Ethernet Protection - Latest Standards Work Update

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Evolving Ethernet Applications Have Resulted in Protection Challenges

Ethernet Protection

Yesterday vs Today

- Originally – business only
  - an intra-building computer data interface used for interconnect and LAN applications transported by coax or twisted pair in a star or ring configuration.
- Today – business and residential!
  - Generally uses unshielded Cat 5 or higher twisted pair cable
  - Various Ethernet technologies are quickly becoming the primary interface for short-haul telecommunications and video transport.
  - Residential deployments expanding exponentially with possible exposure to induced lightning, lightning related GPR.

Ethernet Protection

Ethernet Today (cont)

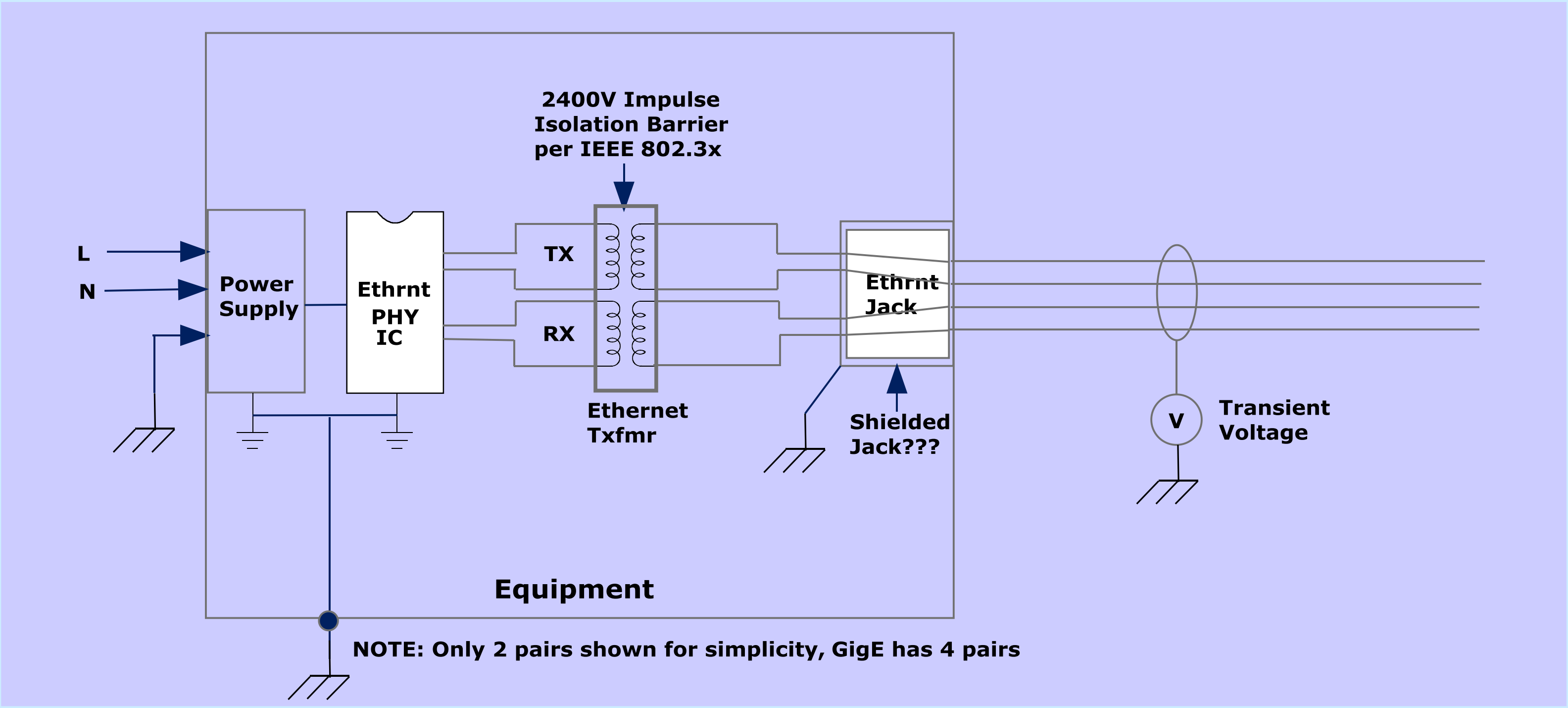
- **Residential deployments increase possible exposure to overvoltages from AC distribution wiring in walls compared to a business environment.**
- **Cell site communications between cabinets and buildings**
- **Fiber to the neighborhood (node), Ethernet to home (ONT's)**
- **POE including Ethernet Traffic security cameras on poles (lightning rods).**
- **Wi-max applications (Ethernet running around in attics connected to an antenna)**

Protection techniques and understanding applications is now essential to the design and the of the protection opf modern Ethernet interfaces!!!

Ethernet Protection

The Physical Side
(what are we needing to protect?)

