Leveraging Shared IT Networks for Control Systems

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Outline

- **A Framework for Describing the Problem**
- **A Proposed Technology Solution**
- **Key Technologies and Standards**
- **Implementation Experience**
- **Discussion and Future Directions**

Peaceful Coexistence with IT?

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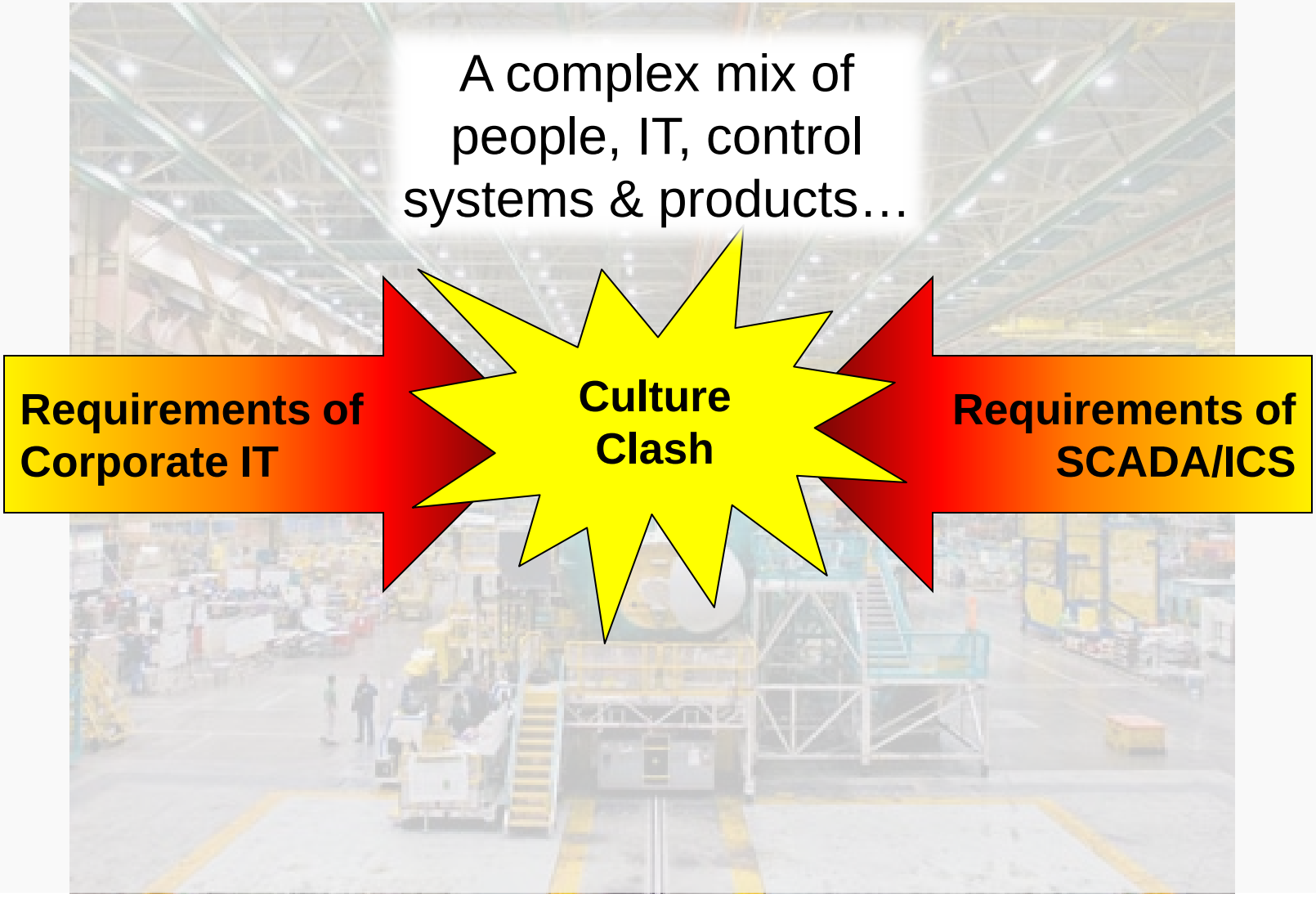
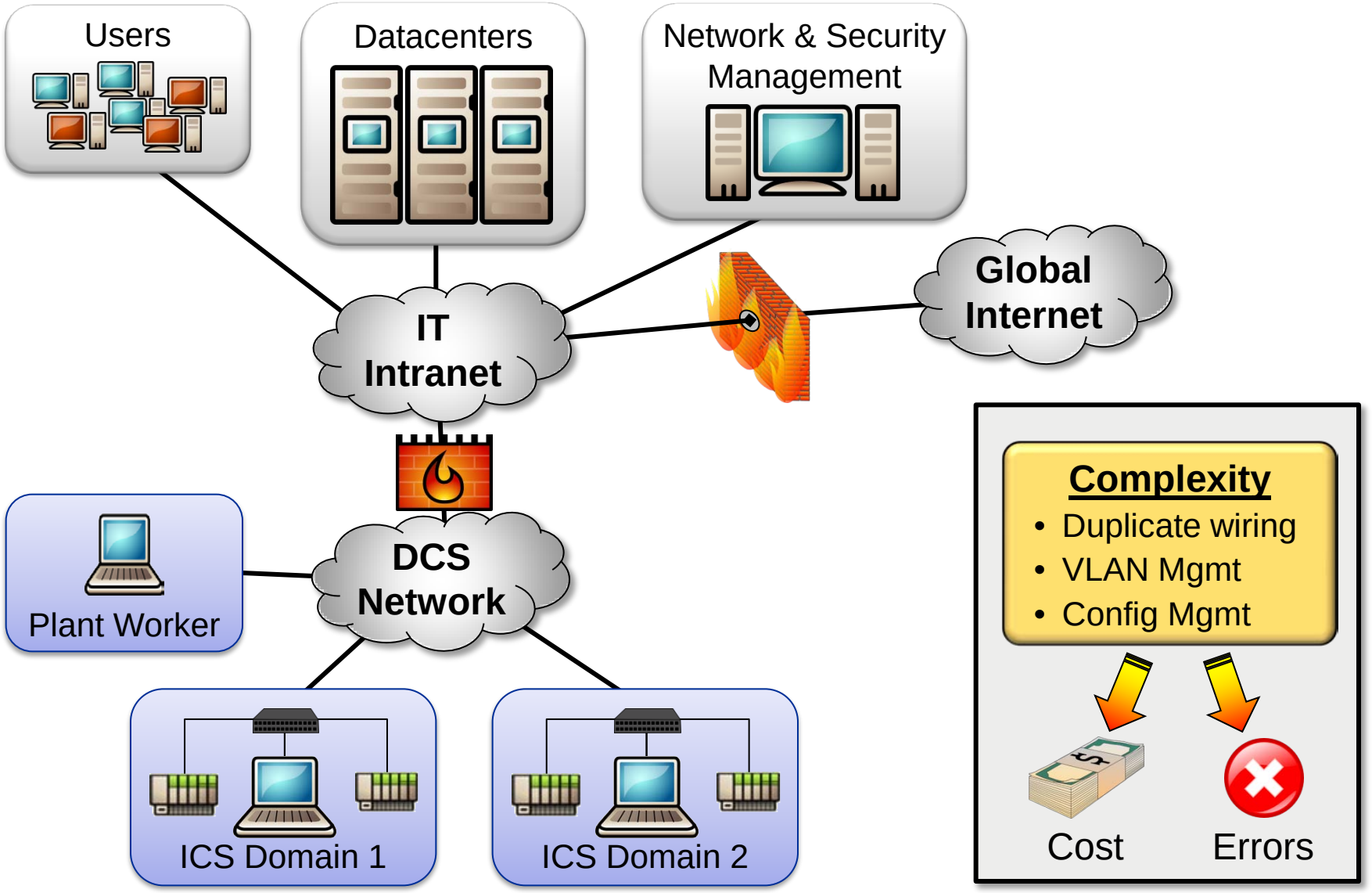
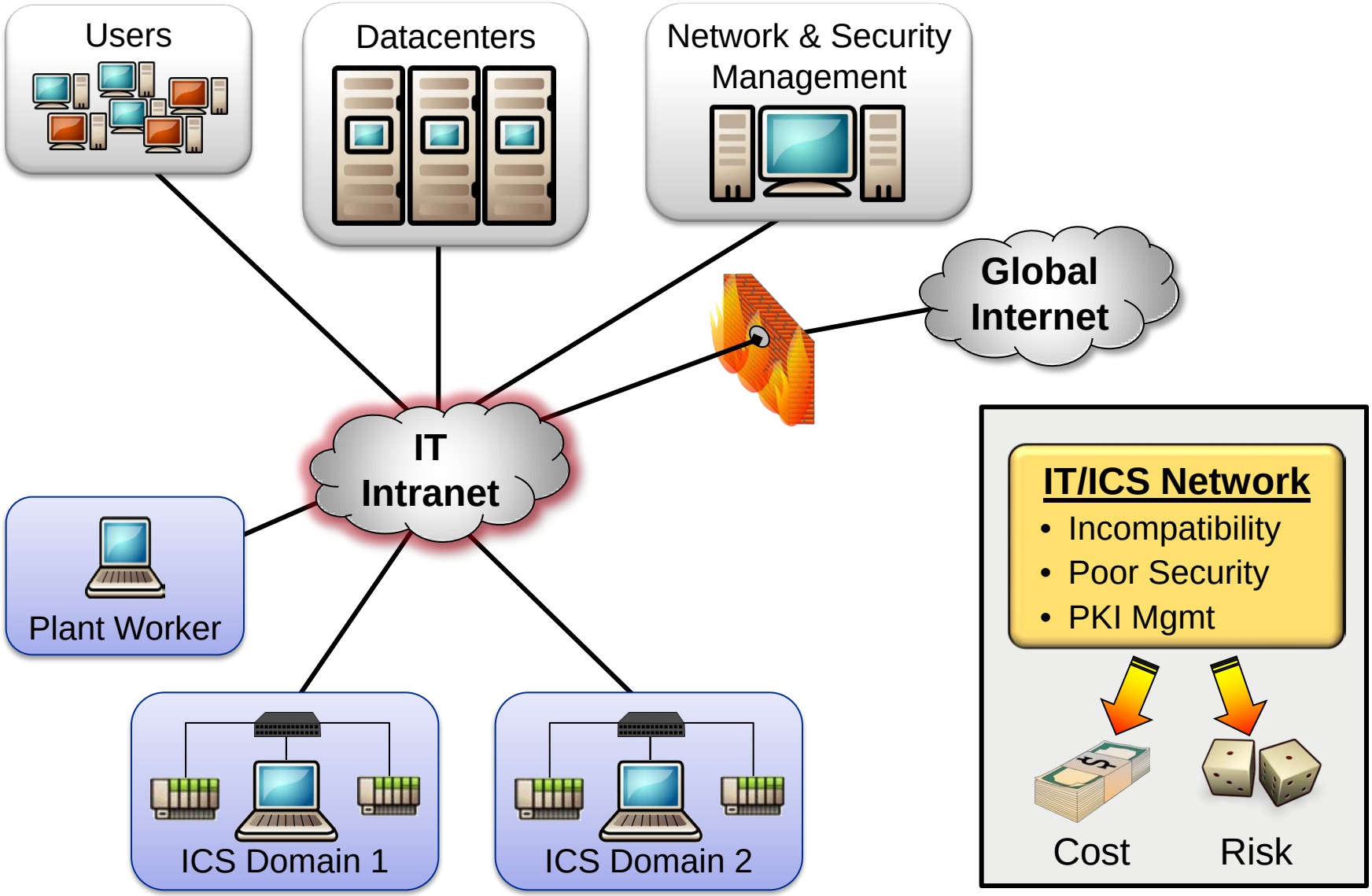


