



Benefits of IEC61850 Networking

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Marketing Subcommittee Chair

UCA International Users Group



Objective

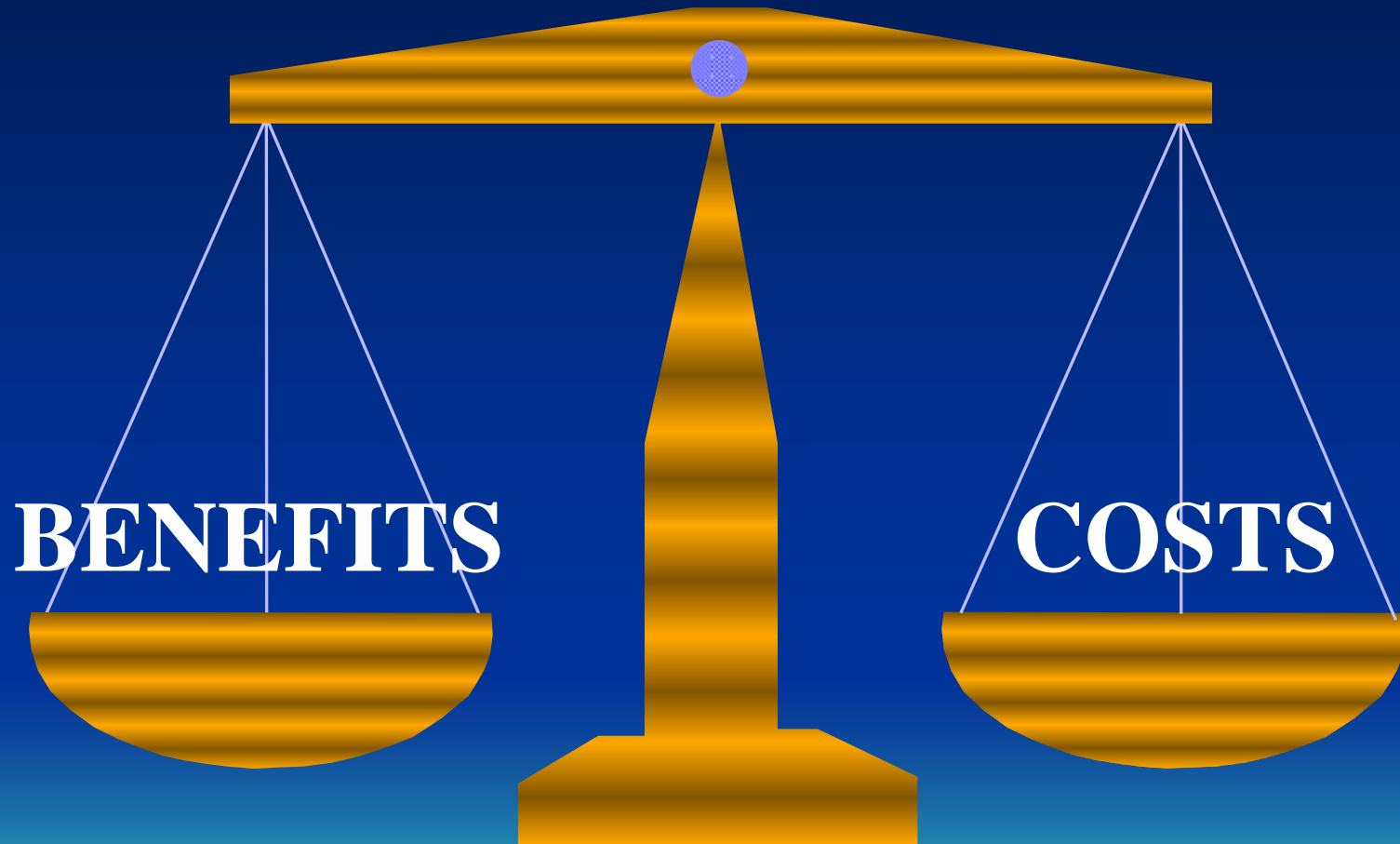
To provide a framework for substation engineers to identify the benefits of using IEC61850 technology for substation automation (SA) projects.



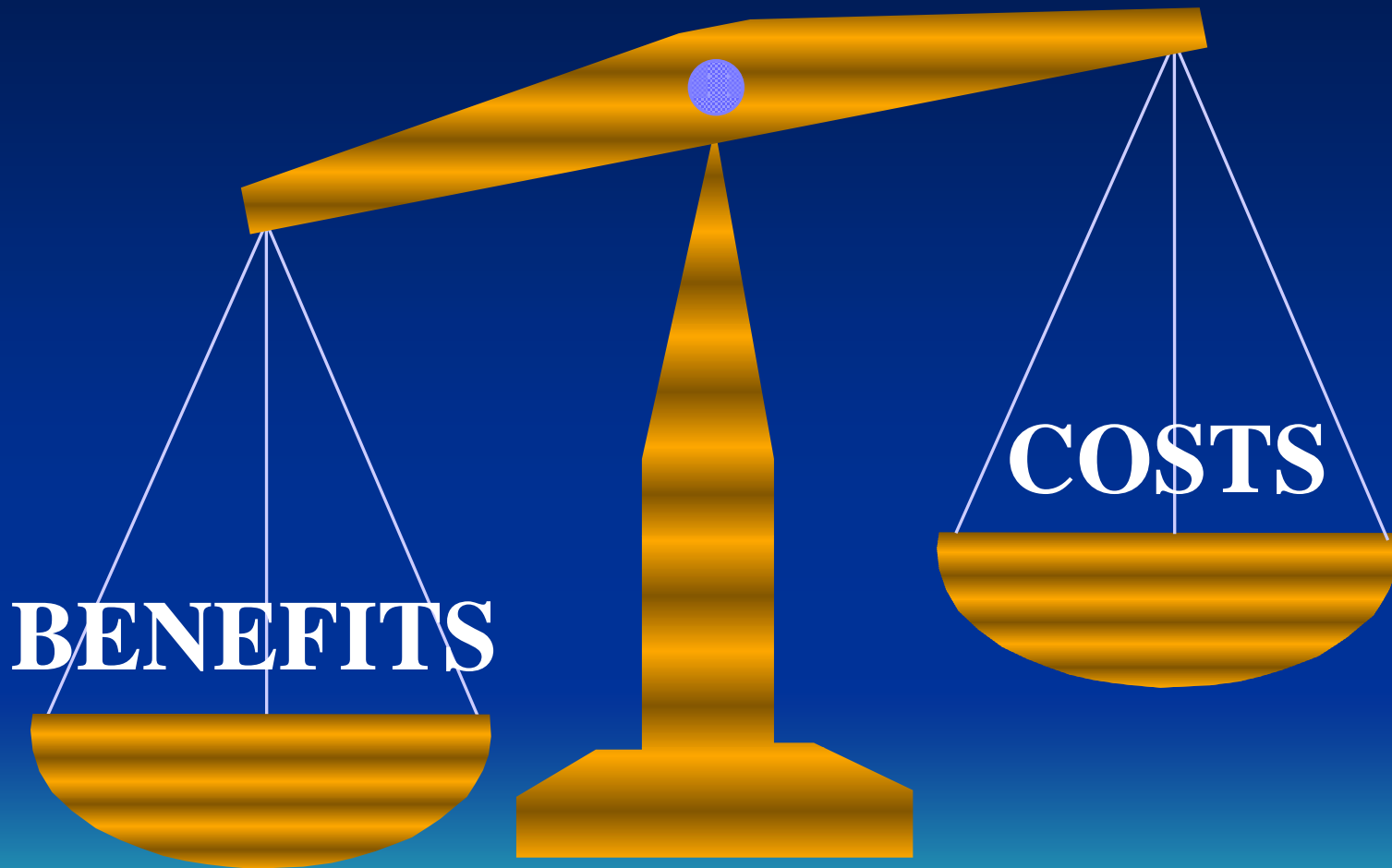
Overview

- Justification Dilemma
- Legacy Approaches
 - SCADA
 - Protection
- Networking Based Approaches
 - SCADA
 - Protection
- Benefits

