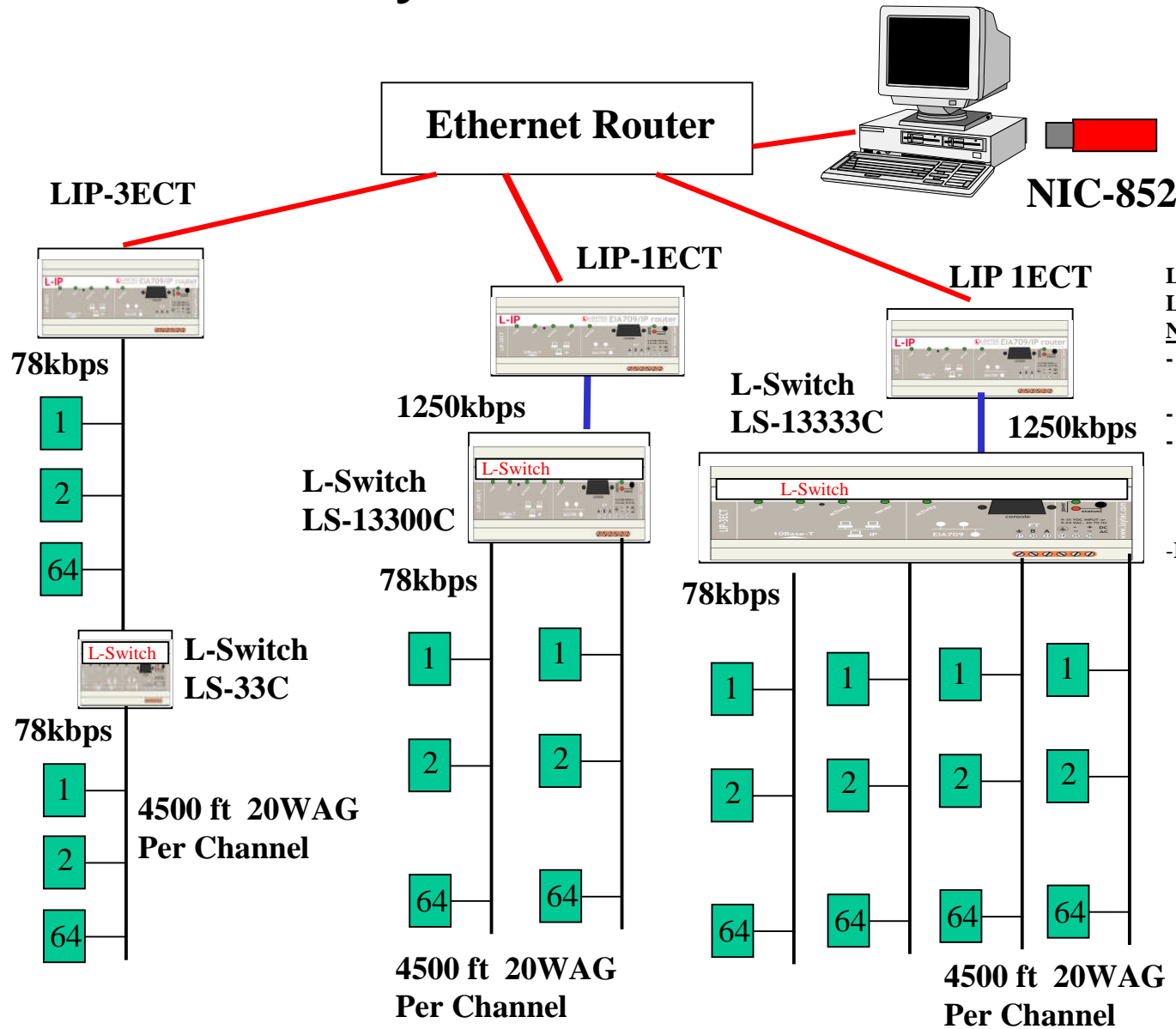


LPA driver in PC with NIC-852 Key
NIC-IP Hardware for remote monitoring
L-Switch Multi-Channel
Smart Switch / Configured Router
L-Switch 2 channel. Smart Switch
NIC-USB Used for mobile testing

New Capabilities

- LPA Protocol Analyzer can open multiple applications at once. A-E as shown
- LSD Software - Network Monitoring
- LPA-SPY Software -Network Monitoring
- Network Management Installation Tool
 - LNS Based NM Tools
 - LDV (MIP) Based NM Tools
 - NODEUTIL

Loytec Product Solutions



LNS Manager
Protocol Analyzer
NodeUtil

- Loytec driver in PC with NIC-852 Key
 L-IP Routers and L-Switch Routers
New Capabilities
- LPA Protocol Analyzer of Channels
 Both LonWork and Ethernet
 - LSD Network Monitor
 - Network Management Installation
 - LNS Based NM Tools
 - LDV (MIP) Based NM Tools
 - NUTIL
 - Router Server Config Table
 in one L-IP

Discussion

Loytec Products



<u>Number</u>	<u>Description</u>	<u>Compatible</u>
<u>ANSI/EIA709 Routers</u>		
LS-33CB	2 x TP/FT-10	LPR10
LS-13CB	1 x TP/FT-10 , 1 x TP/XF-1250	LPR12
LS-11CB	2 x TP/XF-1250	LPR15
LS-13300C(B)	1 x TP/XF-1250, 2 x TP/FT-10	
LS-33300C(B)	3 x TP/FT-10	
LS-13333C(B)	1 x TP/XF-1250, 4 x TP/FT-10	
<u>ANSI/EIA-709 to EIA-852 IP Routers</u>		
LIP-1ECTB	1 x IP-852 (Ethernet), 1 x TP/XF-1250	iLON600
LIP-3ECTB	1 x IP-852 (Ethernet), 1 x TP/FT-10	iLON600
LIP-33ECTB	1 x IP-852 (Ethernet), 2 x TP/FT-10	= 2-iLON600
LIP-3333ECTB	1 x IP-852 (Ethernet), 4 x TP/FT-10	= 4-iLON600
LIP-3ECRB	1 x IP-852 (Ethernet), 1 x TP/FT10 w. Redundancy	
<u>Network Interface Products</u>		
NIC709-PCI	PCI Bus to TP/FT-10, TP/XF-1250 and TP/RS-485	PCLTA-21
NIC709-USB	USB to TP/FT-10, TP/XF-1250 and TP/RS-485	U10/U20
NIC709-IP1E	Ethernet to TP/XF-1250 Network Interface	iLON10
NIC709-IP3E	Ethernet to TP/FT-10 Network Interface	iLON10
NIC852	Ethernet IP-852 Network Interface	
<u>Protocol Analyzer Package (LPA)</u>		
LPA-SET-USB	NIC709-USB + NIC852 + LPA-Software Protocol Analyzer Kit	
LPA-SW	LPA-Software for NIC709 Interface Products	LonScanner
<u>Other Products</u>		
LVIS-3E100	Color TFT Touch Display with GUI	
LP-13333C	Multi Port Gateway 1-TP/XF-1250/4-FT10	
LT-33	Dual Terminator FT10/TP78	
LT-13	Dual Terminator FT10/TP/XF-1250	

Further information and Software-Updates

<http://www.loytec.com>

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