Assuring Mission Readiness with Resilient, Cybersecure Critical Infrastructure

Start Secure. Stay Secure. Restore Secure!

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OBJECTIVES

- “Resiliency” of Critical Infrastructure in military operations
- Key cyber engineering principles of resilient systems
- Real-world, practical application of commercial-off-the-shelf (COTS) IT/Operational Technology (OT) solutions
- Opportunities for data analytics created by convergence of OT, Facility-related Control Systems (FRCS) and IT

KNOWLEDGE PRIMER

- **“Facility-related Control Systems”**[1,2] (FRCS) monitor and control equipment and systems related to facilities (e.g. building automation, utility control, electronic security, fire & life safety, etc.).
- “**National Critical Functions**”[3] (NCF) are functions of government and the private sector so vital to the United States that their disruption, corruption, or dysfunction would have a debilitating effect on security, national economic security, national public health or safety, or any combination thereof.
- **“Critical infrastructure“**[4] is/are systems and assets sustaining NCF (e.g. DoD typically refers to as Tier 1, Defense Critical Assets, or Task Critical Assets).
- **“All hazards“**[5] are threats or incidents, natural or manmade, targeting critical infrastructure (e.g. natural disasters, cyber incidents, industrial accidents, pandemics, acts of terrorism, sabotage, destructive criminal activity, or any combination thereof.)
- “**Resilience**" is the ability to prepare for and adapt to changing conditions

FRCS is...


HVAC Maintenance Services
Fire Detection & Alarm
Lighting Control & Retrofit
Security & Access Control
Smoke Control
Digital Video
Indoor Air Quality Services
Energy Supply & Load Management
Intrusion Detection
Environmental Control
Mechanical Maintenance & Retrofit
Enterprise Systems Wireless • Voice/Data Internet/Collaborative Services
Assets
On-Site
Energy Information
Water Management

WHAT IS OPERATIONAL RESILIENCY?

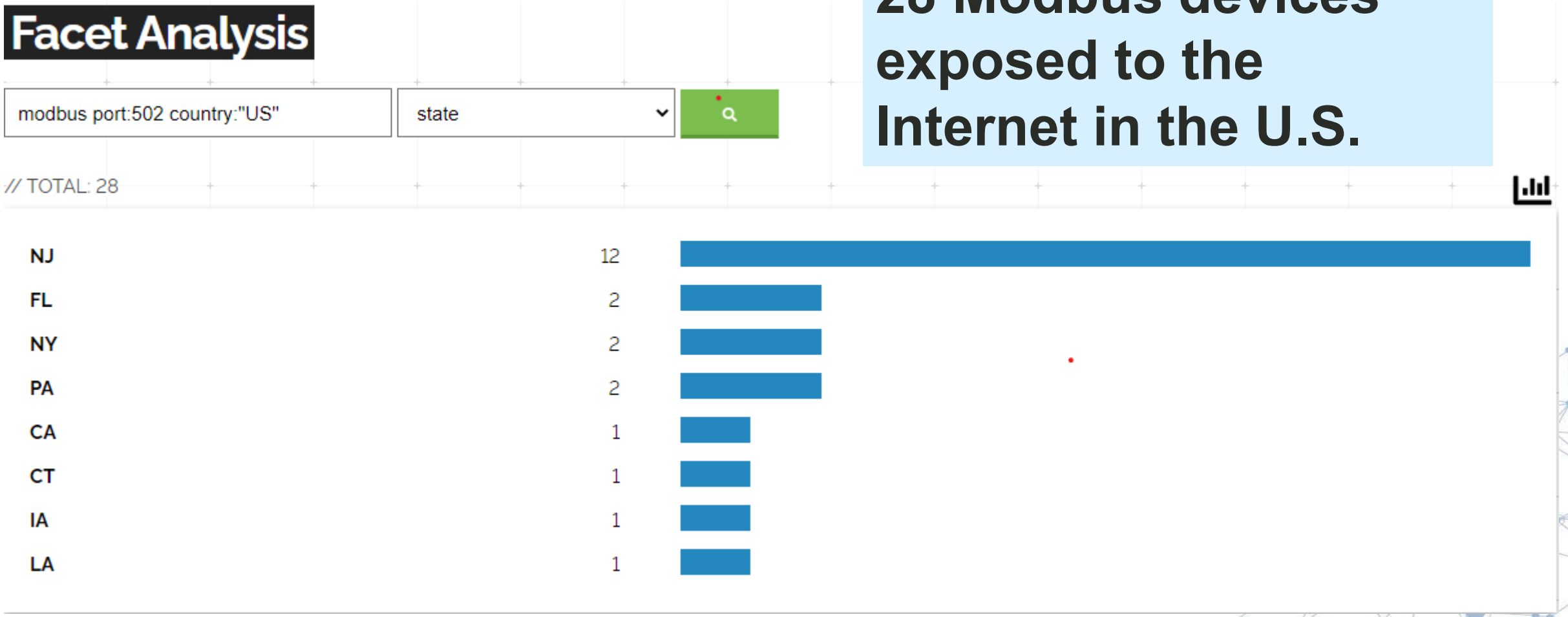
- **Resilience of Critical Infrastructure enabling military operations:**
  - "Must be secure and able to withstand and rapidly recover from all hazards"[5]
  - "Must survive and continue to operate National Essential Functions"[5]
- **"Ability of systems to resist, absorb, and recover from or adapt to an adverse occurrence during operation that may cause harm, destruction, or loss of ability to perform mission-related functions"[6]**
- **A resilient system is capable of mitigating operationally damaging effects from all hazards–which includes cyber attacks**