The Justification Dilemma

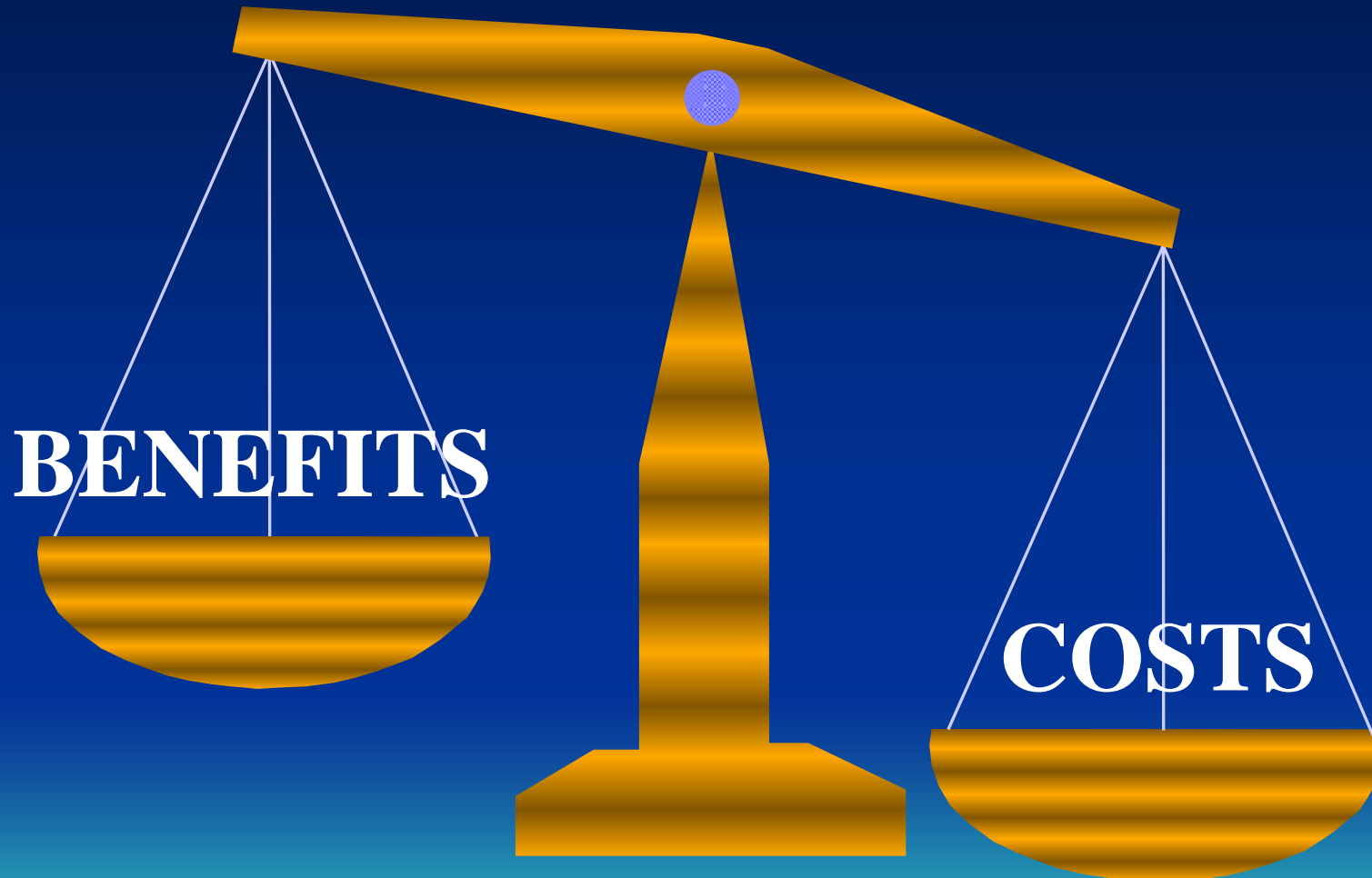


The Justification Dilemma



Engineer's View of Justification

The Justification Dilemma



Accountant's View of Justification

The Tragedy of Automation



There are no benefits
without some cost



Keys to Successful Justification

- Identify all the benefits (obvious).
- Identify **ALL** the costs:
 - Equipment
 - Installation
 - Engineering
 - Commissioning
 - Utilization Costs
 - Impact on External Systems
 - Costs to Change/Migrate in Future
 - Intangibles (new capability)



Identifying **ALL** Costs

- Requires a complete view of cost.

You can't justify an IEC61850 device by examining only the price of the device.

- OR -

The benefit of an IEC61850 device is not in the price of the relay.



Identifying **ALL** Costs

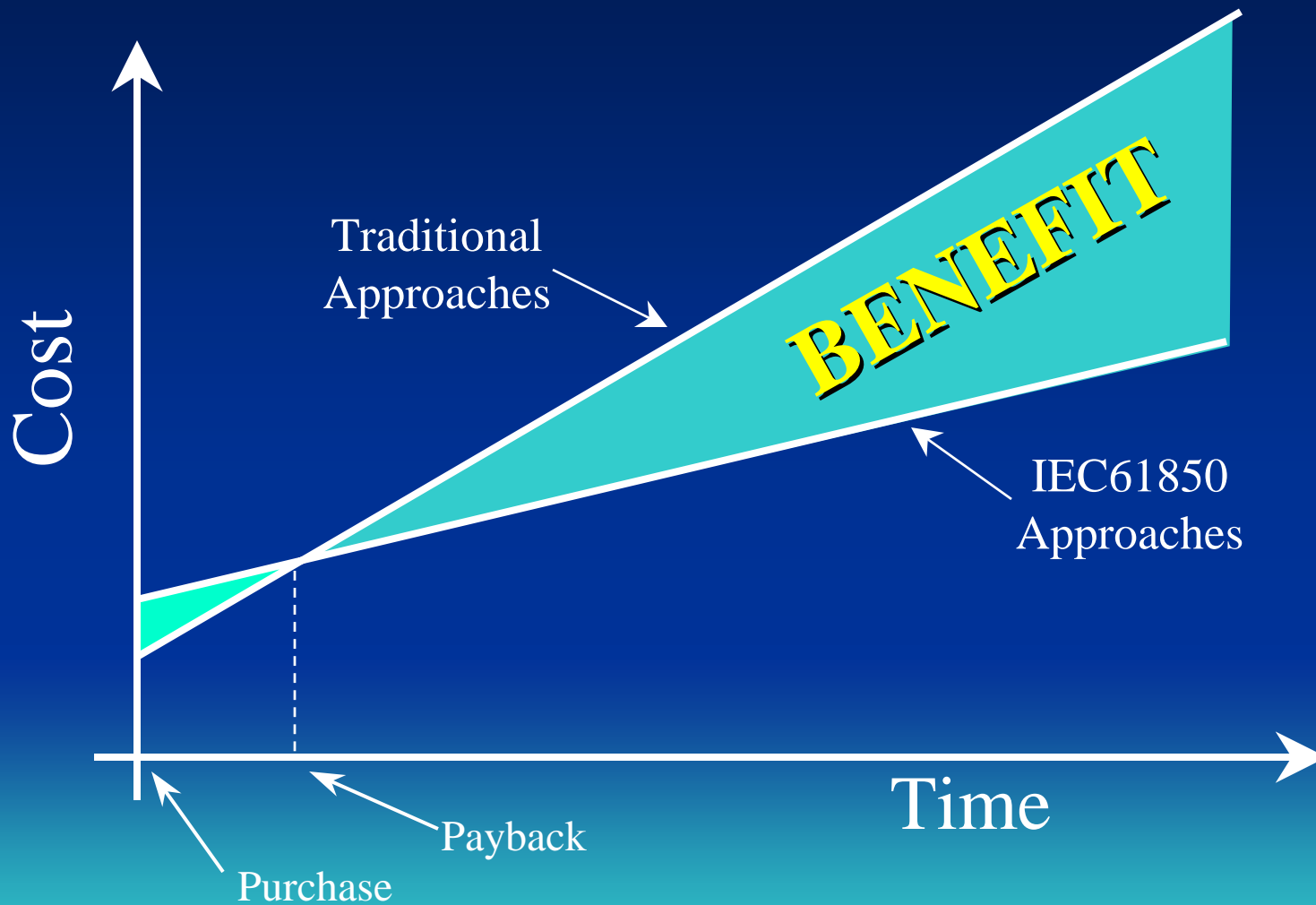
- Requires a longer time frame.

It is hard to justify any system by examining only the purchase price.

- OR -

Benefits are received as systems are used, not when they are purchased.

Justification





IEC61850 is Unique

- Not a recast serial RTU protocol
- Designed specifically for LANs to lower life cycle cost to use a device:
 - Cost to install, configure, and maintain
- Real object-oriented approach for SA:
 - Supports standardized device models using names instead of custom object numbers and indexes.
 - Standardized configuration language (SCL).
 - Feature rich with support for functions difficult to implement otherwise.