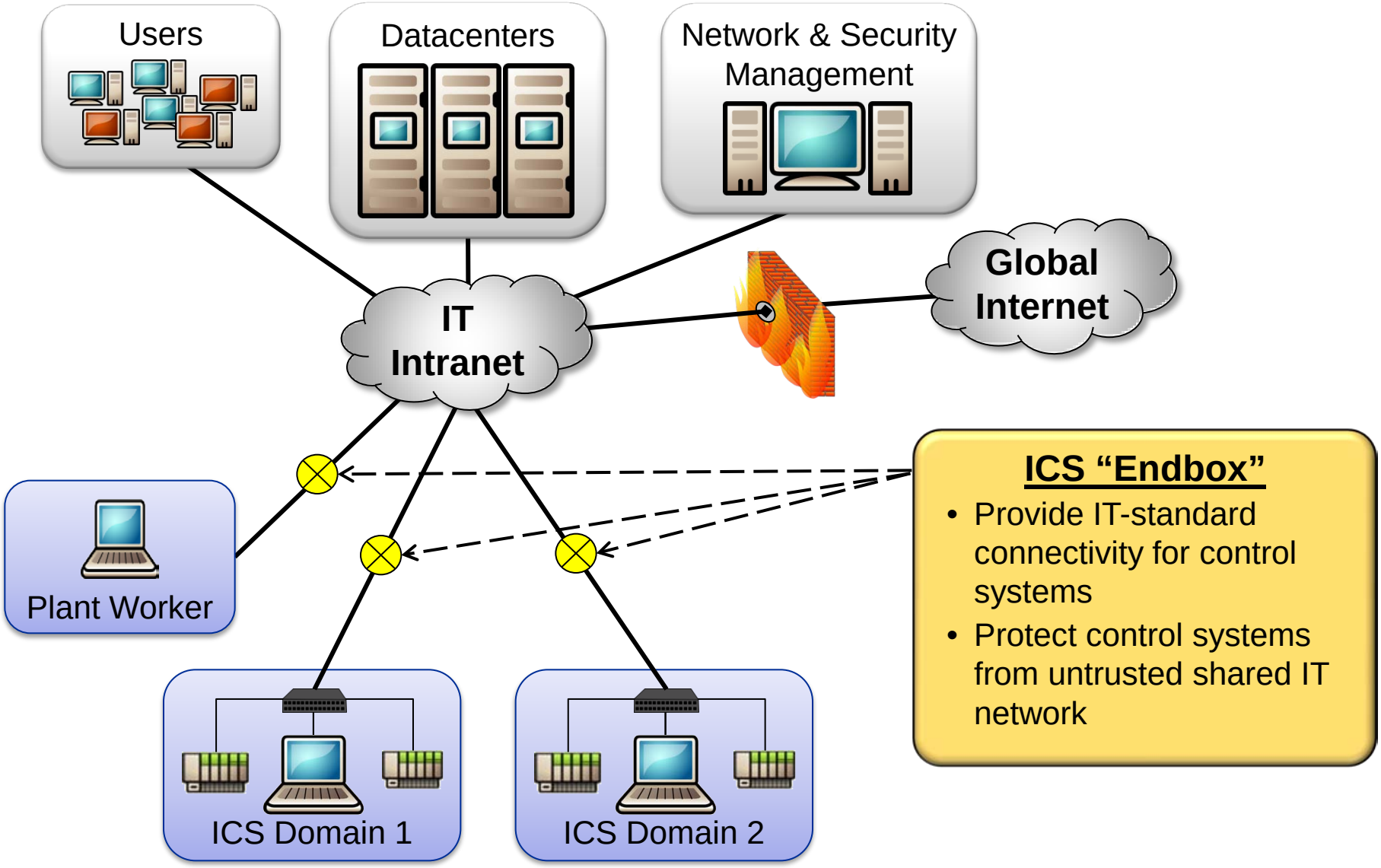
Typical IT ⇔ ICS Isolation Scheme



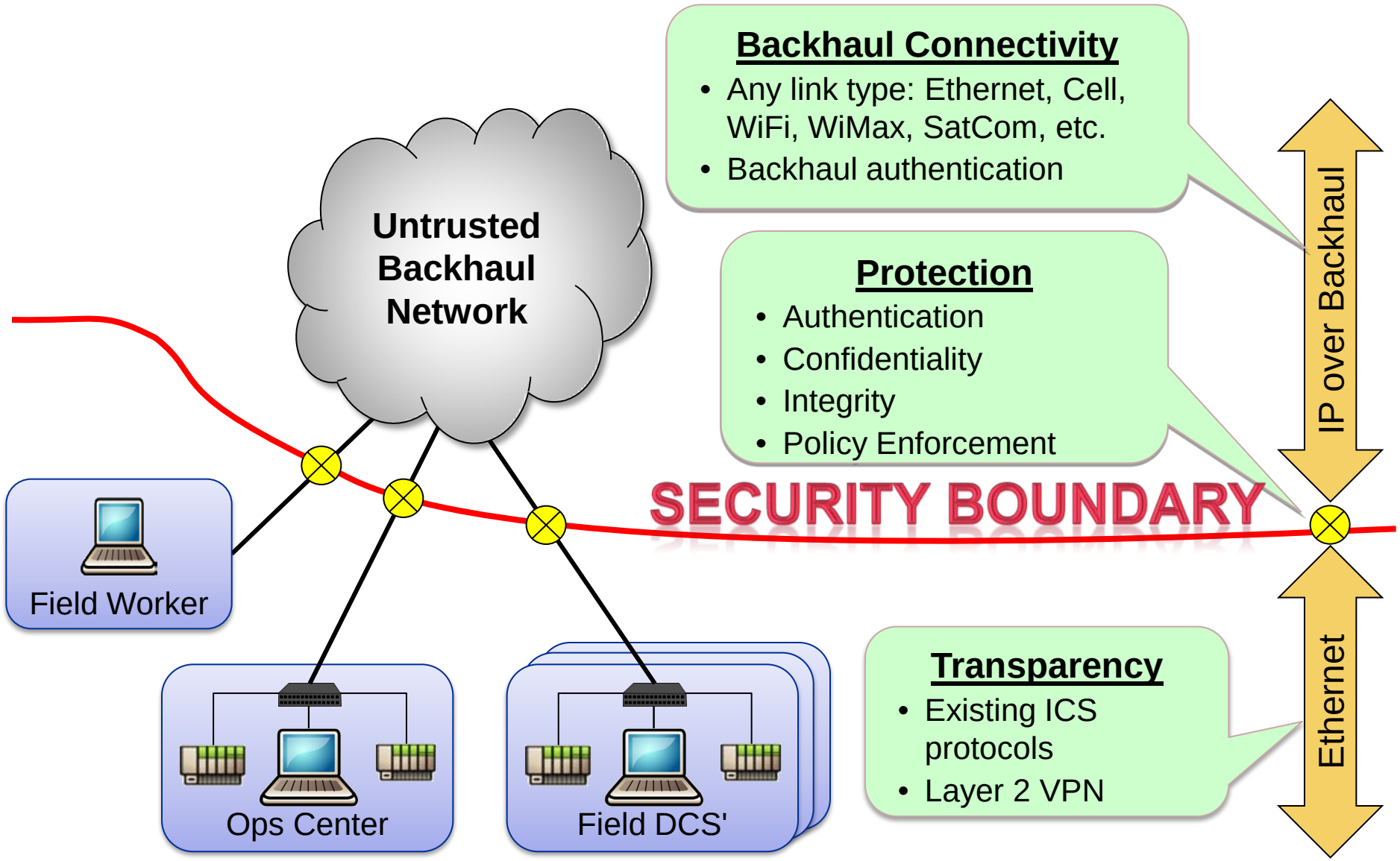
Ideal ICS ⇔ IT Shared Network



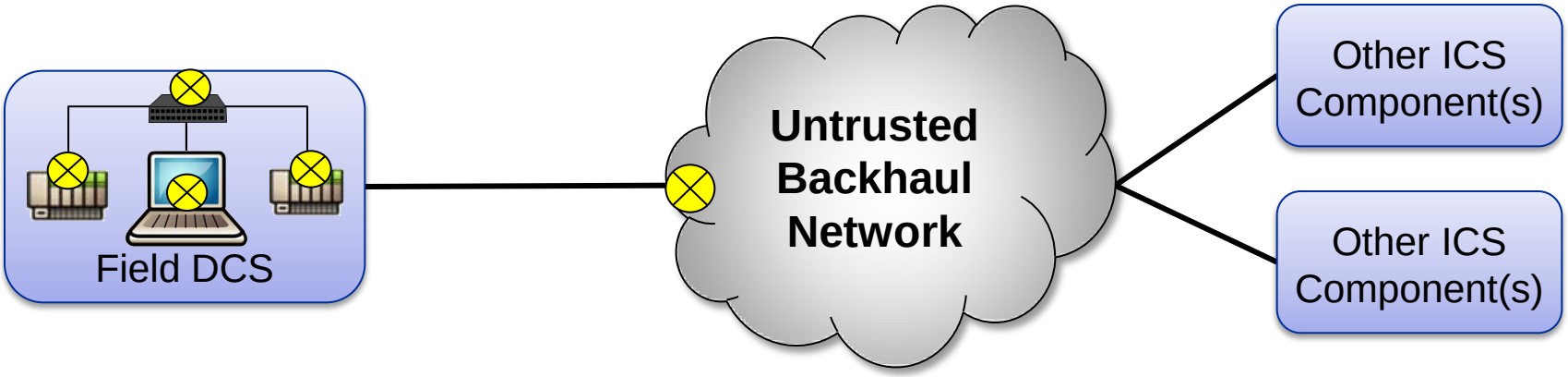
Protected ICS using Untrusted IT Network



Generalized Secure Backhaul for ICS



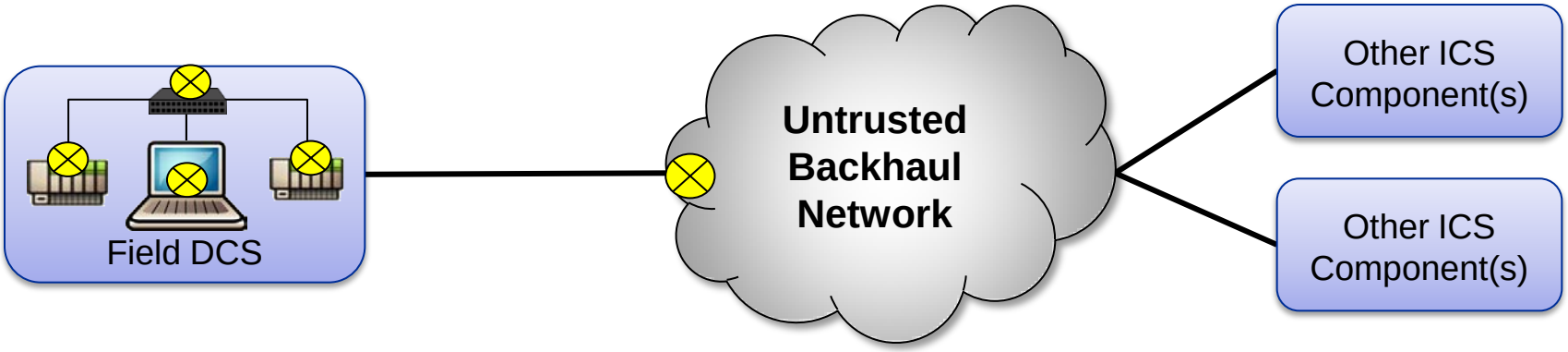
Where does the Endbox functionality belong?



A: There are multiple implementation approaches:

1. **It could be provided by the backhaul "ISP"**
2. **It could be placed in a separate box in front of a cluster of ICS devices**
3. **It could be incorporated right into the control system devices**
4. **It could be any combination of the above**

How do we make this inexpensive to deploy & operate?