Typical Schematic

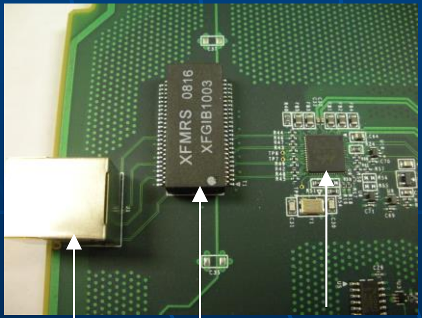

2400V Impulse Isolation Barrier per IEEE 802.3x
L
N
Power Supply
Ethrnt PHY IC
TX
RX
Ethernet Txfmr
Ethrnt Jack
Shielded Jack???
V
Transient Voltage
Equipment
NOTE: Only 2 pairs shown for simplicity, GigE has 4 pairs

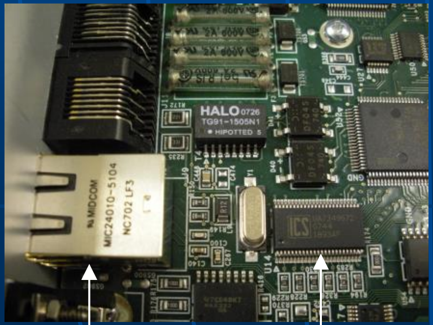
Ethernet Protection

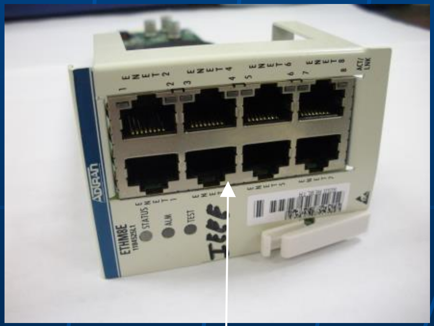
The Physical Side

(what are we needing to protect?)

- **Physical connection point (8 pin modular jack)**
- **Transformer**
- **Tertiary Protection**
- **PHY (Ethernet Integrated Circuit)**