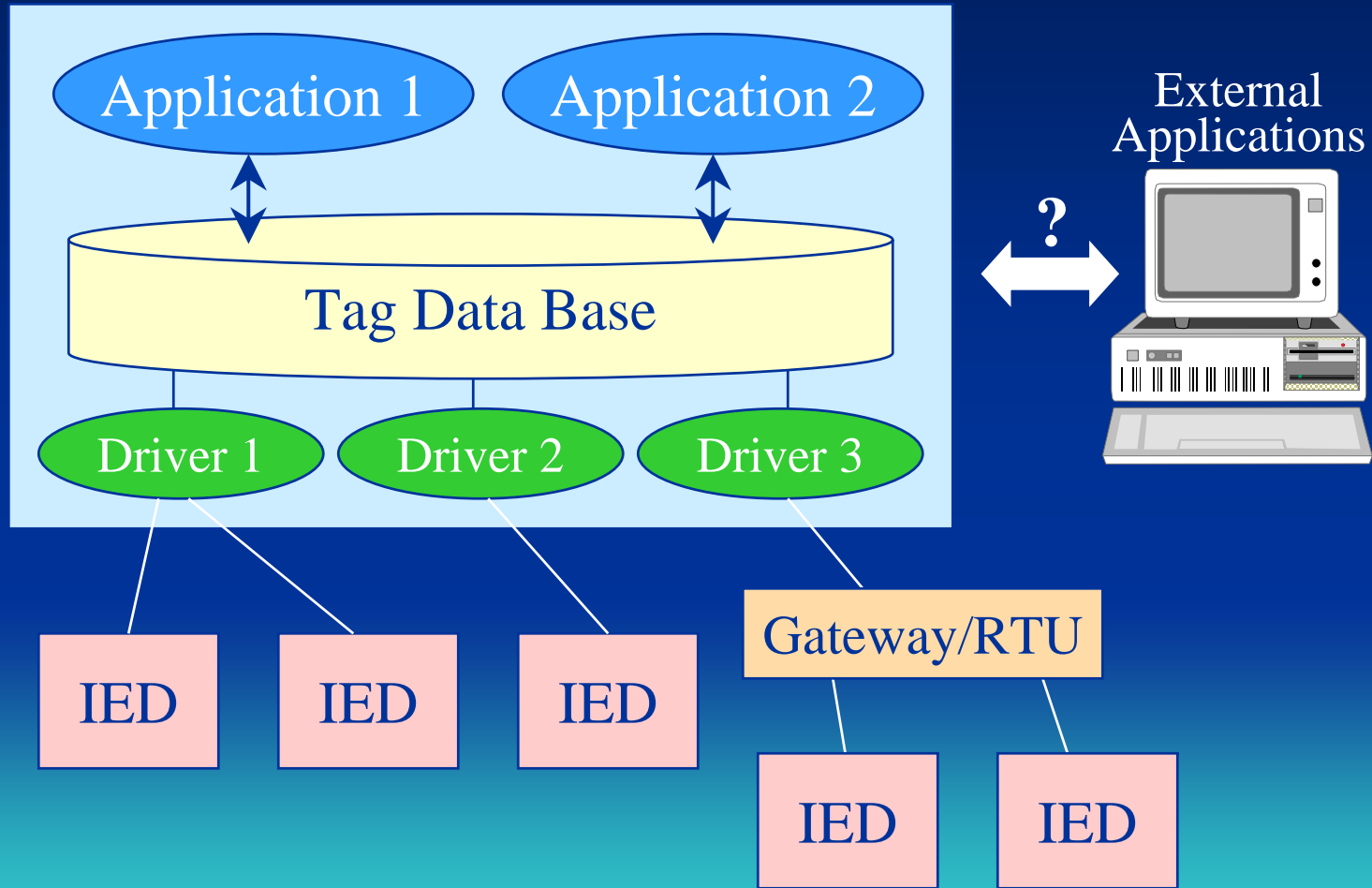
Ground Rules

- Qualitative analysis based on comparison of legacy approaches versus IEC61850 approach
- Simplified Examples Shown.



Substation Networks

Legacy Substation Network Architecture



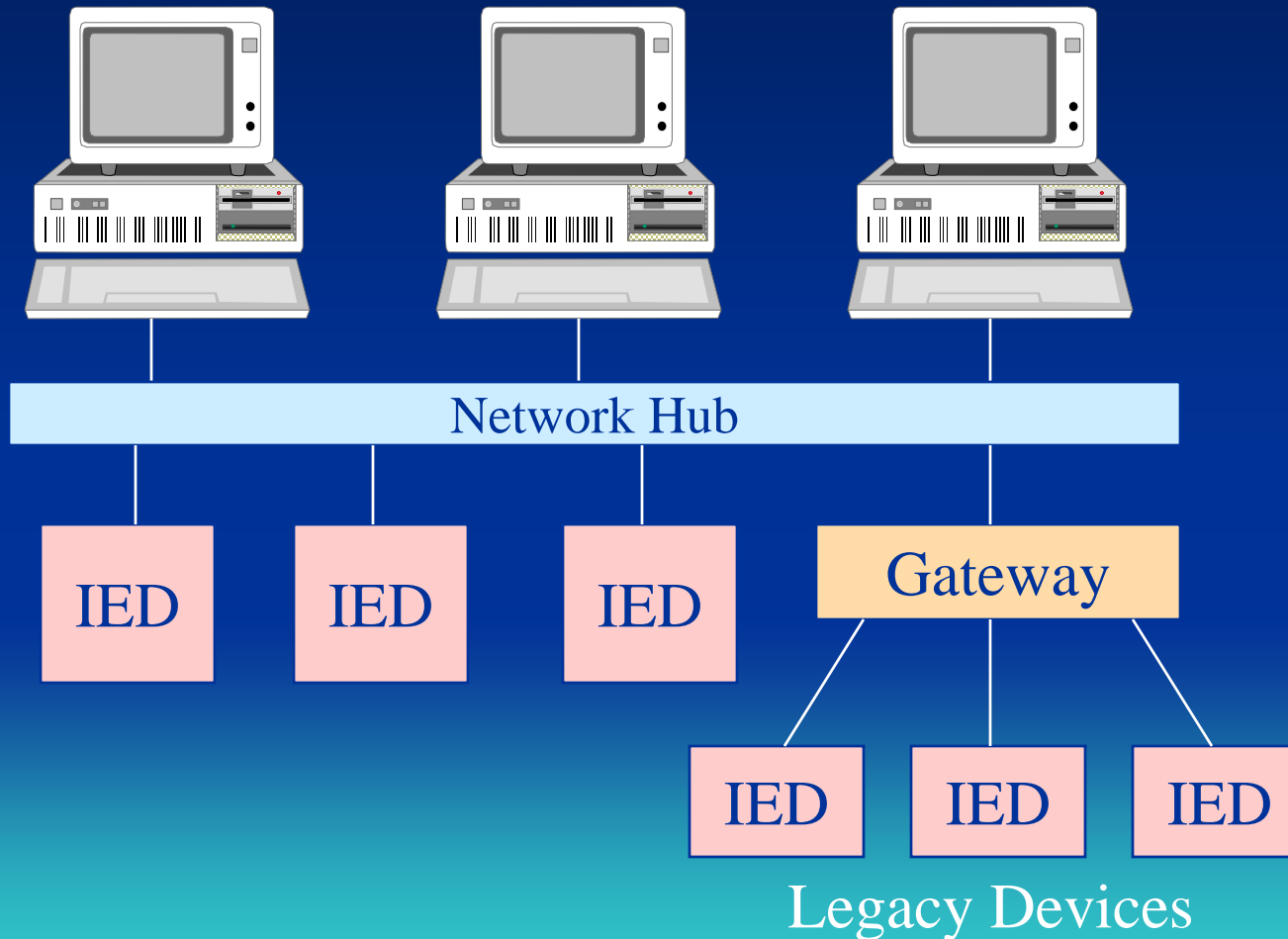


Legacy Substation Architecture

- Specialized point to point links to IEDs.
- Applications must deal with numerous:
 - Protocols
 - Data Formats
 - Data Addressing
- Protocols used have limited capabilities.
- Difficult or no access point for other apps.
- Comm. path must be reconfigured when new devices or applications are added.

