Zero Trust Networks - The Future is Here

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About Me

- Degrees in Computer Science, Electrical Engineering, 3 cybersecurity patents, **SANS since 1992**, curriculum lead for US Cyber Challenge, CIS Charter member
- Musician Indie Award Winner (No Strings Attached) 9 albums, wrote original theme song for PRI program, “World Café”, toured US, Europe
- Assistant Volleyball Coach VA Tech, USVA Club, Bronze medal winner (Handball, VA Commonwealth games)
- Biking (bicycle, motorcycle), Volleyball, handball

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Most Common Security Mistakes Made by Individuals (2001)

- Poor password management
- Leaving your computer on, unattended
- Opening e-mail attachments from strangers
- Not installing anti-virus software 
- Laptops on the loose
- Blabber mounts (file access open to the world)
- Plug and Play without protection
- Not reporting security violations
- Always behind the times (OS, application patches)
- Keeping an eye out inside the organization

EDU (now) vs. Corporate Structure (future)

- **Administrative** – the process that runs the institution (**CORP**)
  - Payroll, HR, Purchasing, Facilities, Legal, etc.
  - **Security model closest to corporate model**
- **Academic/Instructional** – the process that supports teaching/learning (**ISP**)
  - Learning Mgt Systems such as CANVAS, Blackboard, Moodle
  - Course Delivery systems – Zoom, Webex, etc.
  - Heavily BYOD – all flavors, types
  - **Security model closest to an ISP**
- **Research** – **hybrid** of the previous 2
  - Intellectual Property protection, High risk, visibility
  - **Security model is a hybrid of corporate and ISP**

What are You Defending? What Should You Defend?

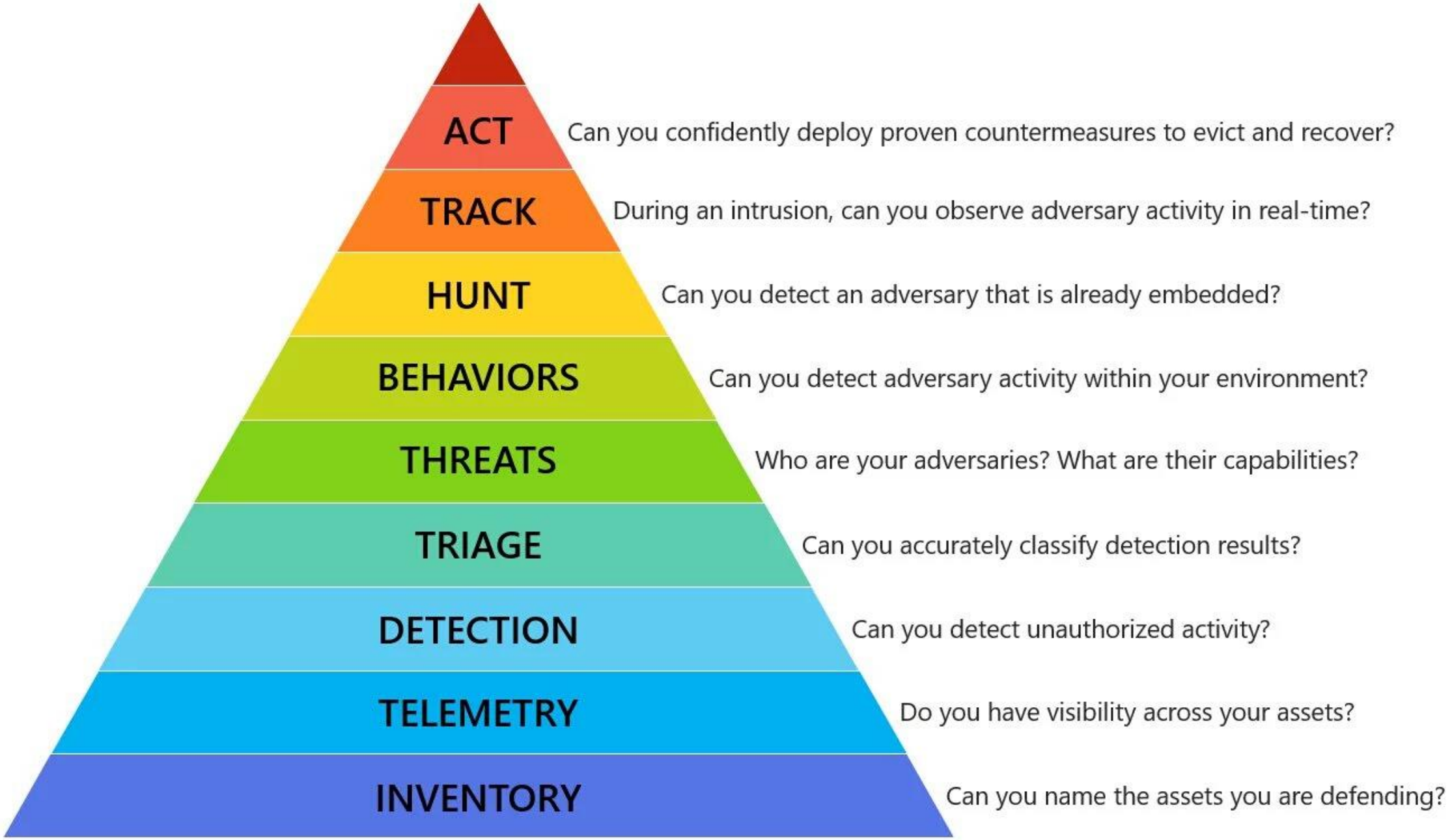
- Systems? Not really but that's what we thought should be defended.
- Networks? Safe answer.
- DATA – what we should be defending.