A: Automate as much as possible:

- **Certificate provisioning and lifecycle management**
- **Endbox configuration management**
- **Connectivity policy definition and enforcement**
- **Monitoring and fault diagnosis**

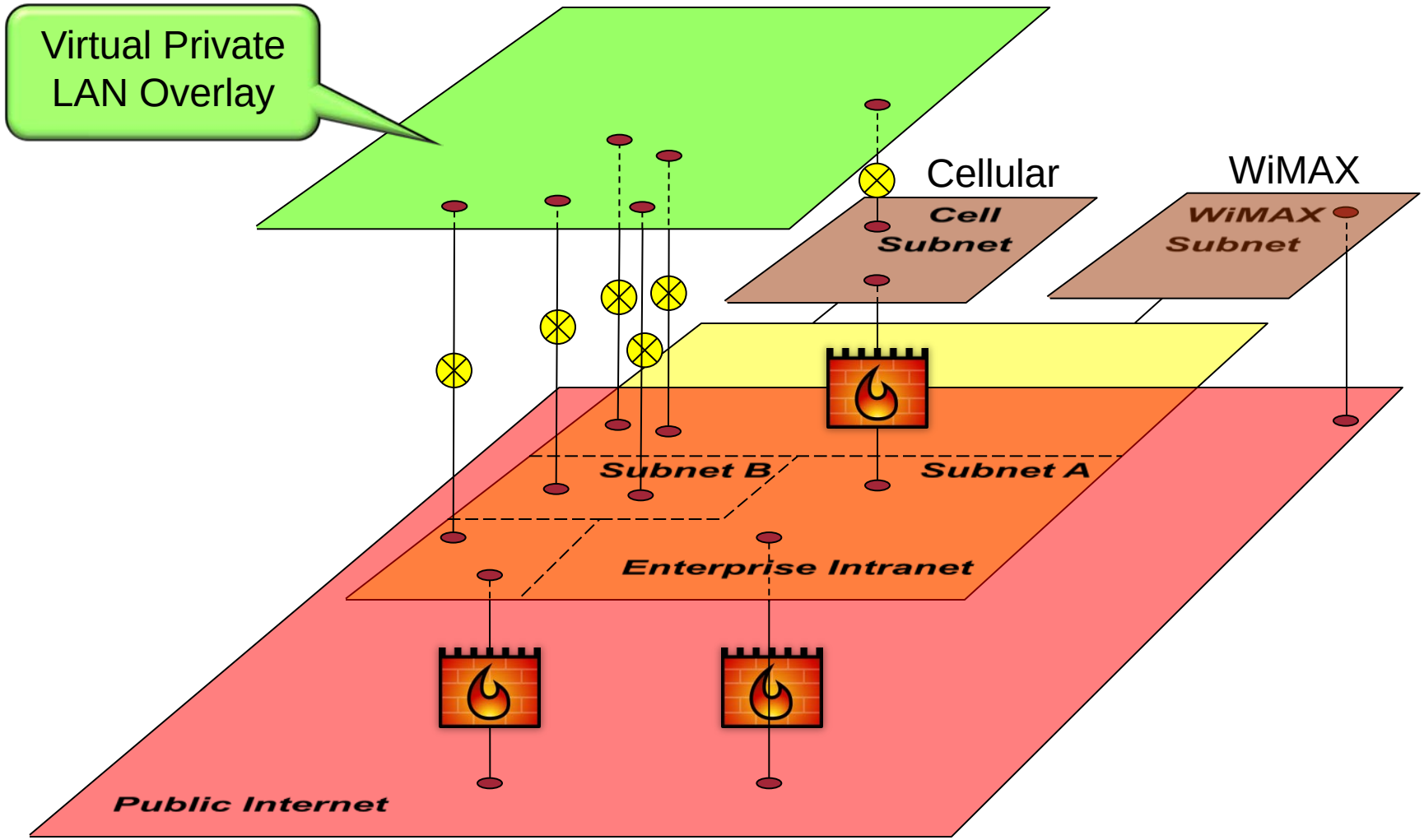
A: Use public standards wherever possible

- **IT standard services**
- **Key protocols and interfaces for interoperability**

High-level Architecture Goals

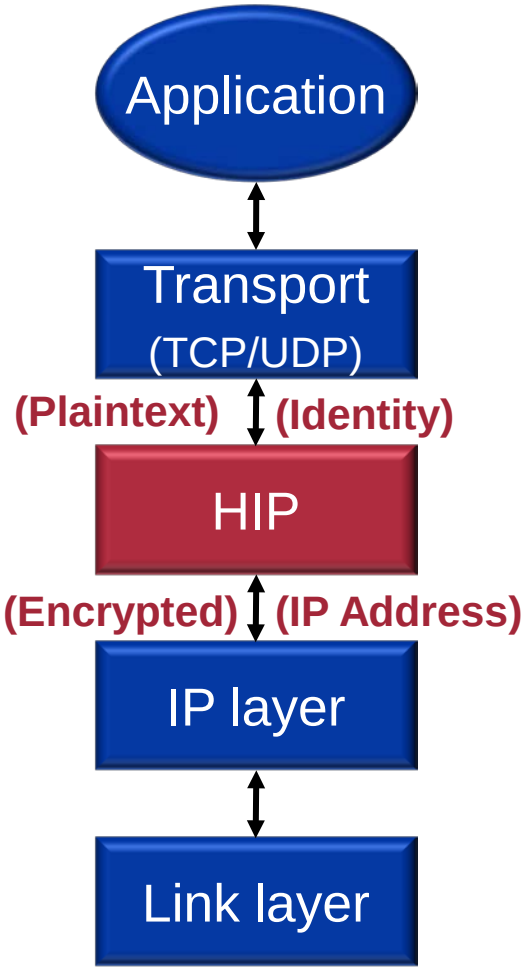
1. **Allow control systems to utilize a common shared network infrastructure to minimize deployment costs**
   - **Both wired and wireless**
   - **Support hybrid approaches (shared + isolated networking infrastructure) where appropriate**
2. **Isolate control systems from the shared network to protect "primitive" control devices**
   - **"Bake in" cryptographic identities and authentication**
3. **Allow controls engineers (not IT) to manage their own devices**
   - **Create a clear delineation between the roles and responsibilities of controls engineers and IT services**
4. **Keep CapEx/OpEx costs low and reliability high**

Virtual Private LAN Service (VPLS)



Host Identity Protocol (HIP)