OT CYBER RISK & VULNERABILITIES

- **We consistently hear from clients…"But our OT Network is not connected to the internet". However, we routinely find at least one external connection; typically used to:**
  - Download patches/updates
  - Access systems or services hosted on the corporate network
- **OT/FRCS cyber attacks are believed to have increased in Q1 CY2022**
  - Probing from Russia and China against U.S. ICS resources
  - Globally, 45% of ransomware attacks target industrial organizations and infrastructure in North America (36% of that in the U.S.)[7]
  - 75% of ransomware attacks targeted the manufacturing sector[7]

Let's look for ICS - SHODAN scan

28 Modbus devices exposed to the Internet in the U.S.

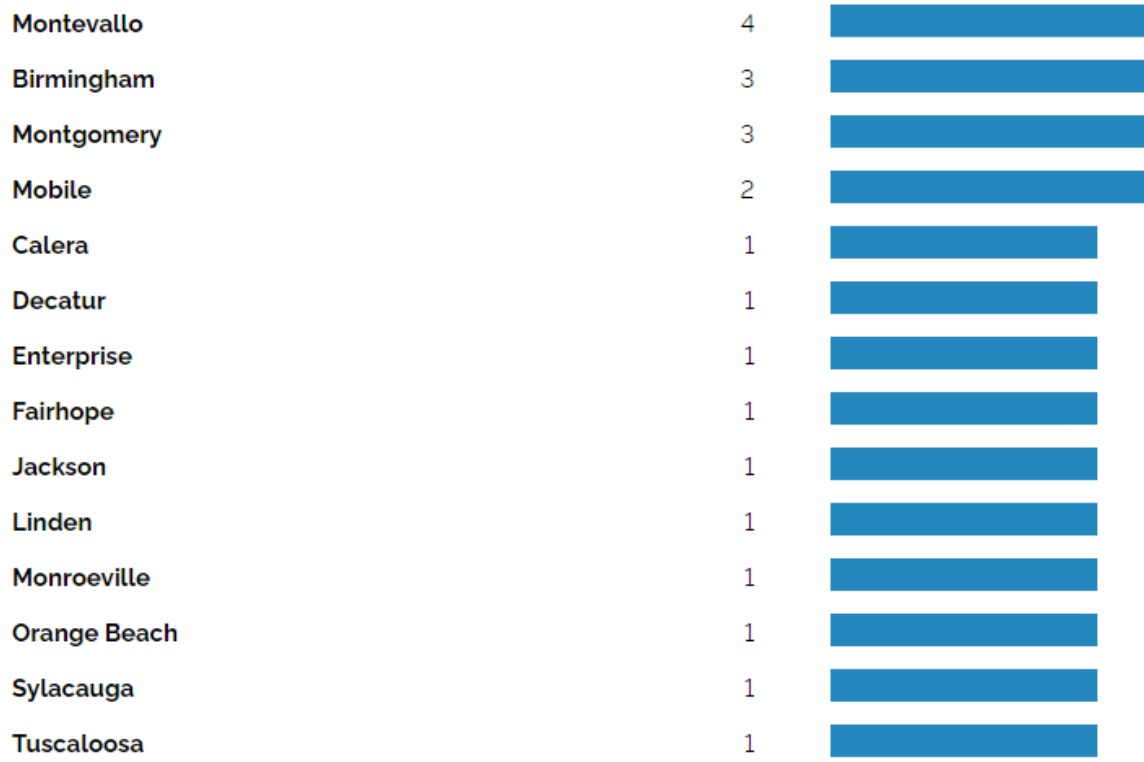


Let's look for ICS - SHODAN scan

bacnet port:47808 country:"US" state:"AL' | city

// TOTAL: 22

22 BacNET devices exposed to the Internet in Alabama




```
Instance ID: 100
Object Name: MATRIX-RTR
Vendor Name: American Auto-Matrix
Application Software: R_03_06_00
Firmware: 1.2
Model Name: AAM-Router
Description: Router
```