Hacker Attack Goals

Hacker attack goals are 1 or more of the following:

- **DATA theft/disclosure** aka data breaches
- **ATTACK** other sites using hacked assets
- **DESTRUCTION** of company data (deletion or ransomware).

- **DEFEND** accordingly



Border? What Border?

- Internet 1.0 – static servers, endpoints
- Internet 2.0 – static servers, mobile endpoints
- Internet 3.0 – mobile servers (containers, serverless), mobile endpoints (laptops, phones, tablets, IoT, ICS)
- Current security architectures are somewhere between Internet 1.0 and Internet 2.0.
- We need to adapt to Internet 3.0 now.

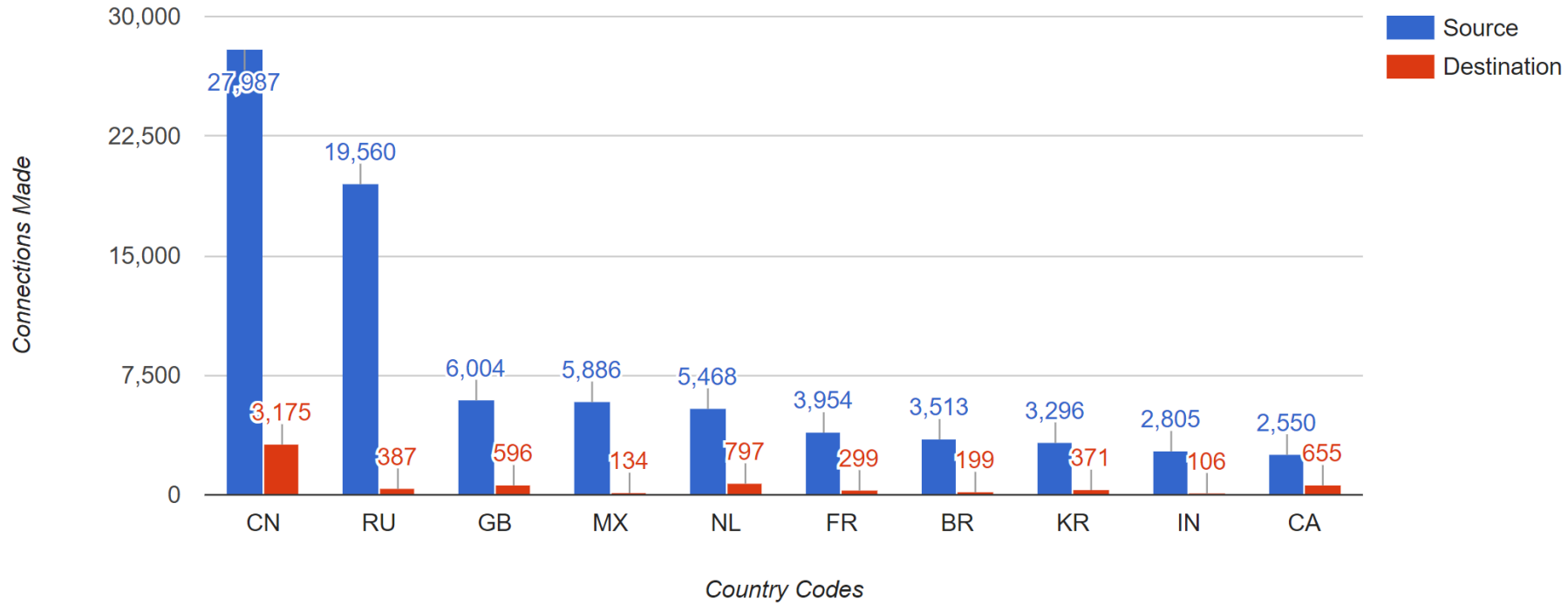
Another View of ZTN

- “As we move our data outside of the firewall, we have to adopt a zero-trust type model, “ [Chris] Townshend said. “We are shifting our security enforcement out to the data itself, and **you have to have a security policy that follows that user no matter where that user is or what device they are using to access the data”**