IEC61850 Network Architecture

Substation Applications

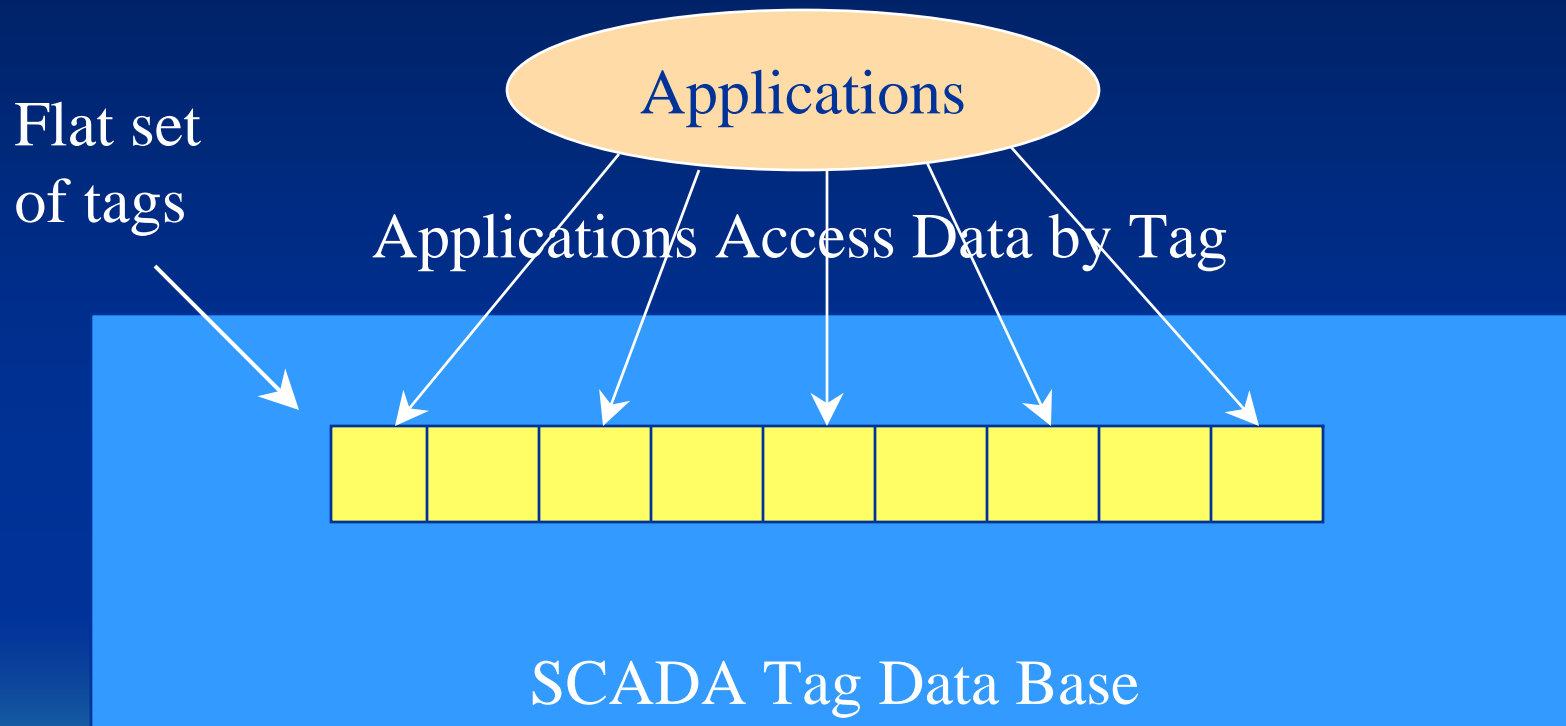




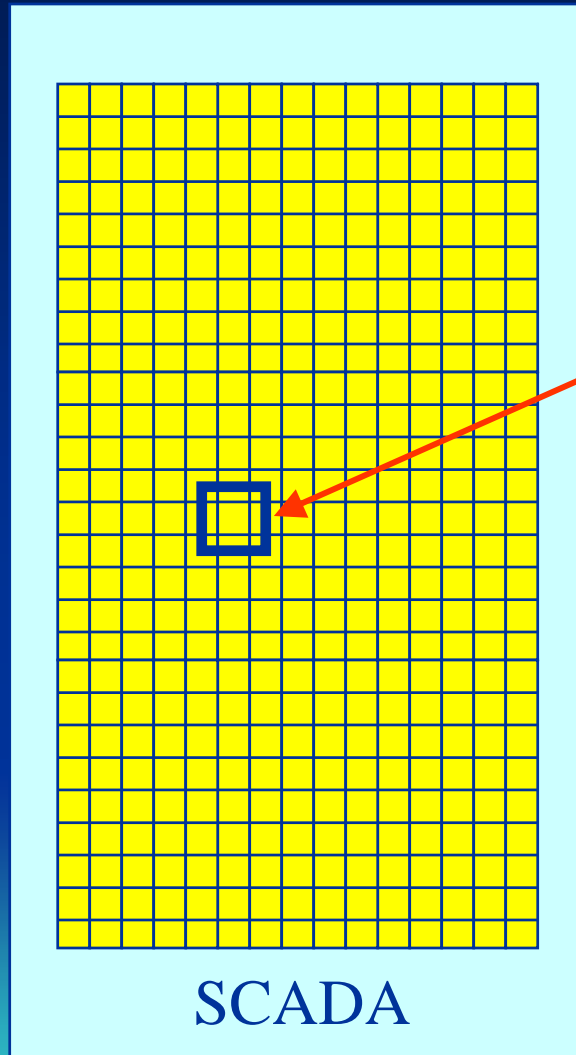
IEC61850 Network Architecture

- Data from IEDs available to all applications via network.
- Comm path unaffected when adding devices or applications.
- Standard net. gear provides high perf. & flexibility with environmental protection.
- Applications and IEDs share common:
 - Protocols
 - Data Format and Context
 - Data Addressing/naming Conventions
 - Configuration Language

Legacy SCADA View of Data



Legacy SCADA Data Access



Feeder #2 Current is
here in Register
400020.

That's intuitive!?