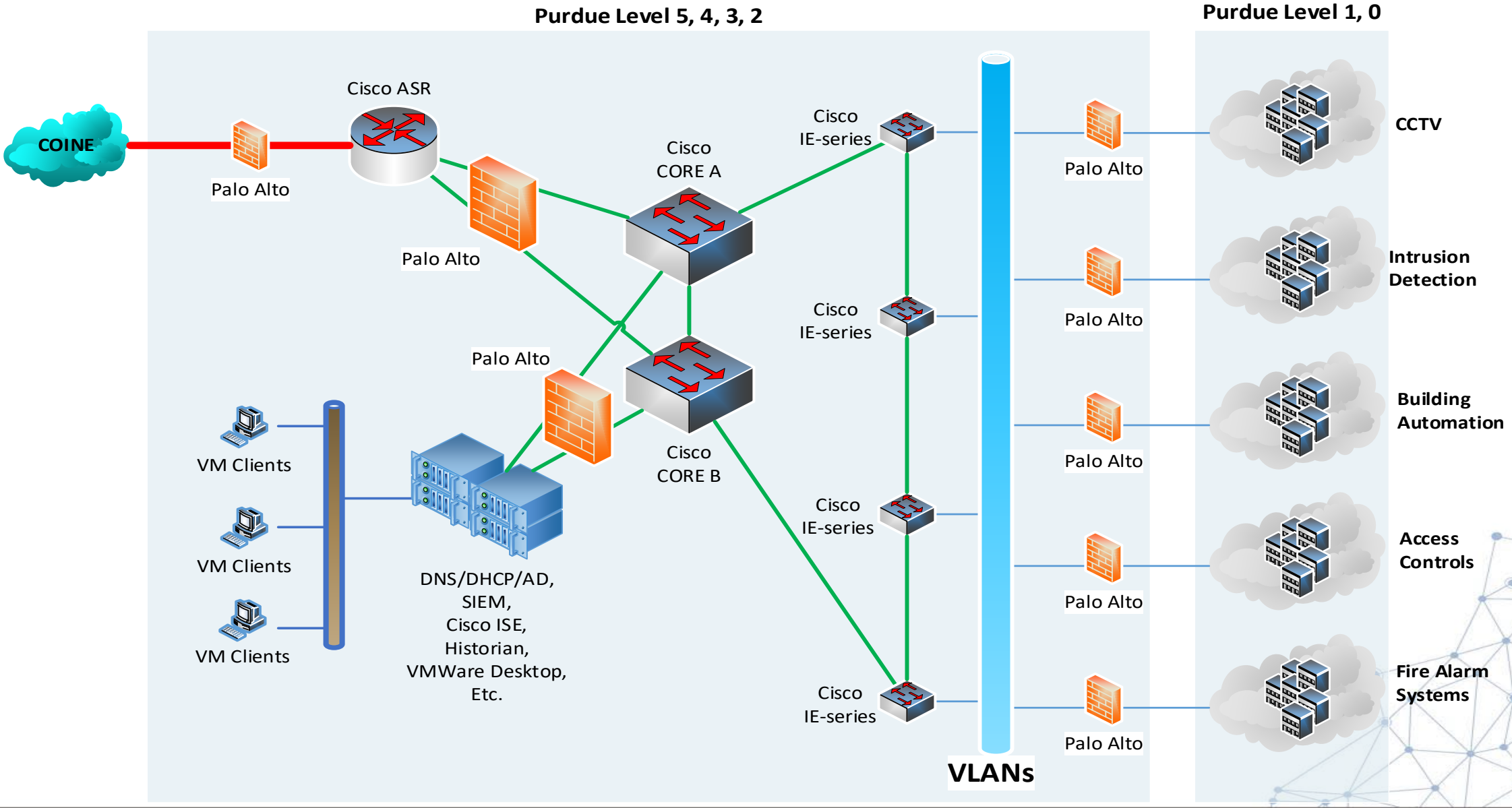
ENGINEERING DESIGN PRINCIPLES

- **Traditional IT is data-centric; FRCS is operations-centric**
- **Key characteristics of a cyber resilient, FRCS architecture**
  - Redundant & recoverable[6,8,9] (high-availability; graceful-degradation)
  - Maintains system integrity[8,9,10] (segmentation, segregation, isolation)
  - Preserves data integrity[6,10] (encryption, backup, and disaster recovery)
  - Perform behavioral monitoring[6,9,10,11] (detect deviation from baseline)
  - Performs analysis & visualization[9,10] (monitor, see anomalies, & alert)
  - Implements Zero trust[9,11] (deny all; only grant access by risk profile)
  - Detects malware & intrusions[6,9,10,11]