  - “The new cyber landscape”, Patrick Marshall, GCN Magazine, vol 37, #1
- In other words, data becomes the border.

Sample In/Out Traffic Profile

Top Source & Destination Countries - By Connection

Aug 01, 2017 to Aug 31, 2017 - ITSO Argus Data



Country Code	Country Name	Source Count	Destination Count
US	United States	91396	206186

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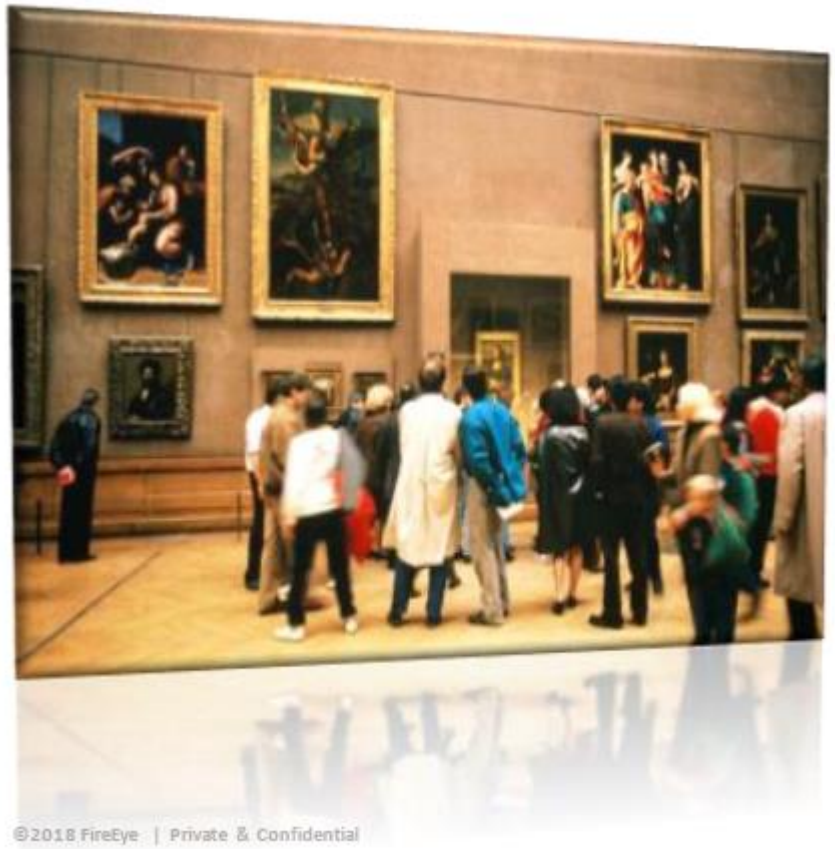
Museum Defense in Depth



- Control access points
  - Limited but **free flowing** access points
  - Additional barriers around high risk assets
- Pervasive Monitoring tools
  - Cameras, motion sensors, etc.
- Active Response
  - Guards, on-demand barriers, fire suppression
- Recovery Measures
  - Insurance
  - Tracking devices
- Assume hostiles are inside.