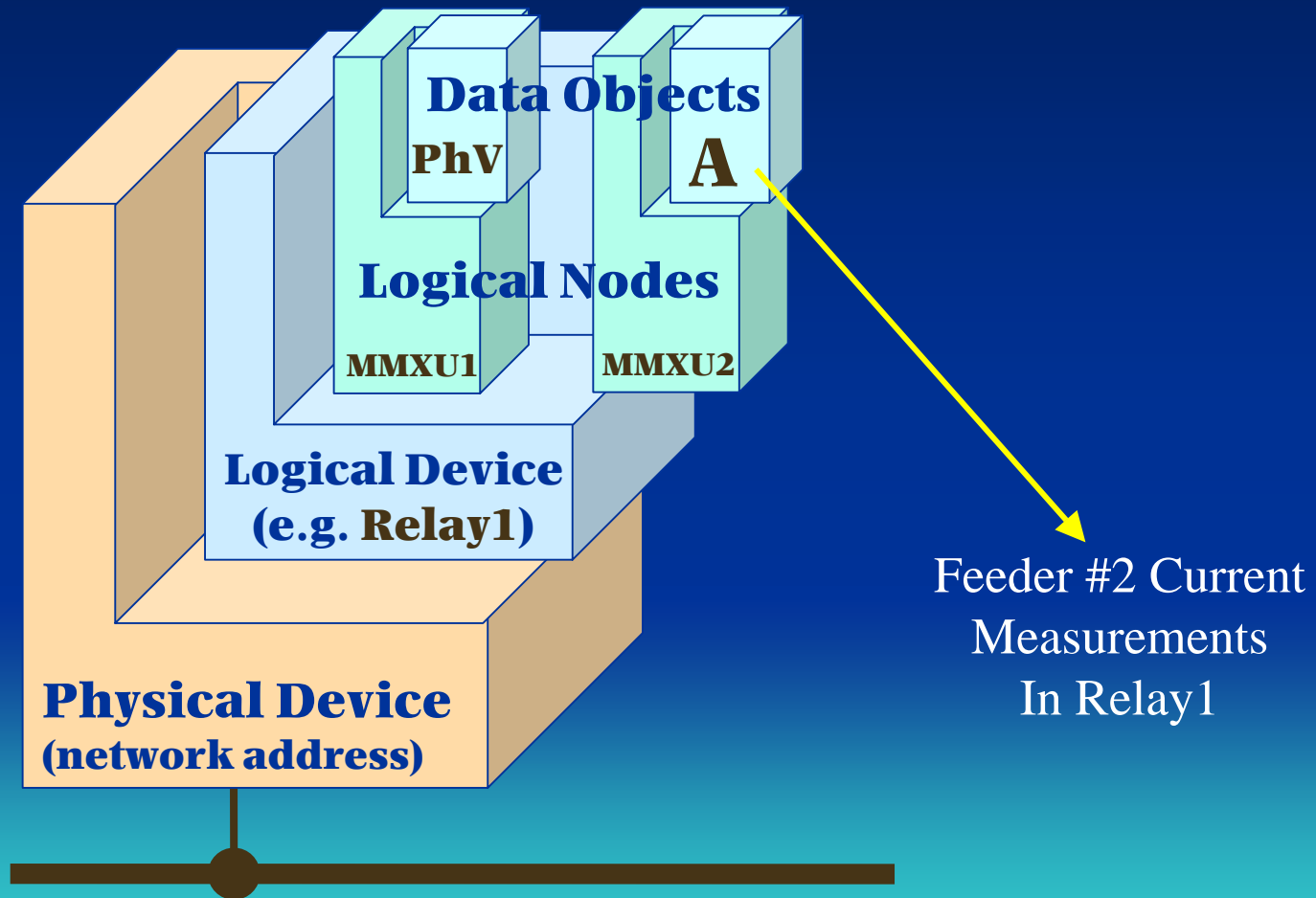




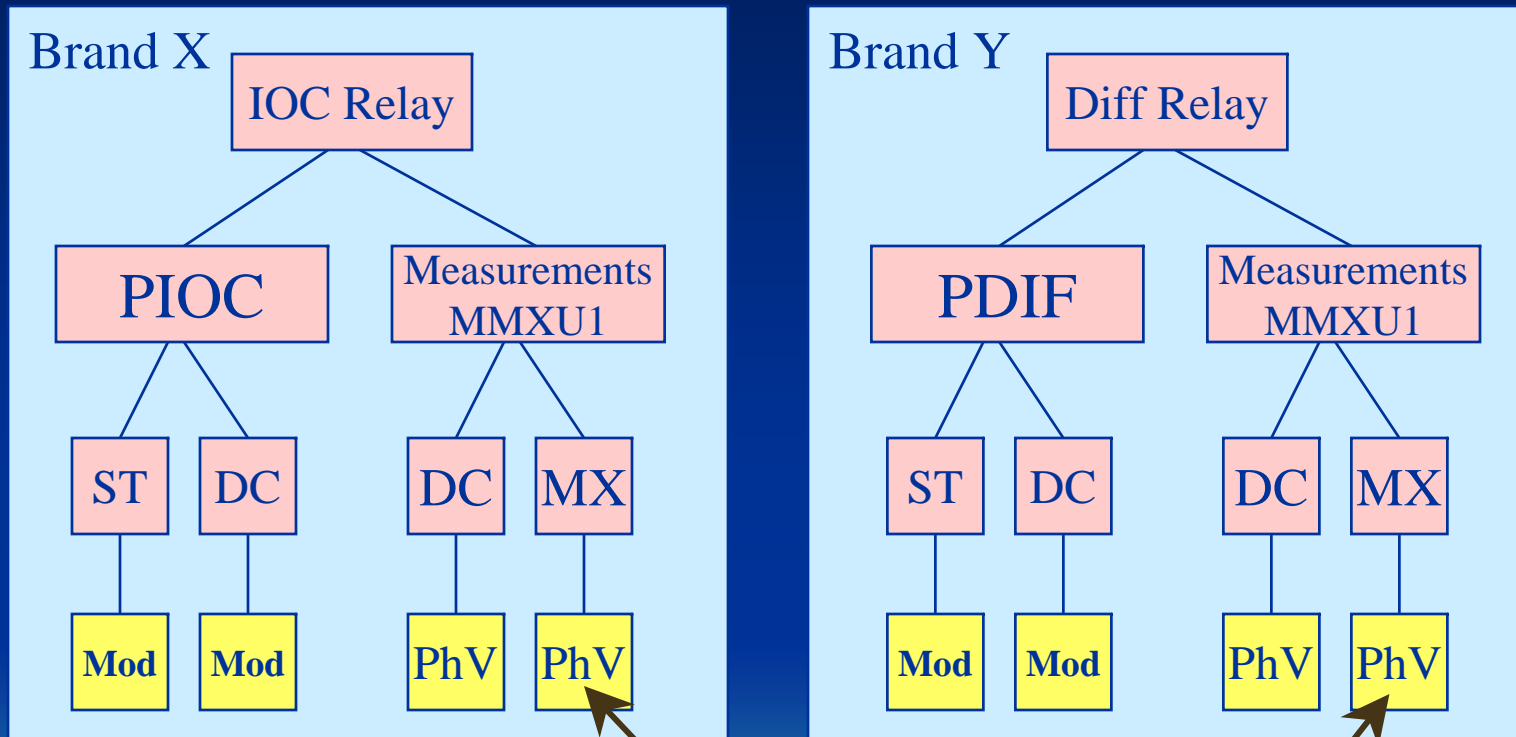
Legacy SCADA View of Data

- Proprietary tag formats.
- Arcane addressing:
 - Driver
 - Wire
 - Rack
 - Device Register/Index #
 - Network
- Manually entered.
- Manually verified.
- Applications tied to tag or free form alias.
- Any tag conventions are proprietary.

Anatomy of an IEC61850 Object Model



IEC61850 View of Devices



MMXU1\$MX\$PhV
IEC61850-8-1 Name



IEC61850 View of Devices

- Only network addressing requires configuration in the remote client.
- Point names portray the meaning and hierarchy of the data with no mapping to I/O required.
- **Point names can be retrieved from the device automatically without manual intervention.**
- All devices share a common naming convention.
- Device configurations can be exchanged using IEC61850-6-1 (SCL) files



Benefits

- Reduced configuration costs from common naming and automatic point configuration and retrieval.
- Equipment migrations occur with minimal impact on applications.
- Application changes have minimal effect on devices, network or other applications.



Justification

<u>Description</u>	<u>Legacy</u>	<u>IEC61850</u>	<u>Impact</u>
Equipment Purchase	\$	\$\$	-
Installation	\$	\$	0
Configuration	\$\$\$	\$	+
Equipment Migration	\$\$\$	\$	+
Application Additions	\$\$\$	\$	+



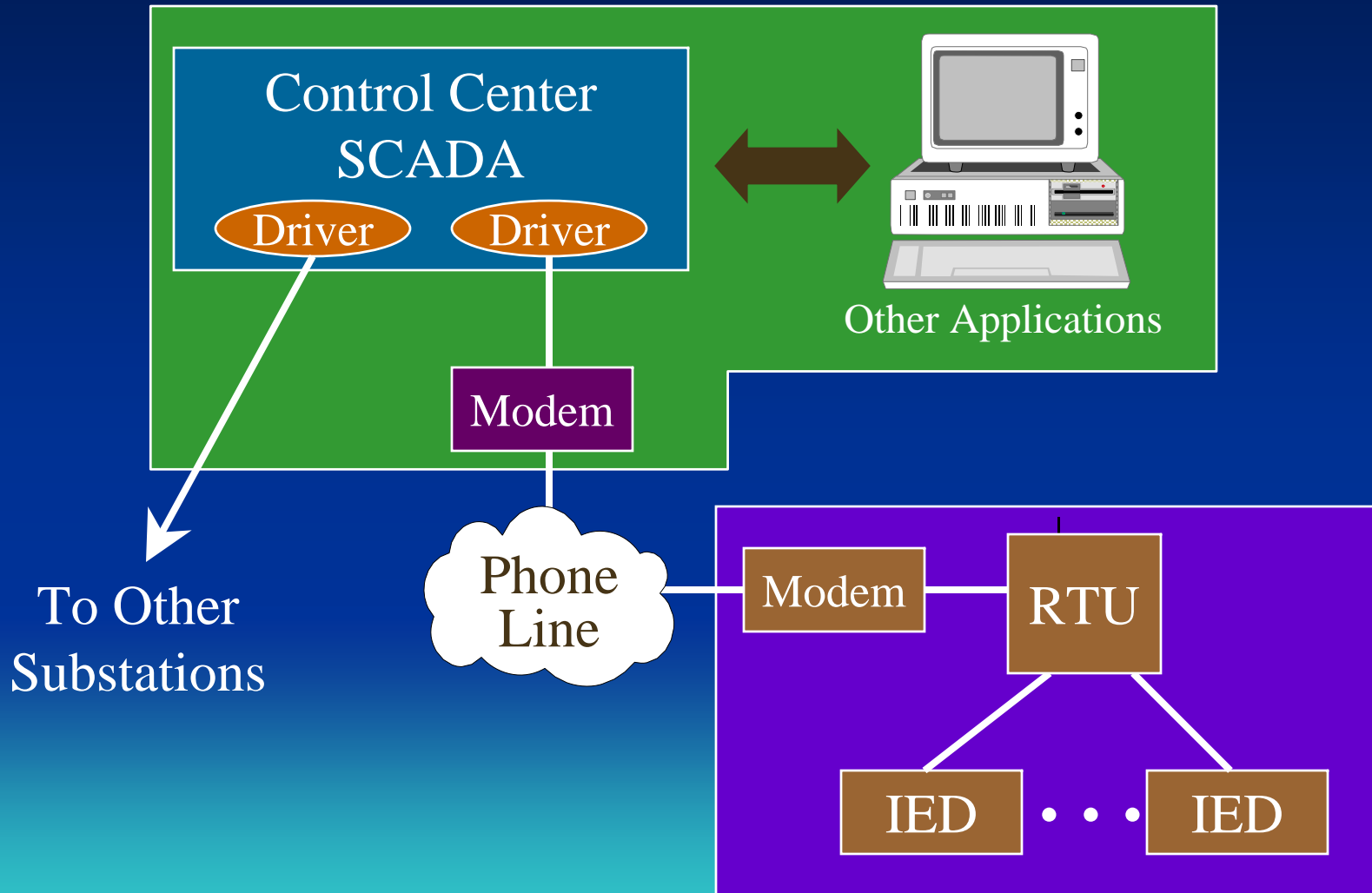
Small Co-op Experience

- Substation Modernization Pilot did 2 substations
 - DNP3.0 over TCP and UDP
 - UCA2.0 (subset of IEC61850)
- Time to get DNP3 relay configured and communicating: ~ **8 hours**
- Time to get UCA/IEC61850 relay configured and communicating: **20 minutes**
- **\$325K Cost Savings for overall deployment**