ENGINEERING CYBER RISK MANAGEMENT

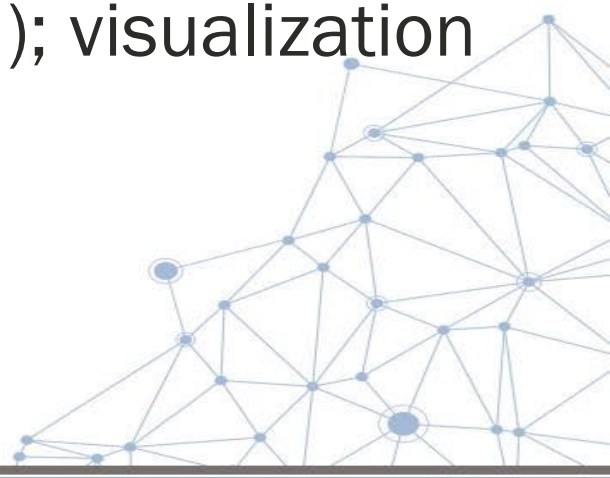
- **Perform functional system decomposition for "…identification of mission critical functions and critical components …"[12]**
  - Discover NCFs & critical Data/Assets/Applications/Services (DAAS)[13]
  - Idaho National Labs -- "consequence-driven" engineering[14]
- **UFC 4-010-06 Cybersecurity design process; Risk Management Framework (RMF)**
- **Facility and System Testing and Commissioning**
  - Inspection/Assessment against common set of cyber standards
  - Assure Cybersecure, Reliable and Safe operation of critical systems