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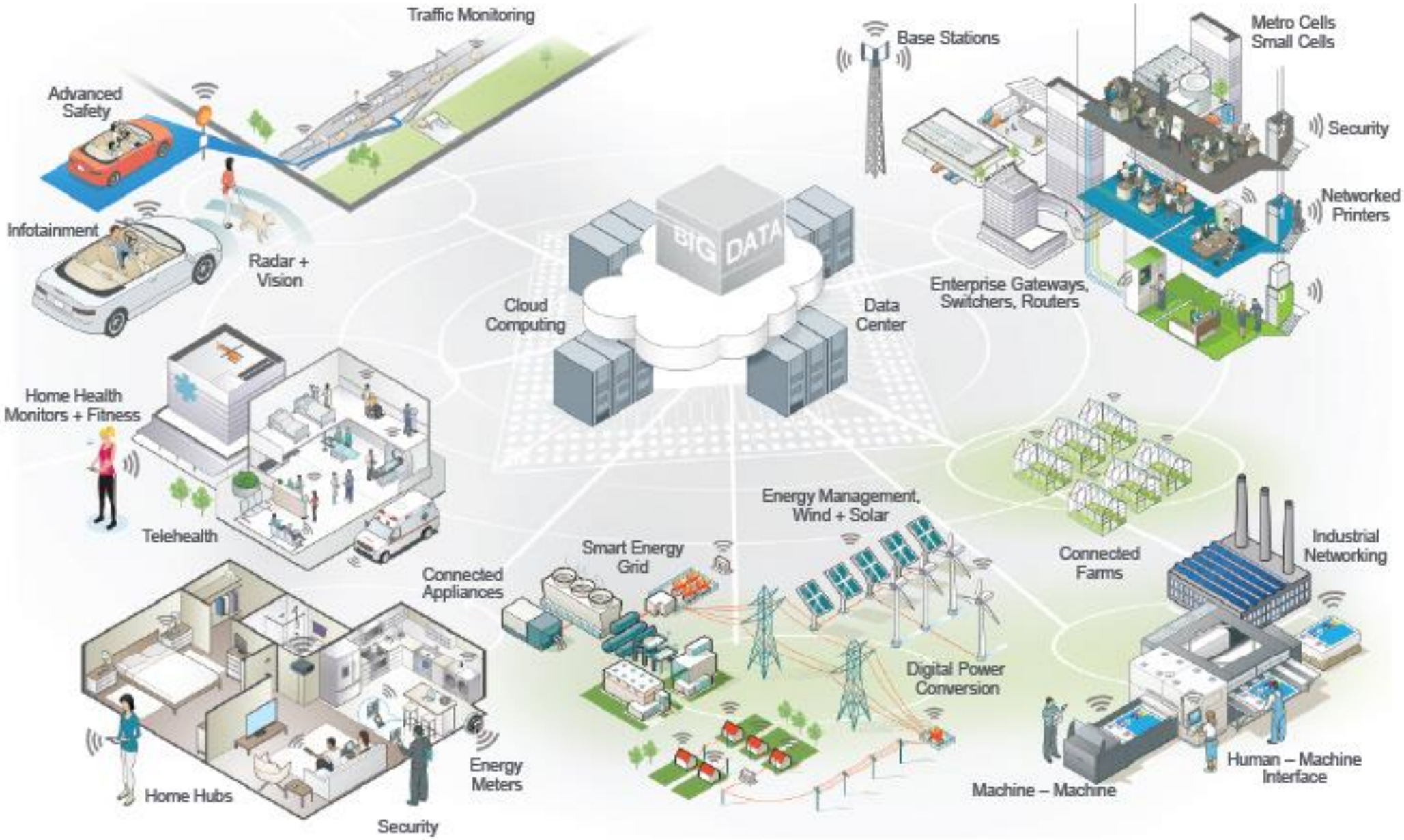
ENABLING SMART CONNECTED SOLUTIONS FROM THE END NODE TO THE CLOUD



*Zero Trust Networks(ZTN) Characteristics**

Network and user traffic patterns have changed dramatically in the past 20 years.