XFMRS 0816
XFGIB1003
PHY
Txfmr
Jack

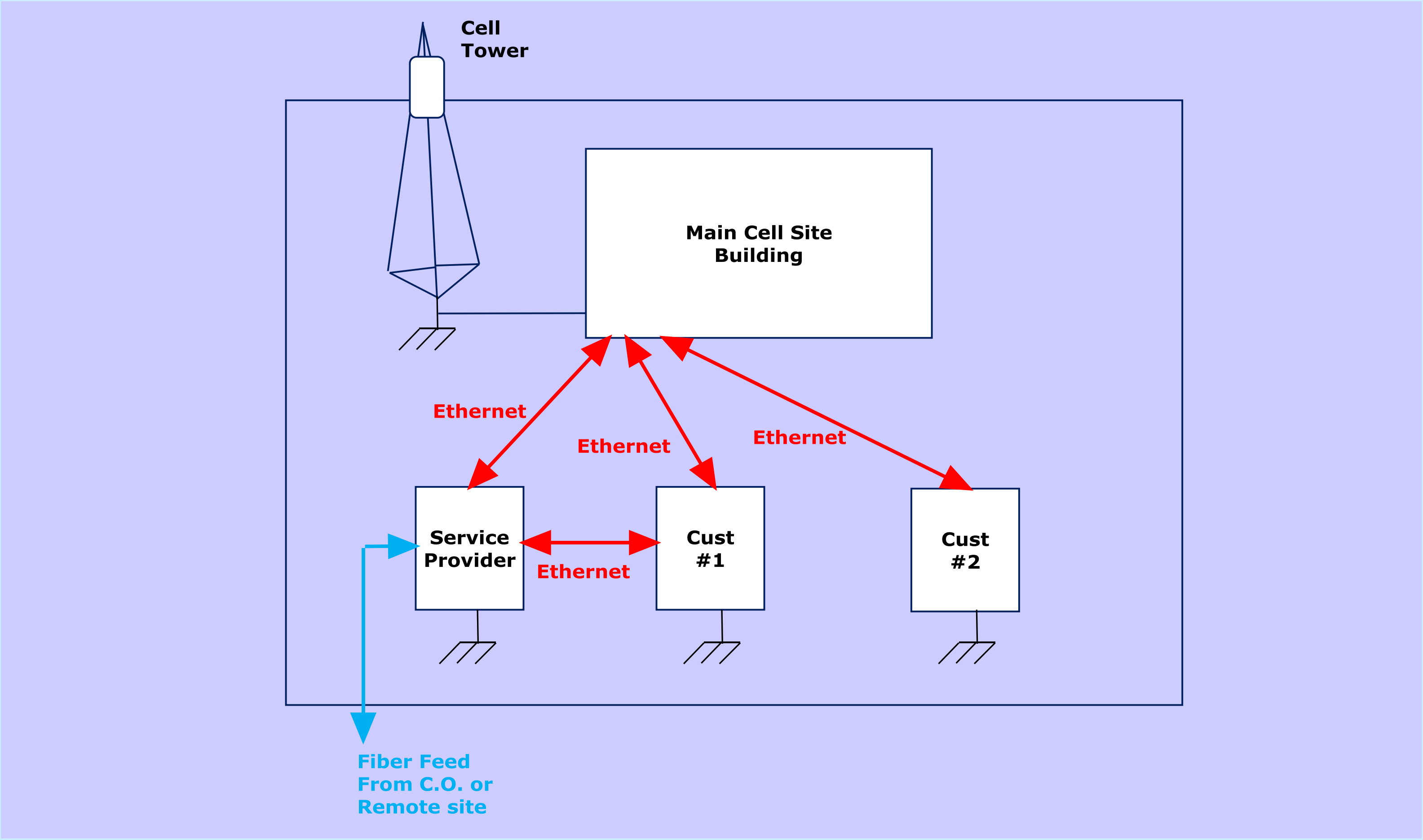

HALO
Jack/Txfmr
PHY


8 Port Integrated
Jack/Txfmr/LEDS

BROADCOM
8 Port PHY

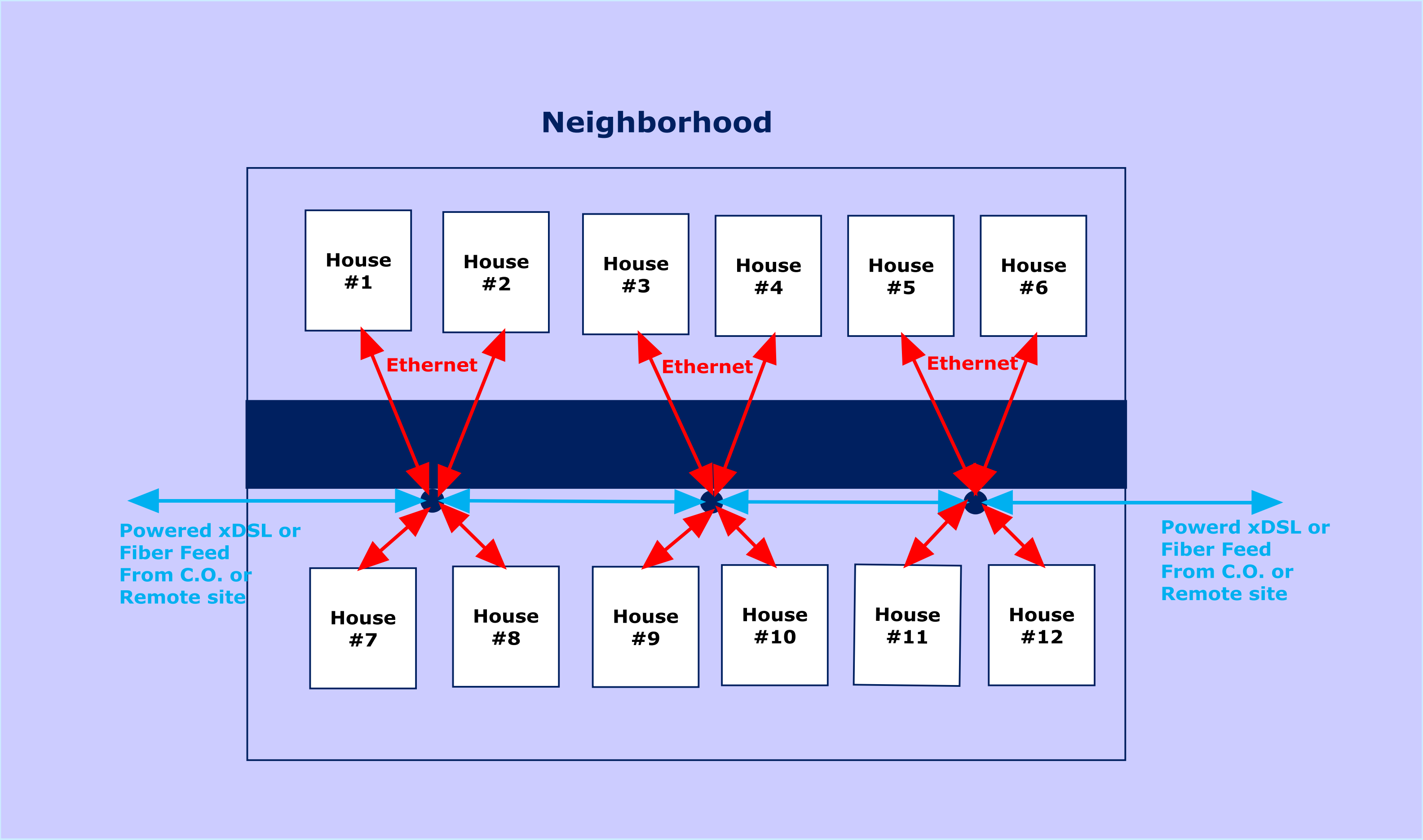
Evolving Ethernet Applications

Examples of Modern Deployments and the Challenges They Create!!!!!!!


Cell Tower
Main Cell Site Building
Ethernet
Ethernet
Ethernet
Service Provider
Ethernet
Cust #1
Cust #2
Fiber Feed From C.O. or Remote site