Substation to Control Center

Legacy Substation to Control Center

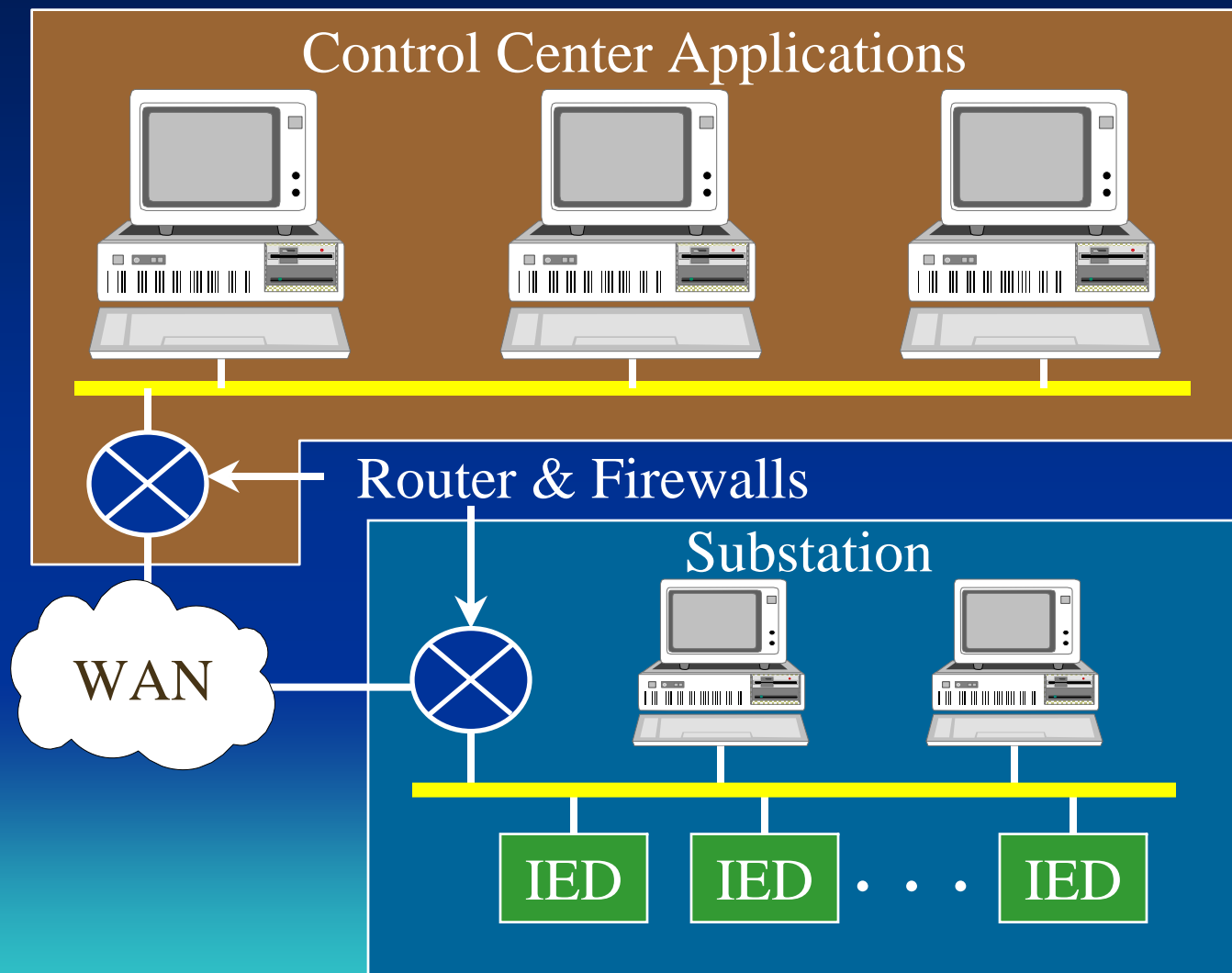




Legacy Substation to Control Center

- Low speed modem links to RTUs in substation.
- Other applications access through SCADA.
- Every substation has separate access.
- Every application and node must be configured for access.

IEC61850 CC-Substation Integration





IEC61850 CC-Substation Integration

- Creates a single virtual network that eliminates barriers to data access.
- Applications access data independently.
- Market driven solutions expanding rapidly for WAN:
 - Wireless
 - Frame Relay/ATM
 - Metropolitan Fiber rings



Benefits

- Performance and flexibility:
 - Network migration
 - Application migration
 - System capabilities
- Eliminates config dependencies: add a point w/o reconfiguring intervening equip.
- Improved maintainability via use of generic widely available technology.



Justification

<u>Description</u>	<u>Legacy</u>	<u>IEC61850</u>	<u>Impact</u>
Equipment Purchase	\$	\$\$	-
Installation	\$\$	\$	+
Configuration	\$\$	\$	+
Equip/App Migration	\$\$\$	\$	+
Flexibility & Capability	\$\$\$	\$	+



Large Midwestern Utility

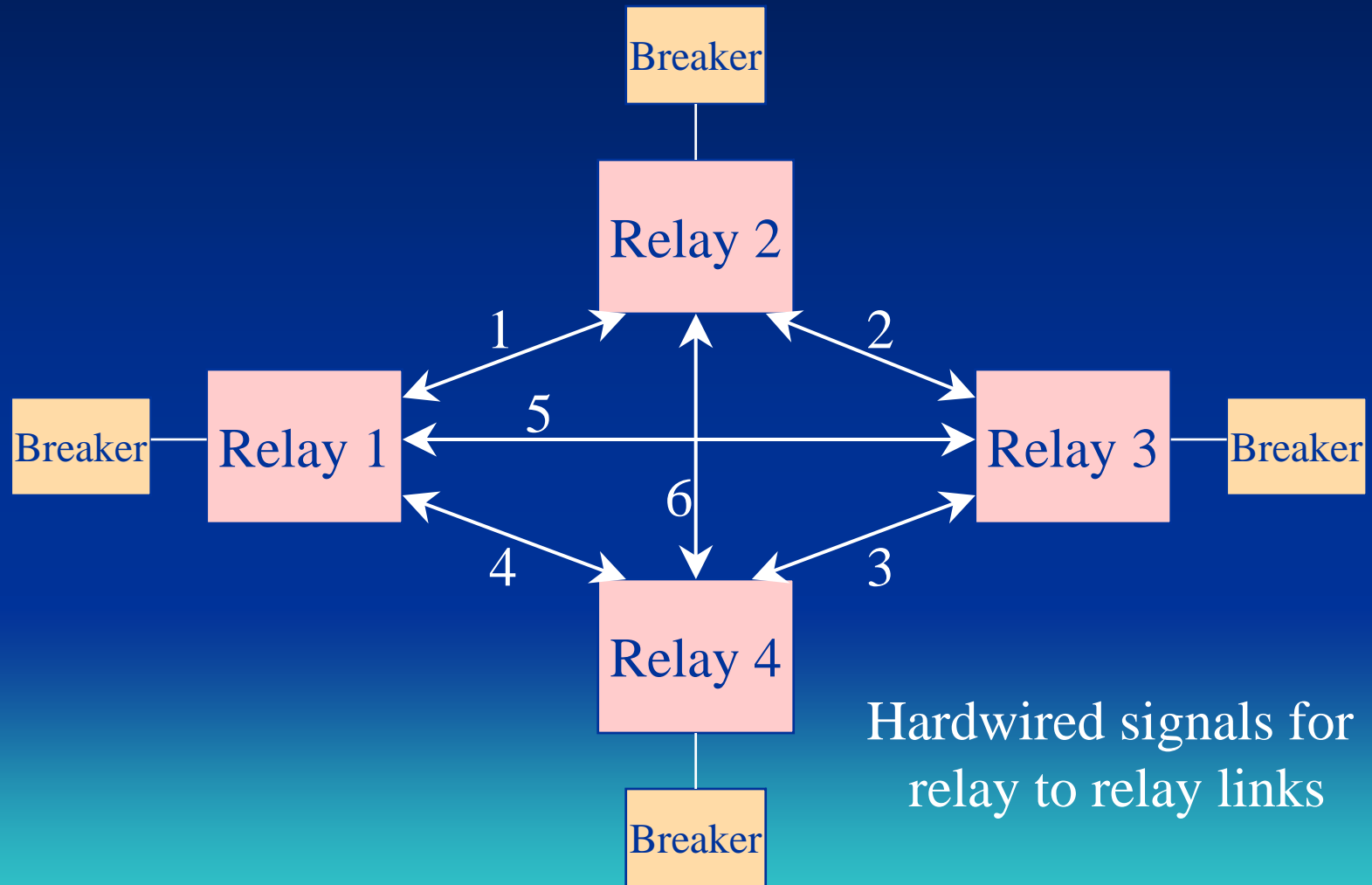
- Using Legacy Protocols:
 - 40-50 manhours to configure an RTU for data collection using legacy RTU protocol.
- Using IEC61850:
 - Press a button and retrieve the point list from the devices....no need for an RTU.
 - Network devices and configuration at much lower cost.
 - Instead of spending time configuring RTUs they will be integrating more substations.
 - Already have corporate WAN...only need to use it.



Relay to Relay Applications

a.k.a. “Peer-to-Peer messaging”

Legacy Architecture

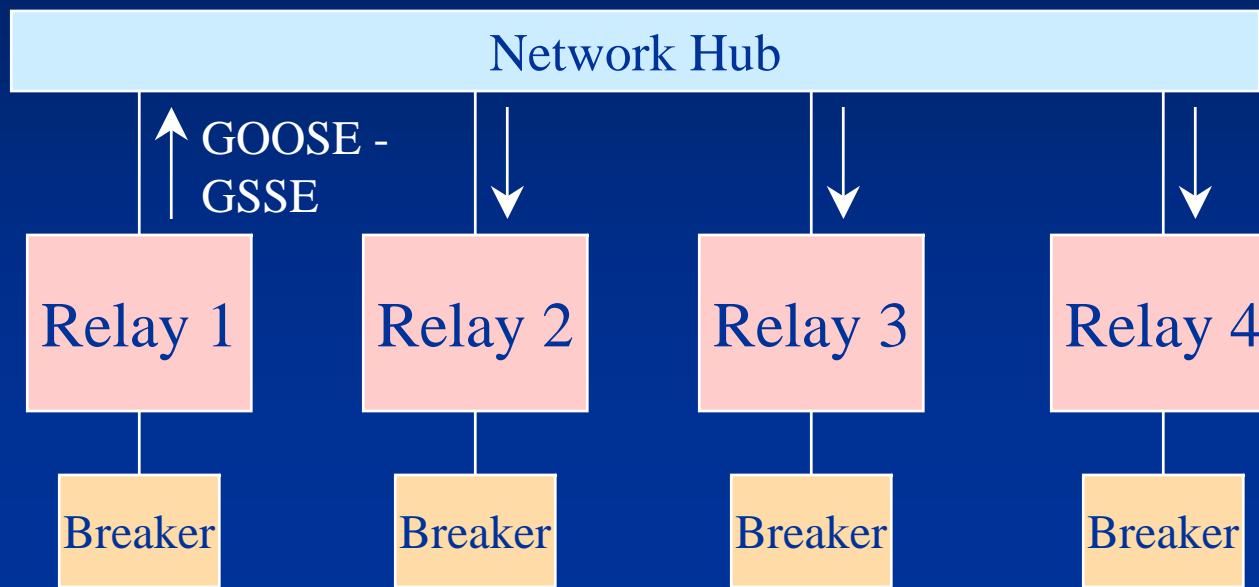




Legacy Architecture

- Requires $N*(N-1)/2$ links for N relays.
- Requires filtering on links to prevent false trips.
- Reprogramming can require rewiring.
- Don't know if links are working until you use them.