- **Devices communicate over end-to-end encrypted HIP tunnels**
- **Basic HIP Features:**
  - **Requires no changes to layer 2/3 network infrastructure**
  - **Like IPSec, but tunnels are bound to cryptographic identities, not IP addresses**
  - **Creates a arbitrary "overlay networks" without having to mess with VLAN's**
  - **Secure over untrusted network infrastructures**
- **See IETF RFC's 5201-5207**

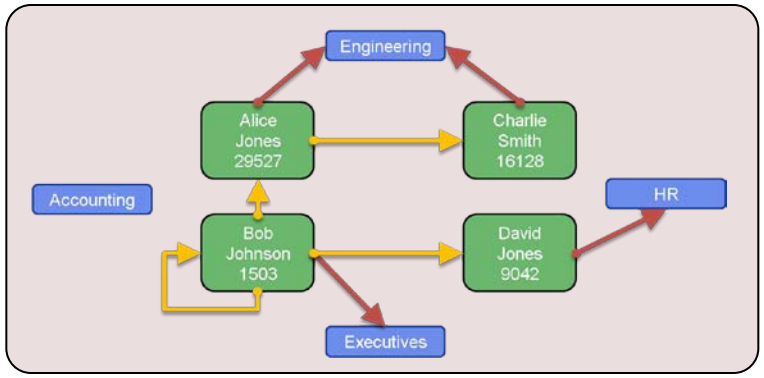


Interface for Metadata Access Points (IF-MAP)

Relational Database

LDAP Directory

MAP Database



Needed data properties

- **Lots of real-time data writes**
- **Unstructured relationships**
- **Diverse interest in changes to the current state as they occur**
- **Distributed data producers & consumers**

For more information, see the Trusted Computing Group website:

http://www.trustedcomputinggroup.org

Public Key Infrastructure (PKI)

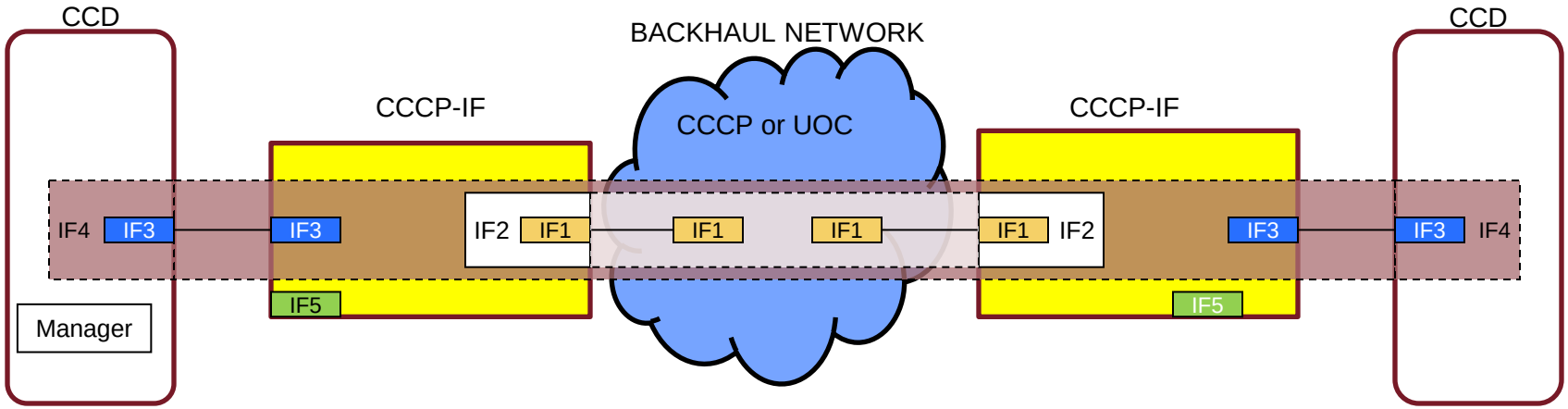
- **Full lifecycle management for cryptographic identities must be**
  - **Secure**
  - **Scalable**
  - **Robust**

- **Embedded systems are particularly sensitive to this issue (E.g., certificate expiry or revocation)**
  - **(Re)Bootstrap problem: How do you securely provision & manage a distant embedded system if it doesn't already have a cryptographic credential to identify itself for secure communications?**

- **We are working on automating much of the identity lifecycle management process using coordination through IF-MAP**