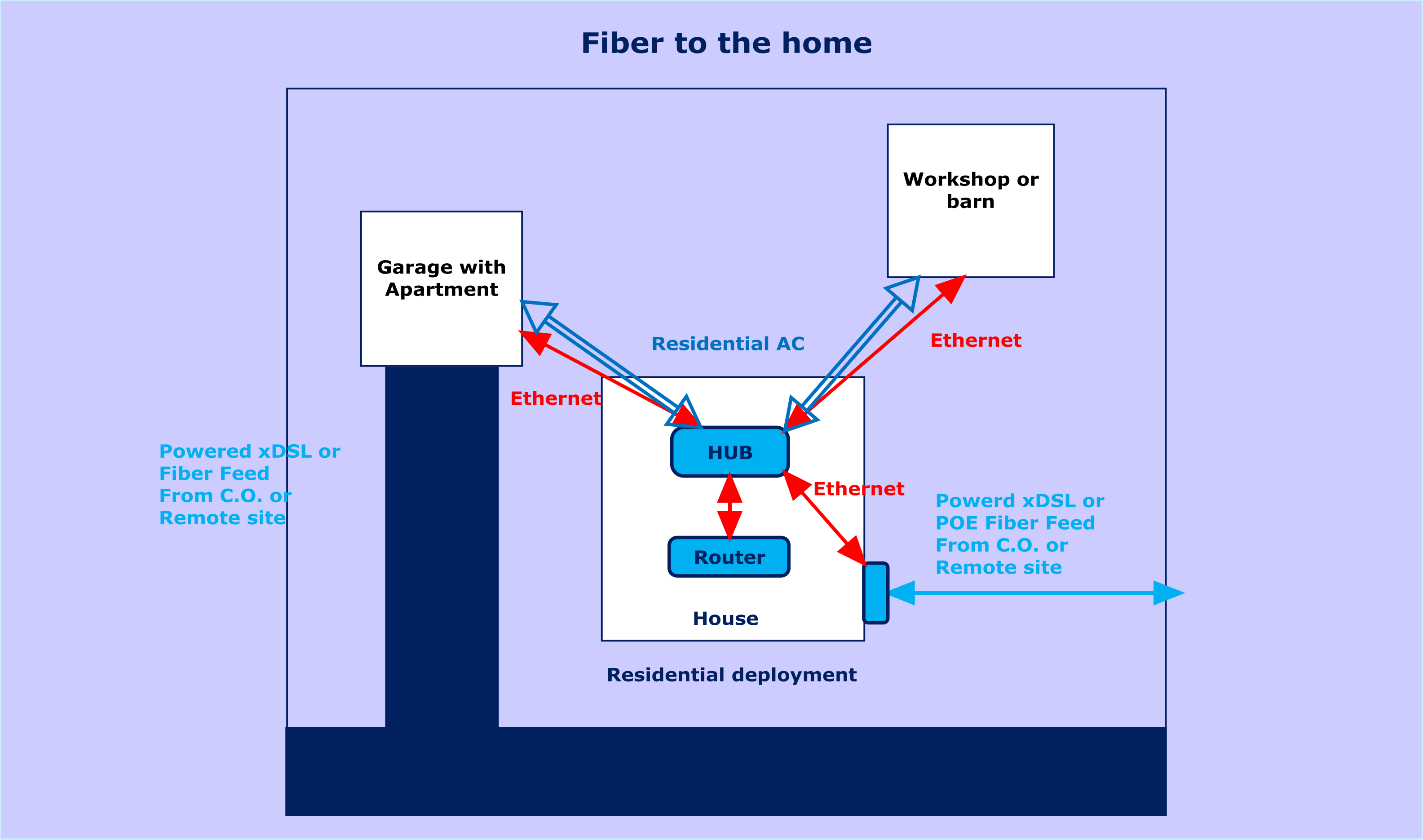
Evolving Ethernet Applications

Examples of Modern Deployments and the Challenges They Create (cont.)


Neighborhood
House #1
House #2
House #3
House #4
House #5
House #6
Ethernet
Ethernet
Ethernet
Powered xDSL or Fiber Feed From C.O. or Remote site
Powerd xDSL or Fiber Feed From C.O. or Remote site
House #7
House #8
House #9
House #10
House #11
House #12