IEC61850 Network Architecture



GOOSE - Generic Object Oriented Substation Event (data sets)

GSSE – Generic Substation Status Event (status)



IEC61850 Network Architecture

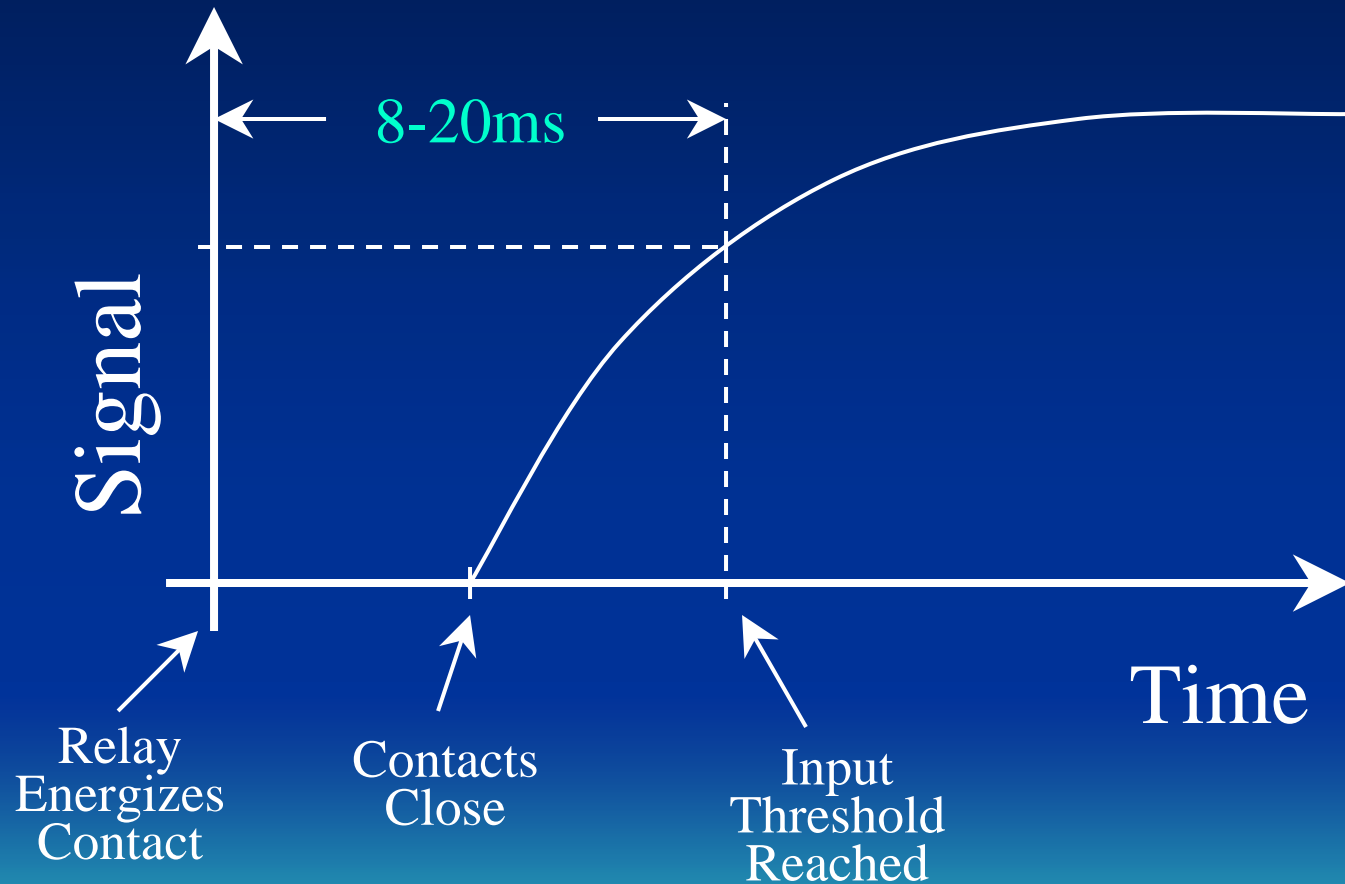
- Relays share a common network making sophisticated protection schemes possible.
- Number of links for N relays is N and shared with SCADA.
- Relays send their status to all other relays at once using GOOSE.
- Status exchanged continuously.
- High performance.



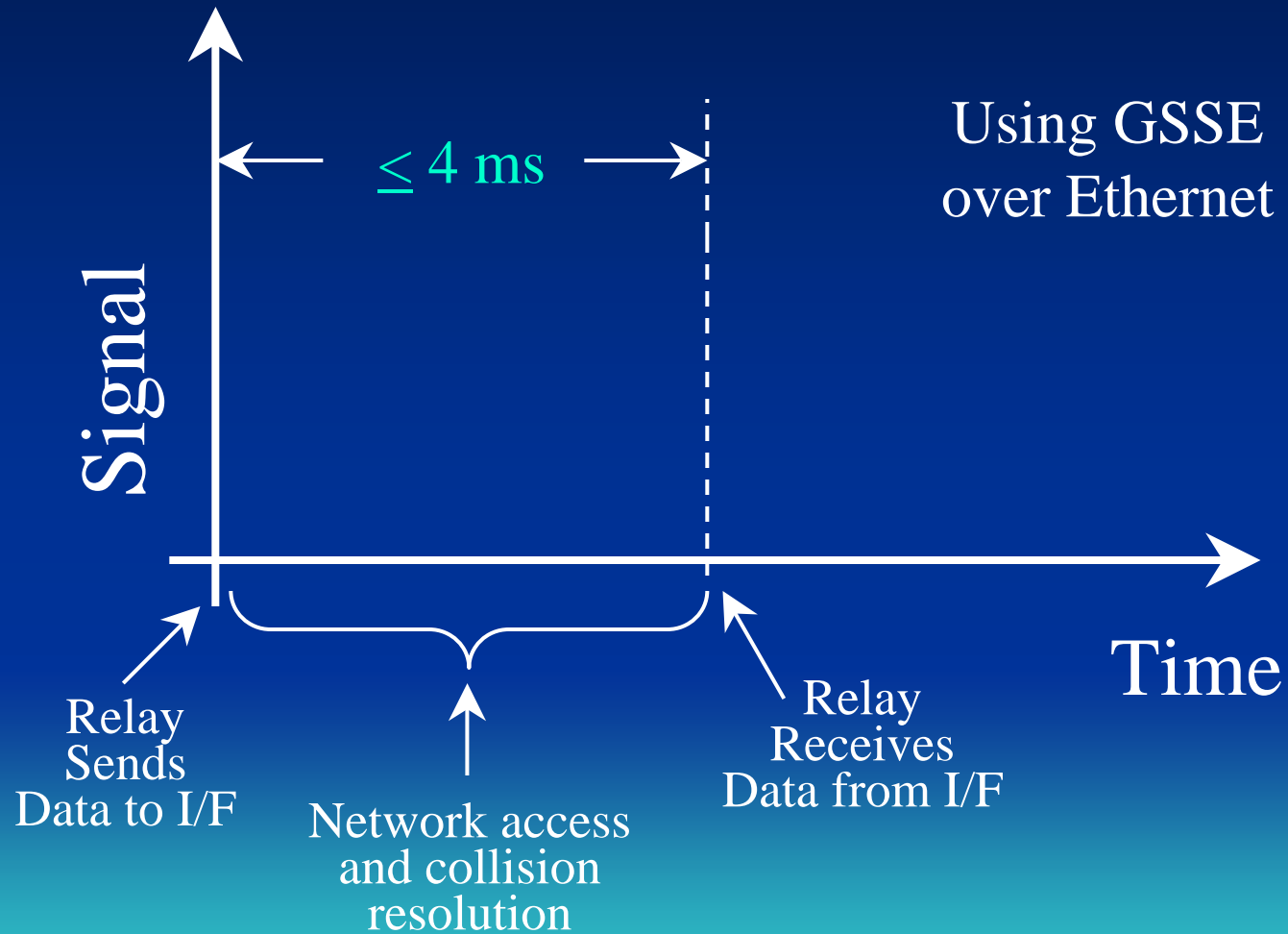
Benefits

- Reduction of wiring costs
- More flexible programming is independent of wiring
- Reliability: Link status known before use.
- New capabilities not cost-effective with hardwired systems.
- Higher performance with more data.