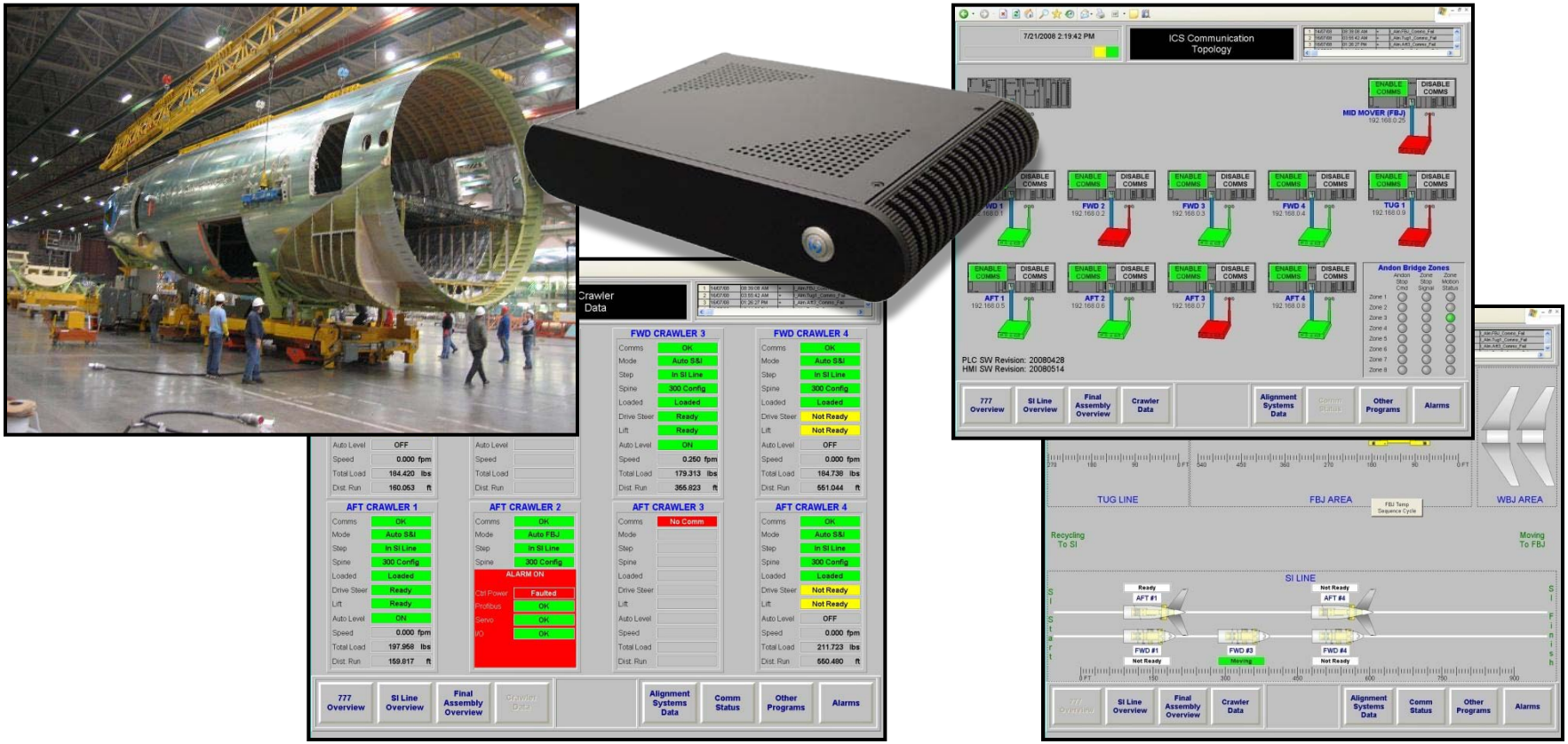
ISA100.15 Working Group

- **Creating a standard for "Secure Backhaul"**
  - **Commodity Commercial Communications Provider (CCCP)**
  - **User Owned Communications (UOC) infrastructure**
- **Focus on standardizing functional requirements and interface specifications**
  - **Leveraging existing standards wherever possible**
  - **Interoperability and compatibility are particularly important**



First Implementation at Boeing

- **Using 777 F/A as a pilot program**
  - **9 “Crawlers”, F/A tug, Integrated Control System (ICS)**
  - **In production use for more than 2 years**
  - **Formed baseline for standards & commercialization efforts**



Tofino “Endbox” LSM

One Possible Commercial Implementation

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April 2010

byres security inc
intrinsically secure

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The Vision

- Standards-based solution for general management of secure control system networks within the constraints of IT infrastructures
- Solution must work with existing legacy devices as well as future standards and products
- Must separate IT and controls group roles and responsibilities

A Standards Based Solution

- Solution based on open source software and public standards:
  - IPv4/IPV6, TPC/UDP
  - ITEF Host Identity Protocol (HIP)
  - TCG Meta-Data Access Protocol (MAP)
- Co ng the ICS inte
- Collaboration between Byres Security and Boeing to incorporate open source software created by Boeing into BSI commercially supported platform

This is NOT a proprietary solution

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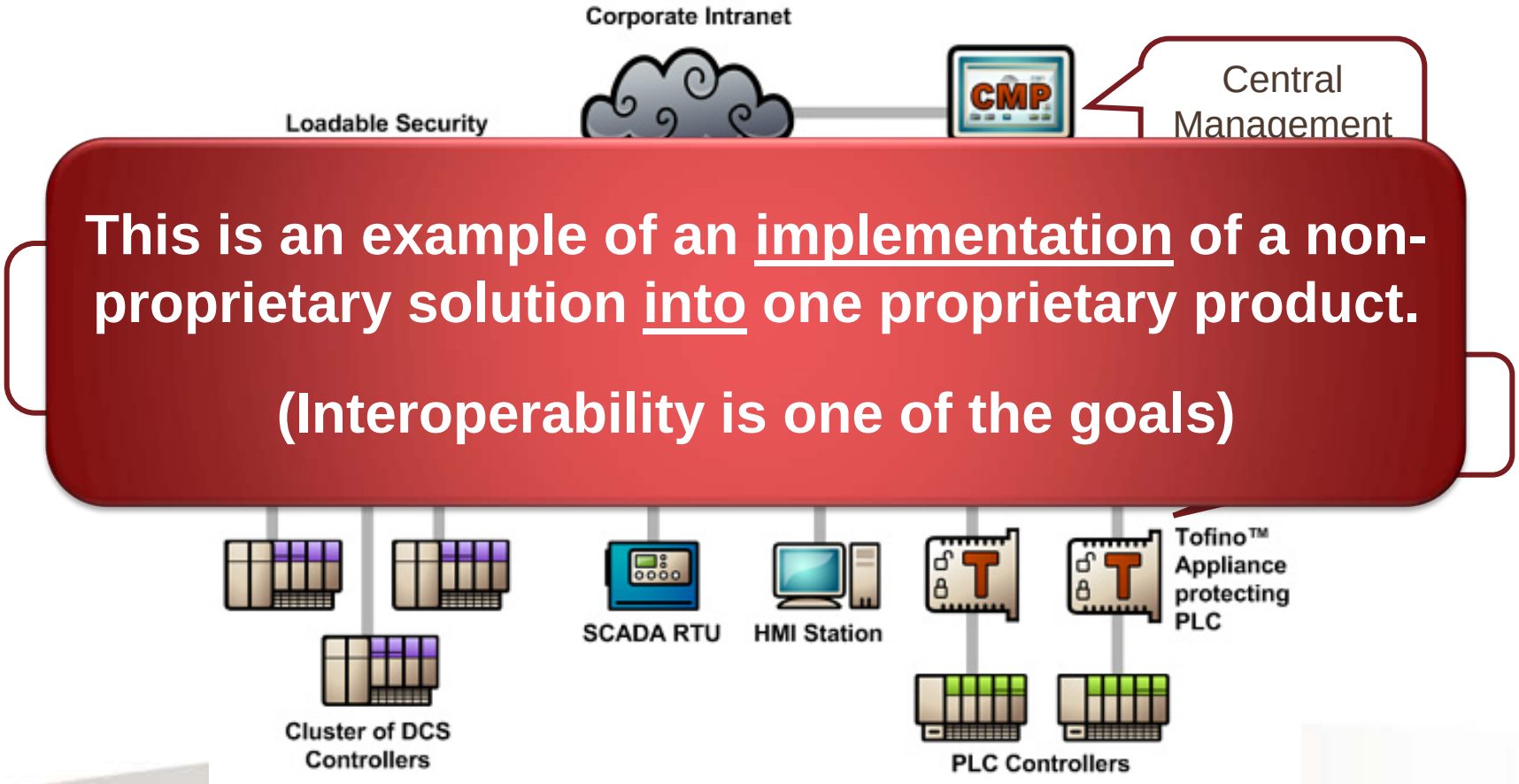
Incorporation into Tofino™ Architecture