Evolving Ethernet Applications

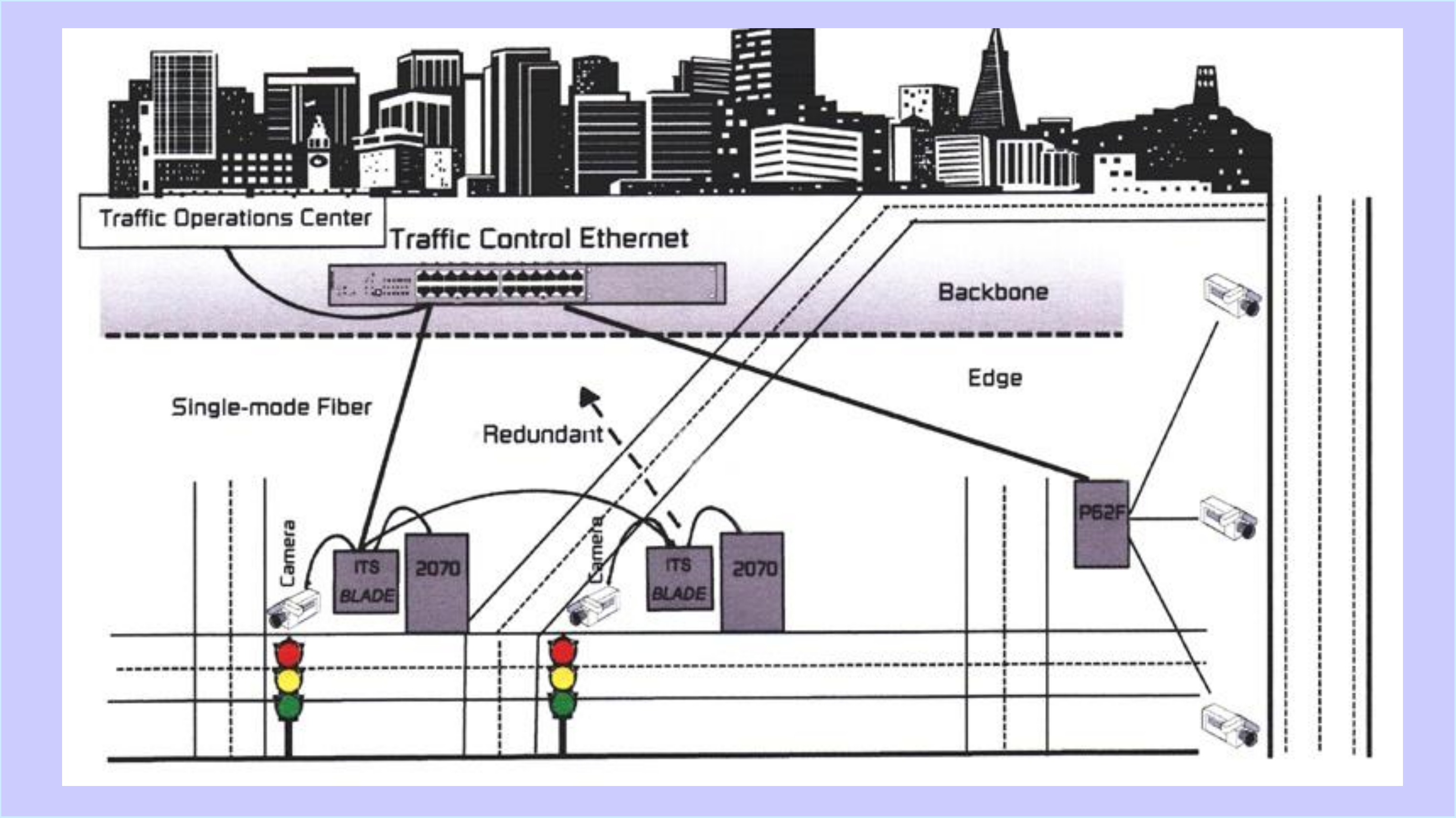
Examples of Modern Deployments and the Challenges They Create (cont.)


Fiber to the home
Workshop or barn
Garage with Apartment
Residential AC
Ethernet
Ethernet
HUB
Ethernet
Router
House
Powered xDSL or Fiber Feed From C.O. or Remote site
Powerd xDSL or POE Fiber Feed From C.O. or Remote site
Residential deployment

Evolving Ethernet Applications

Examples of Modern Deployments and the Challenges They Create (cont.)

UGH (Lightning rods)!!!!!!!!!!!