FRCS TOPOLOGY

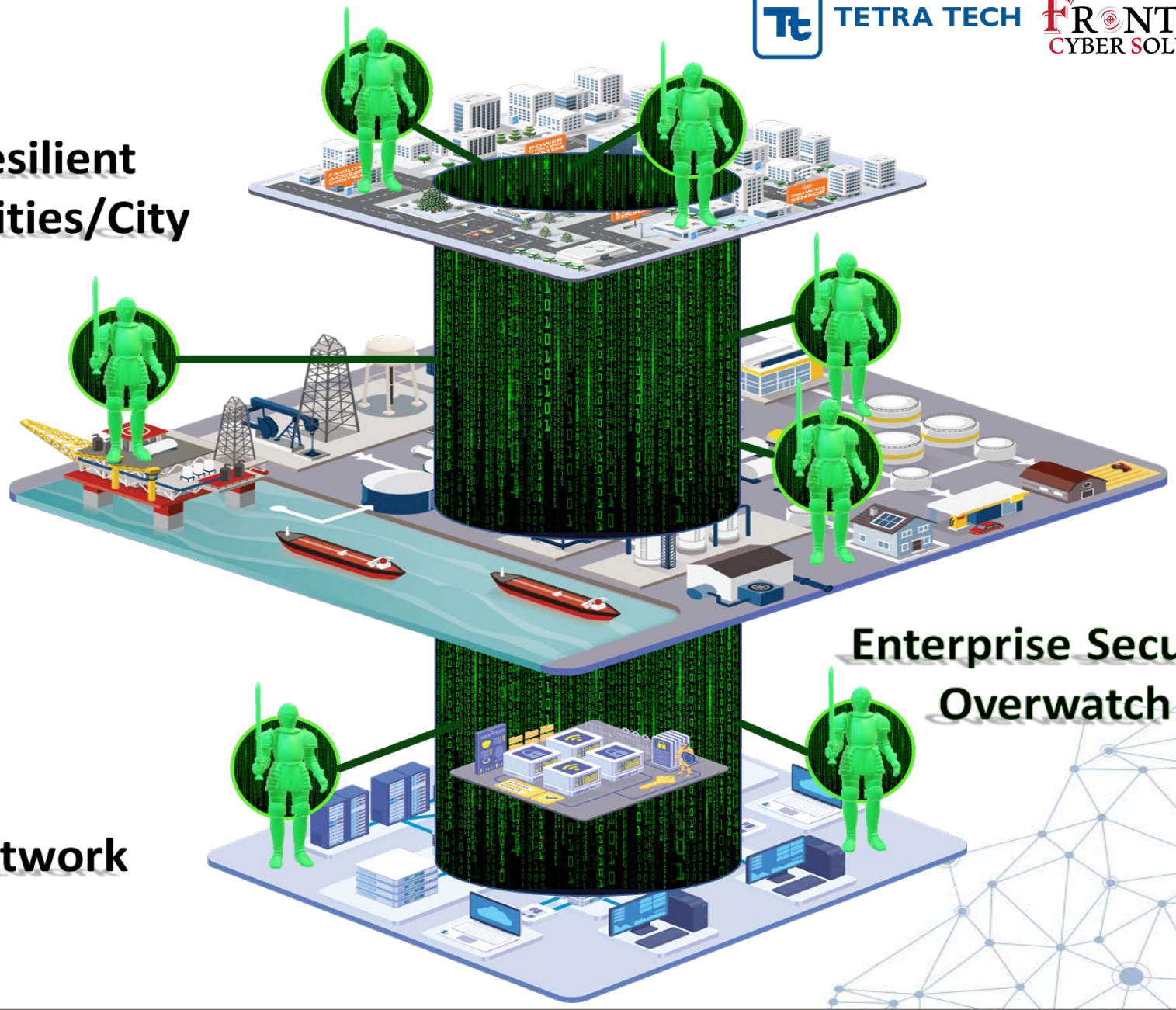


PRACTICAL INTEGRATION OF COTS

- **Implemented at Purdue-model Levels 5, 4, 3, & 2 (IT-centric)**
  - Network devices rated for industrial conditions
  - Virtualization and Zero Client workstations
  - Identity/Access Management; context-based (e.g. user, time, location, and access type)
  - Security Information and Event Management (SIEM); visualization
    - Intrusion & Malware detection
    - Asset identification
    - Event correlation

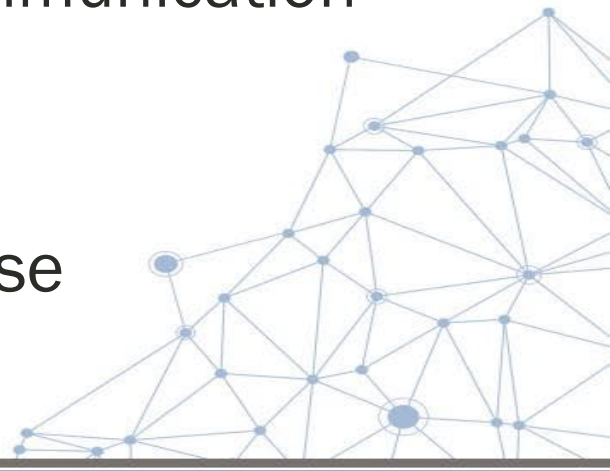


Operational View (OV-1)



PRACTICAL INTEGRATION OF COTS

- **Enterprise security "overwatch" (Monitors Levels 5 through 1)**
  - Monitors both IP and non-IP traffic at source
  - Collects full Packet-Capture (PCAP); FIPS 140-2 encryption
  - Builds full-domain, network model (IT, OT, and IoT)
    - Hybrid active system scanning (includes geolocation and metadata)
    - Visualization engine; models network nodes & communication pathways
  - Detect, characterize & alert on anomalies
    - Machine/Learning; event assessment and response
    - Records event forensics



BEST PRACTICES

- **Embodies NIST, UFC, UFGS and DoD standards/requirements**
- **Scalable architecture; build as much or as little as needed**
- **Assure safe and reliable operation of critical functions during attack**
- **Layered defense; zero-trust**
  - Assumes exploitation (i.e. enemy has compromised network)
  - Both IP + non-IP traffic; real-time monitoring, anomaly detection, and logging
- **Real-time enterprise visibility on cyber-health of system**
- **Correlate and analyze infrastructure and systems' performance data**
  - Enterprise/building condition-based modeling
  - Predictive maintenance analytics

BENEFITS OF DATA ANALYTICS

- Machine-Learning (M/L); baselines “normal” & watches for anomalies
- Predict equipment failures; initiate logistics request for replacement
- Identify sub-optimal equipment performance; auto-generate workorder
- Identify hazardous system configurations – alert operators
- Use-Case:

  Situation: During the routine electrical work, a contractor accidentally trips a maintenance isolation switch which takes a redundant UPS buss offline – putting missile launch operations at risk.

  Outcome: M/L algorithms detect dangerous system configuration and alert operators real-time; restoring redundancy before mission system outage.

CONCLUSION

- **We discussed…**
  - What is a resilient system
  - Threats to a resilient system
  - Things to consider during cyber engineering process
  - Integrating COTS products in system implementation
  - Benefits organizations can gain from data analytics

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