- Created a HIP Loadable Security Module (LSM)



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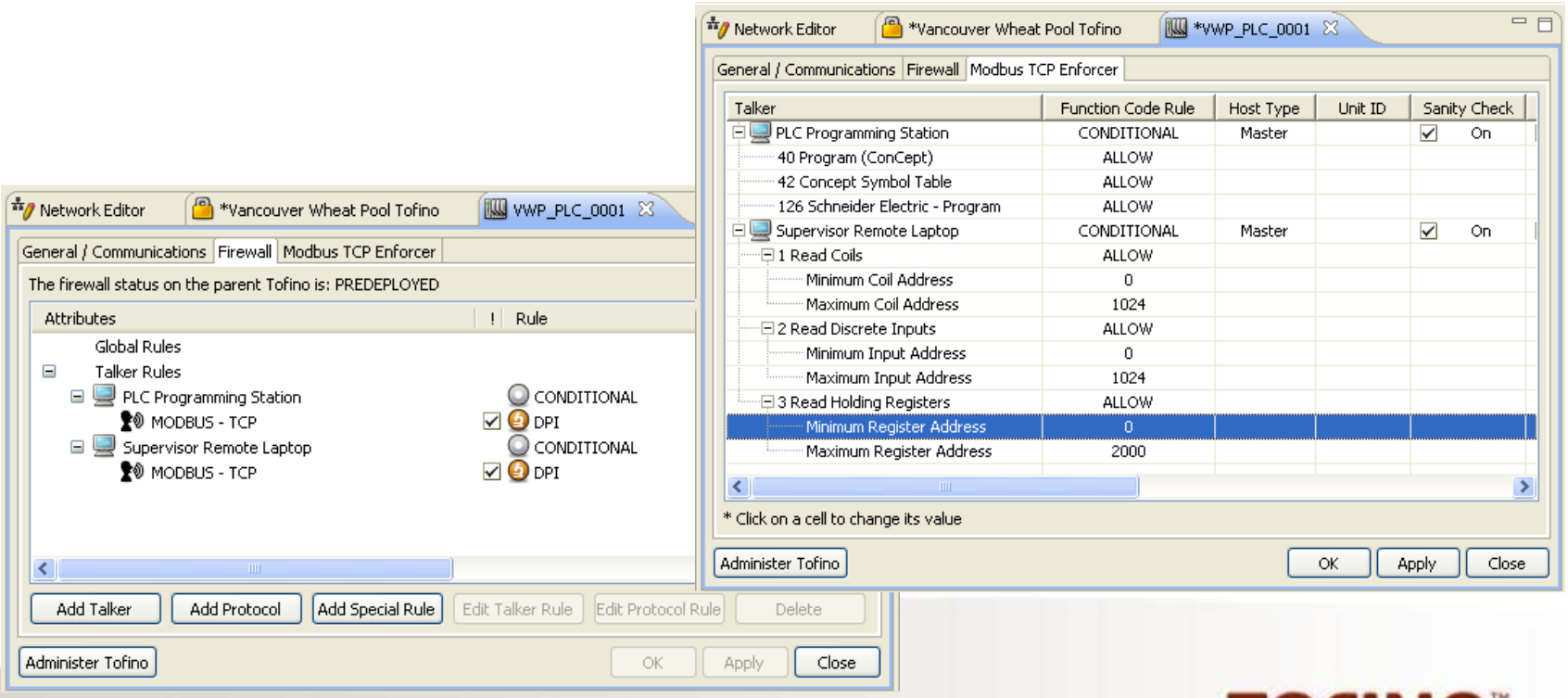
Endbox Configuration and Provisioning

- Endboxes can connect to standard IT networks
  - Uses internal certificate for network authentication as required
- Certificate and overlay configuration managed through a centralized secured web interface
  - Configuration and provisioning metadata stored in MAP
  - Access control for web interface will depend on each company's policies for IT and Controls teams roles.
- Endbox devices ship with factory certificates and settings that facilitate automated configuration and provisioning bootstrap process.

Simple Overlay Management for Controls

- Additional existing Tofino capabilities such as firewall and deep packet inspection can be configured through the BSI's CMP tool.



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Next Steps

- Continued interaction with ISA100 to develop a standardized set of interfaces for this capability
- Continued interaction with the Trusted Computing Group to standardize the ICS use case (provisioning & configuration management)
- Complete productizing and QA testing if sufficient demand is identified in the market space
- Industry awareness

Future Research

- Short Term
  - Fully automated certificate provisioning
  - Standard MAP authentication system
  - HIP for PCs
- Longer Term
  - Functionality embedded directly into future ICS products
    - No Endbox needed in those cases
  - Completion of ISA100 standardization activities for this functional architecture and implementation interfaces to facilitate interoperability

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Summary

- We’ve created an architecture that…
  - Is viable, scalable, and addresses the needs of current and future control system deployments
  - Leverages existing and emerging standards as much as possible
  - Is implementable and already has proven operational experience
- Our implementation experience exposed some gaps in existing standards that need work:
  - Certificate provision process for embedded systems
  - Handling of non-IP protocols in routed networks

Questions?