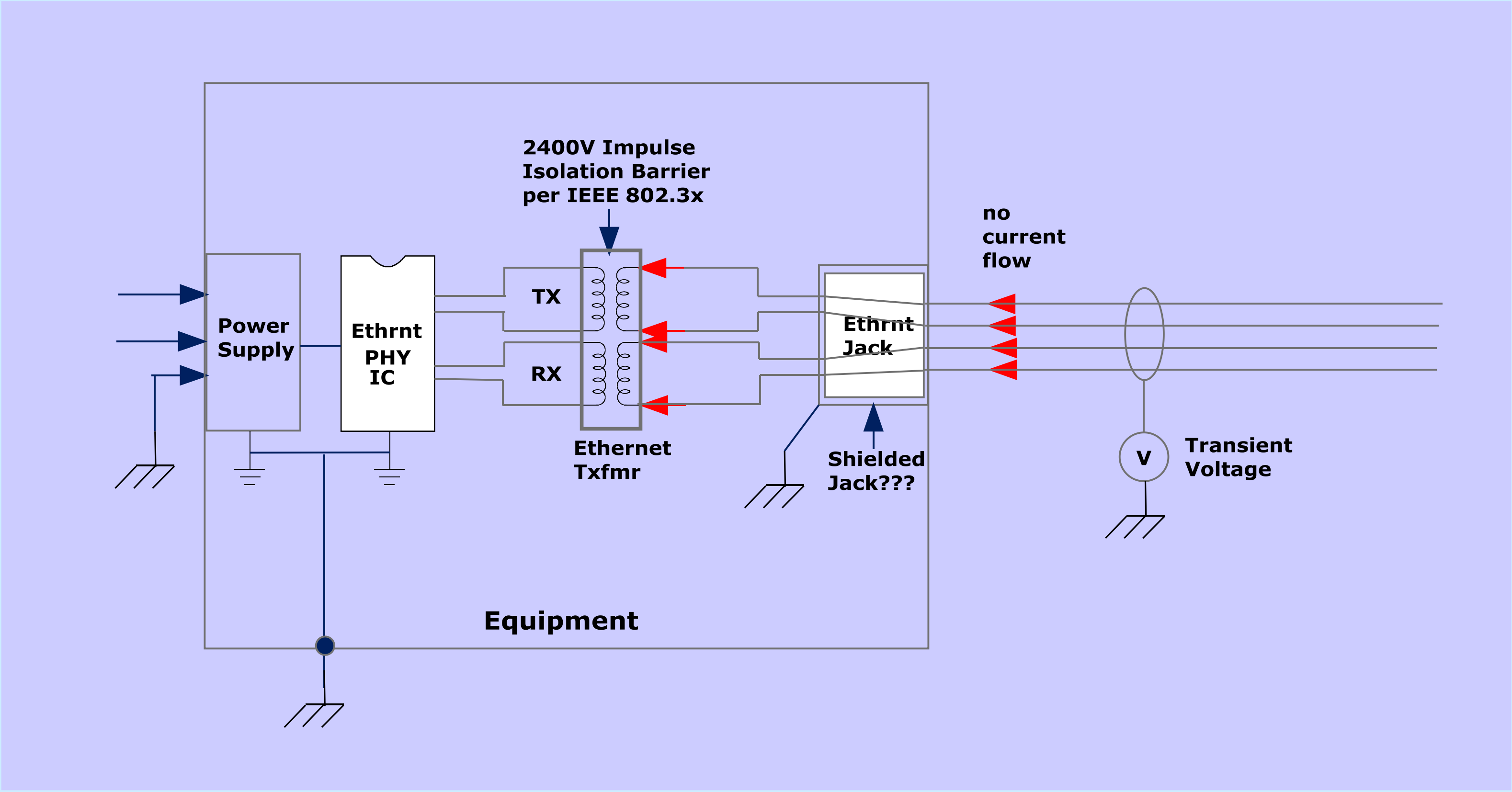

Traffic Operations Center
Traffic Control Ethernet
Backbone
Edge
Single-mode Fiber
Redundant
Camera
ITS BLADE
2070
Camera
ITS BLADE
2070
P62F

Ethernet Exposure

Why the CONCERN??

What Happens in the Event of a Transient?

In this case nothing bad happens, ALL is GOOD!


2400V Impulse
Isolation Barrier
per IEEE 802.3x
no
current
flow
Power
Supply
Ethrnt
PHY
IC
TX
RX
Ethrnt
Jack
Ethernet
Txfmr
Shielded
Jack???
V
Transient
Voltage
Equipment

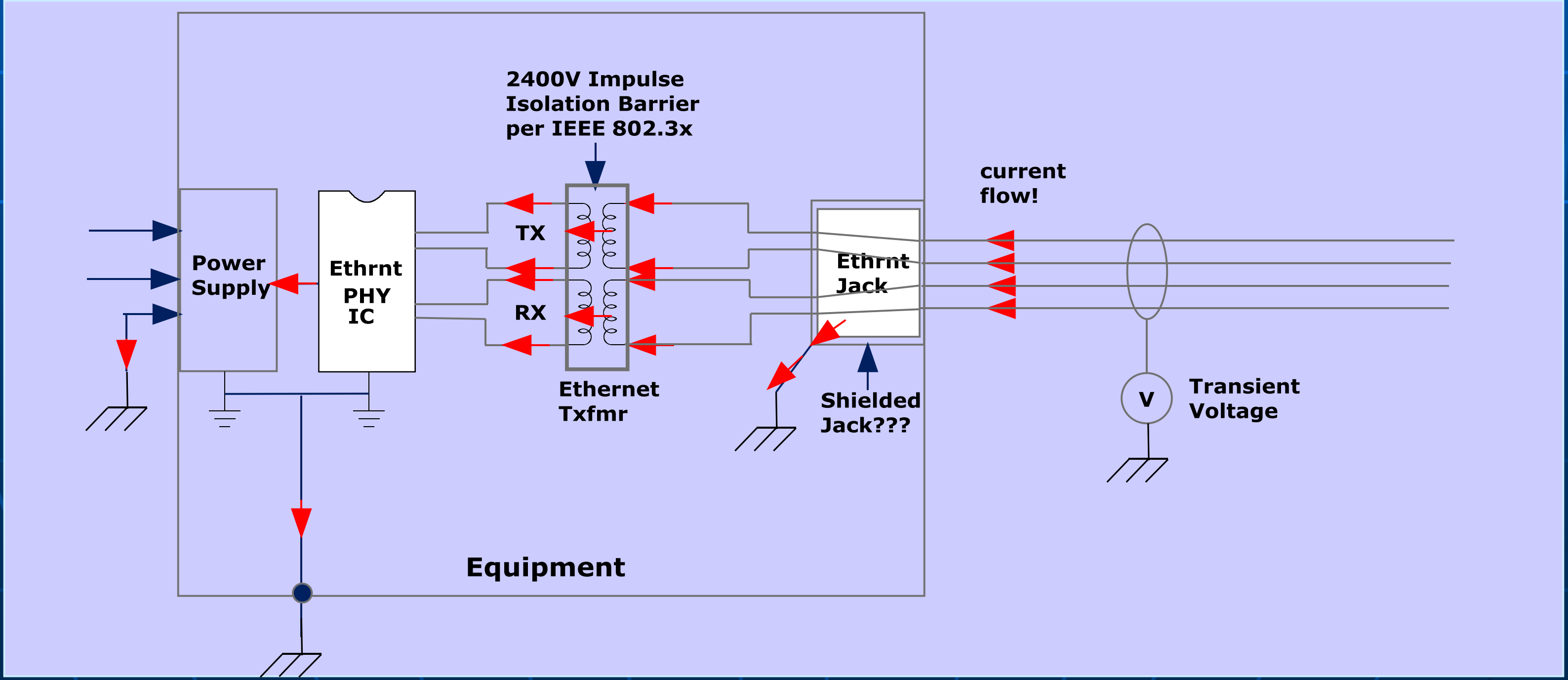
Ethernet Exposure

But What if:

The voltage exceeds the isolation capability of Transformers, Jacks, PCB traces?