Hardwired Performance



Network Performance





Improved Performance

- Network access resolves very fast (even with collisions)
- Duplex Ethernet switches **eliminate** collisions
- Data is transmitted multiple times to avoid missing data.
- Digital error checking instead of analog filtering.



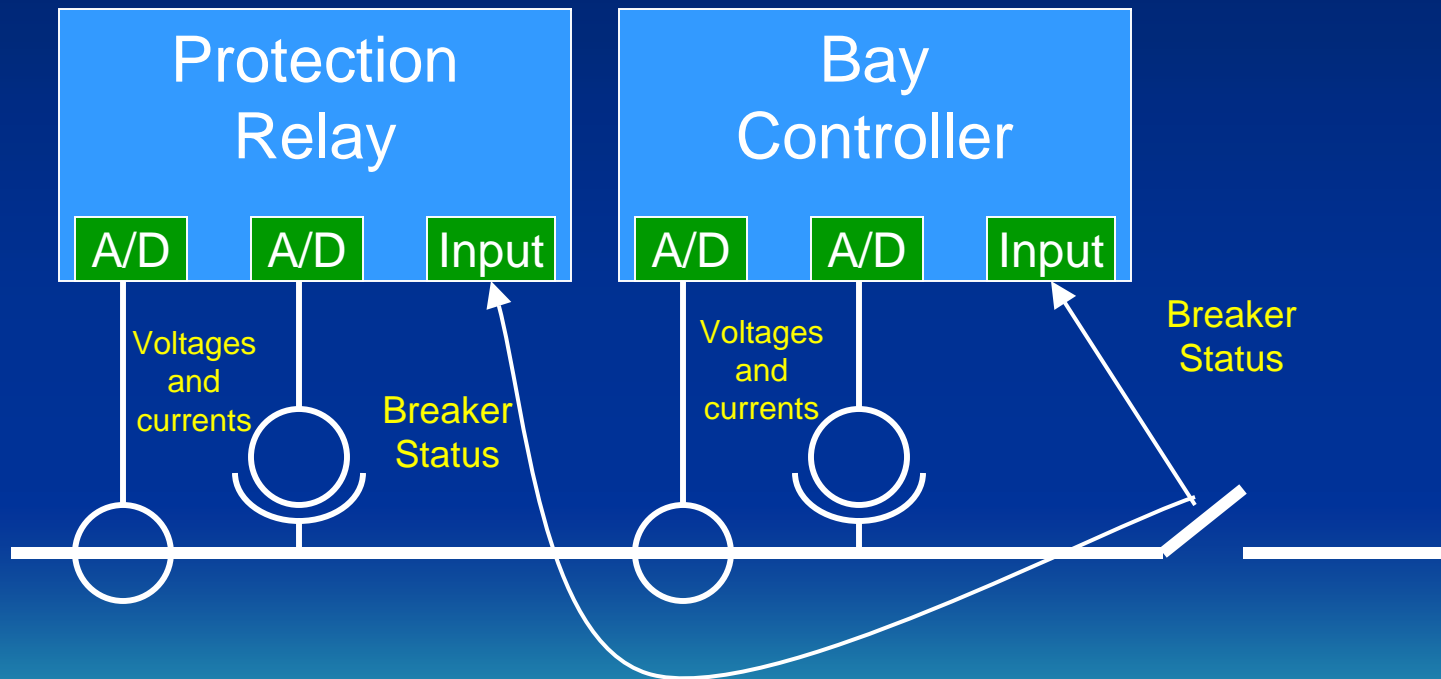
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Equipment Purchase	\$	\$\$	-
Installation	\$\$	\$	+
Configuration	\$	\$	0
Protection changes	\$\$\$	\$	+
Flexibility	\$\$\$	\$	+



Transducer Interfaces

Legacy Approach



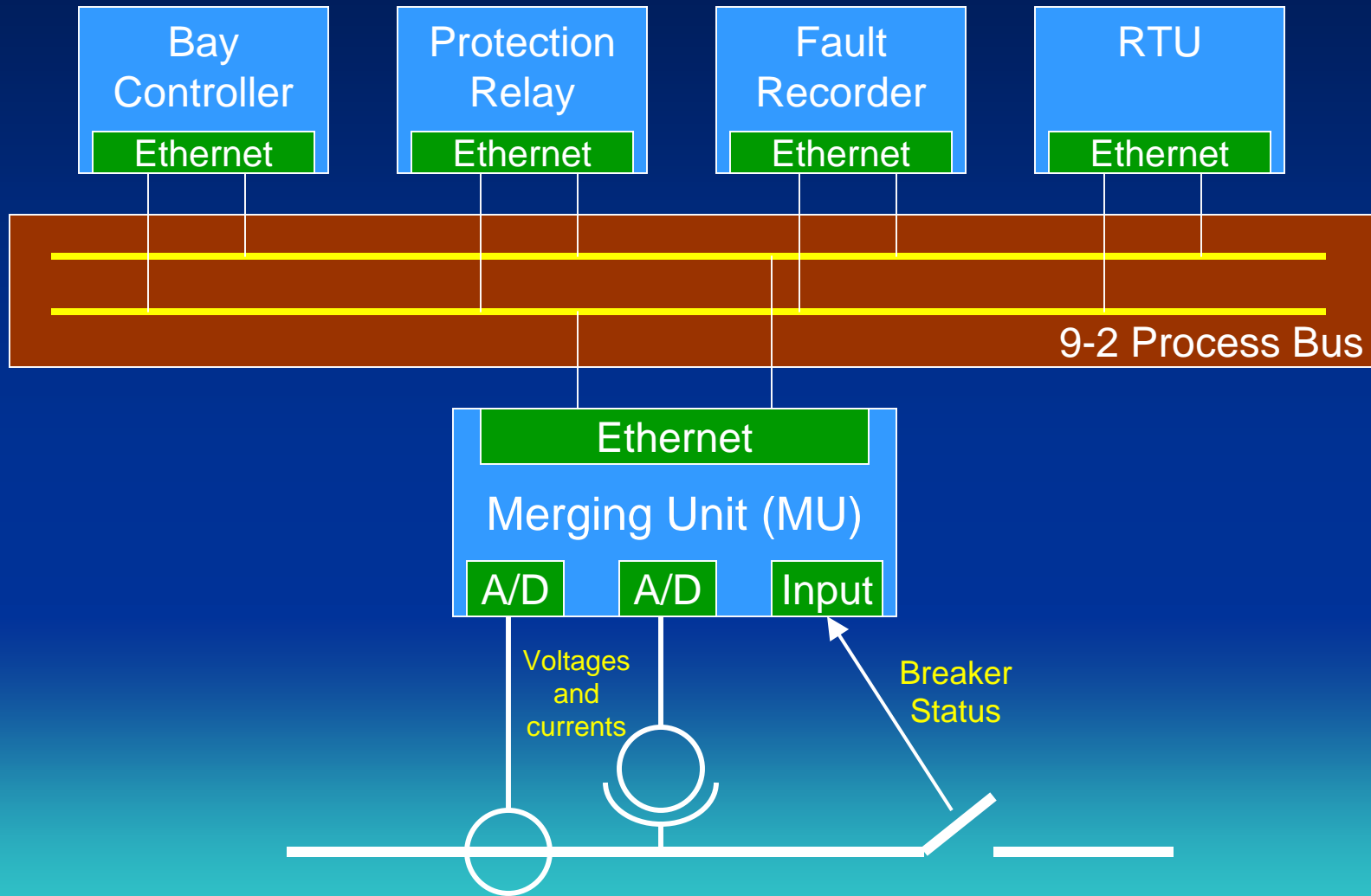


Legacy Approach

- Individually and redundantly wired to all devices needing the same signals:
 - CTs
 - PTs
 - Status Inputs
 - Outputs
- Each individual sensor must be calibrated and maintained separately.
- Incremental cost is exponential (signals x devices)
- Result is minimization of I/O



IEC61850 Approach





IEC61850-9-2 Process Bus

- Transducer and I/O signals are shared via a network.
- Only one transducer or I/O point per signal.
- Minimization of calibration and maintenance.
- Incremental cost is linear (signals only)
- Future: Integrated MU with digital fiber optic transducers



Justification

<u>Description</u>	<u>Legacy</u>	<u>IEC61850</u>	<u>Impact</u>
Equipment Purchase	\$\$	\$	+
Installation	\$\$\$	\$	+
Configuration	\$\$	\$	+
Flexibility	\$\$\$	\$	+



Conclusion

- IEC61850 substation architectures provide significant benefits to users.
- Key intangible: flexibility to accomplish new objectives that are too costly (or not possible) with legacy technology.
- Justification is challenging but realistic.



Thank You



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