What if standards leave loopholes?

What if standards are voluntary and are not followed?


2400V Impulse
Isolation Barrier
per IEEE 802.3x
current
flow!
Power
Supply
Ethrnt
PHY
IC
TX
RX
Ethrnt
Jack
Ethernet
Txfmr
Shielded
Jack???
V
Transient
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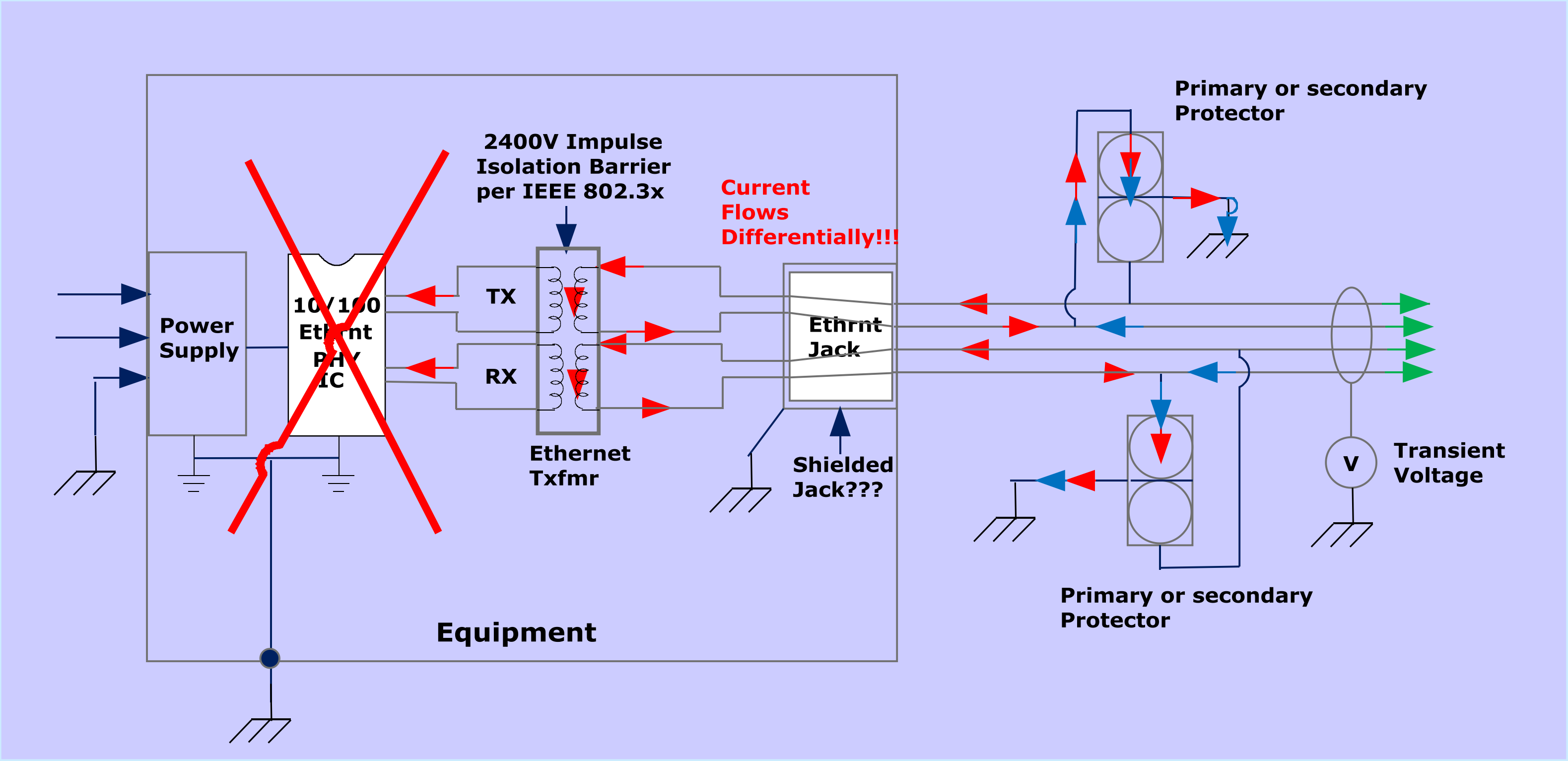
Ethernet Exposure

What Happens in the Event of a Transient if a "Protector" to Ground is Present?

Catastrophe, the Ethernet PHY gets fried!!!


2400V Impulse Isolation Barrier per IEEE 802.3x
Current Flows Differentially!!!
Primary or secondary Protector
Power Supply
10/100 Ethrnt PHY IC
TX
RX
Ethernet Txfmr
Ethrnt Jack
Shielded Jack???
V
Transient Voltage
Primary or secondary Protector
Equipment

Ethernet Protection Solutions

Standards??

Is there a standards solution currently?

NEC – No
Safety Standards – No
IEC - No
IEEE 802.3 – Some (but has loopholes)
Telcordia GR-1089 – Some
ITU-T (K.20/K.21/K.44/K.45) – Some
ATIS NEP – YES, SOON (fall 2014)!!!!!

Ethernet Protection

Recent Activity Relating to Electrical Protection of Copper Ethernet Interfaces

- -Standards Organizations
  - - GR-1089-CORE
    - - No current work (issue 6 published)
  - -ITU-T SG5
    - -Work in process
  - -ATIS NEP
    - -Completing work on Ethernet Protection Standard
    - -www.ATIS.org
    - -STEP-NEP is the committee – Chairman Ernie Gallo

Ethernet Protection

ATIS NEP - Standard

-Un-numbered at this point, but will be part of the family of Broadband protection standards recently published – ATIS 0600012.xx Family

-Provides information on the electrical transient threats based on location and applications

-Provides information on shortcomings of the IEEE 802.3xx isolation requirements with regards to transient protection

-Provides guidance and drawings for protection against common mode, GPR, differential and HV transients

-Addresses PoE & PoE+ Protection

-Provides Testing Requirements

Ethernet Protection

ATIS NEP - Standard

Within the IEEE 802.3 standards, the only criteria related to lightning protection is the "Isolation Test" (only common mode)!

Conductors of an Ethernet interface are to be "isolated" from ground and also "isolated" from other circuitry by one of the following:

- **1500 Vrms for 60 seconds**
- **2250 VDC for 60 seconds**
- **2400 V impulse (1.2/50 uSec)**

To reliably meet this requirement:

-approximately 60 mils of spacing is required

-2KV or higher caps in the "Smith Type" Circuit are necessary

Ethernet Protection

ATIS NEP - Standard

However, in terms of lightning related events, only the *impulse* option is relevant. The ATIS standard only recommends using option a or b for validating isolation characteristics of components or traces.

There is a loophole in option a or b that references IEC 60950, which leads some users to believe that transient supressors to ground can be removed in some cases – *which defeats the purpose of an "isolation test".*

The ATIS Ethernet Protection standard addresses this problem!

Ethernet Protection

ATIS NEP - Standard

The ATIS standard discusses:

IEC TR 62102 Electrical Safety – Classification of interfaces for equipment to be connected to information and communications technology networks – Second Edition 2005-05

- **Specifies environments and how to classify circuits based on deployments.**
- **Somewhat ambiguous but leads to the conclusion that most Ethernet should be a TNV circuit and NOT a SELV circuit**

Note: Currently IEC TR 62102 is a Technical Report and is only informative within IEC 60950-1.

The ATIS Ethernet Protection standard addresses this ambiguity.

Ethernet Protection

ATIS NEP - Standard

IEC 60950-1 (and it variants UL/CSA/EN) are the international safety standards for Telecom/ITE equipment. Currently it treats Ethernet interfaces as data (intra-building) SELV (Safety Extra Low Voltage) circuits. ***As noted earlier, IEC 62102 is informative only, not required.***

- **By being treated as a data circuit, Clause 6 (telecom criteria) is not generally applied**
- **Has no lightning criteria as SELV circuits are not permitted to have exposure to electrical transients**
- **Confusion on what to do with PoE**

The ATIS Ethernet Protection standard addresses this issue, and will hopefully be used to prod changes in the safety Standards.

Ethernet Protection

ATIS NEP - Standard

Currently UL has published a PAG (Practical Application Guidelines) for POE that states that POE must be treated as a telecom interface per clause 6 of UL 60950-1. However, overvoltage tests (even the 120V direct contact tests) are exempted for POE???

Regular Ethernet is not discussed in any PAG's but really should be treated no differently than POE.

All safety labs are supposed to adopt PAG's as they are developed, but classification of Ethernet is all over the map and is generally mis-classifed as SELV.

SELV by definition does not have exposure to lightning transients or overvoltges

The ATIS Ethernet Protection standard addresses this issue, and will hopefully be used to prod changes in the safety Standards.

Ethernet Protection

ATIS NEP - Standard

ITU SG-5 is the international committee responsible for the voluntary or market driven standards relating to Lightning and Power Fault. Only has a 1000V intra-building common mode test currently

K.20 - contains the tests for equipment in C.O.'s
K.21 - contains the tests for equipment at (or on) the Customers Premises
K.44 - describes how to perform the tests in K.20/K.21/K.45
K.45 - contains the tests for equipment between a C.O and the Customers Premises

Ethernet work is in progress

The ATIS Ethernet Protection standard work will hopefully influence the ITU-T's work.

Ethernet Protection

ATIS NEP - Standard

- **Telcordia GR-1089-CORE (issue 6) took significant steps to address Ethernet Protection**

- **Many of the tests and concepts for the ATIS Standard were birthed or formalized in this revision of GR-1089-CORE and will be carried into the ATIS Standard**

- **First standards type document to address Ethernet in some OSP applications**

- **Has some shortcomings with regard to ONT Ethernet interfaces as far as maximum voltage test level**

- **Does not really address HV GPR protection for Ethernet.**

Conclusions

- **Ethernet applications have changed significantly in the past few years**
- **The applications continue to evolve and as they do, more and more Ethernet interface will be exposed to transients that are much higher voltage or much greater current than they were designed to resist.**
- **Ethernet interface damage is increasing at a very fast pace due to the evolving applications and lack of understanding with regard to protection (such as adding protection with a ground reference).**
- **Differential protection is becoming critical**
- **The standards are woefully out of sync and behind the times with regard to Ethernet.**
- **Protection Engineers - Need to become educated to these issues!**

- ***The ATIS NEP Ethernet protection standard will be about the only comprehensive resource available in the near future for understanding and testing the protection levels of Ethernet interfaces- Due to be published fall of 2104***