- Pillar 1: The network is always assumed to be **hostile**
- Pillar 2: Assume the hostiles are already **inside your network**
- Pillar 3: Network locality (segmentation) is **not sufficient** for deciding trust in a network
- Pillar 4: **Every** device, user and network flow is authenticated and authorized
- Pillar 5: **Policies** must be dynamic and calculated from as many sources of data as possible

** "Zero Trust Networks: Building Secure Systems in Untrusted Networks", Evan Gilman, Doug Barth*

The Future: The Mobile Internet

Positioning IT for the future

- Pillar 6: The device is no longer the border. A **user's identity/Data pair is the new border.**
- Pillar 7: Containers, serverless and cloud computing are the new disruptors of traditional security architectures.
- Pillar 8: Mobile users, mobile apps, mobile storage

ZTN - Theory

- Easier said than done. Not all of the technology and components available today….not yet.
- **All data must be secured regardless of location.** Encryption at rest or in transit. Have to find it first!
- **User identities must be confirmed.** Access to data strictly enforced. Default of minimum privileges
- **All network traffic should be logged and analyzed**.
  - “trust but verify” -> “Verify and never trust”
- Eliminates distinction between trusted-inside-perimeter and untrusted activity that crossed the perimeter

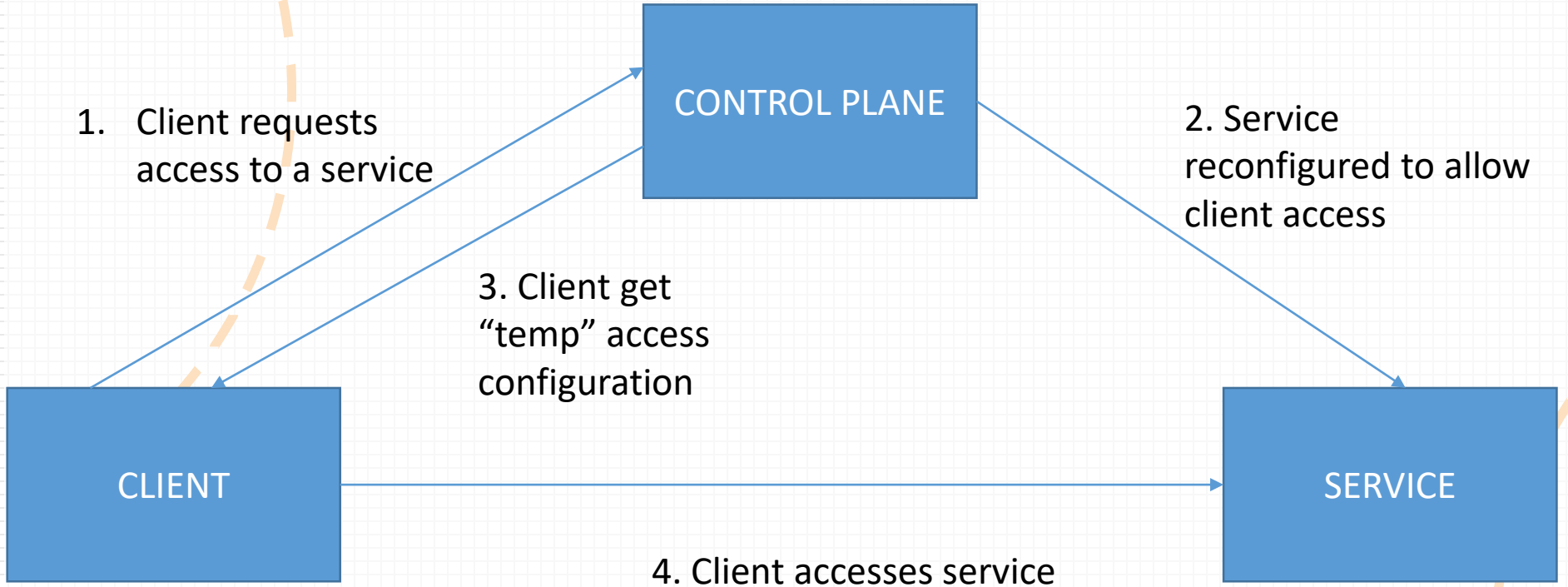
ZTN Characteristics

- Treat all hosts as internet-facing (take that, .com, .gov, .mil ….)
- Use existing tech in novel ways
- Perfect fit for cloud

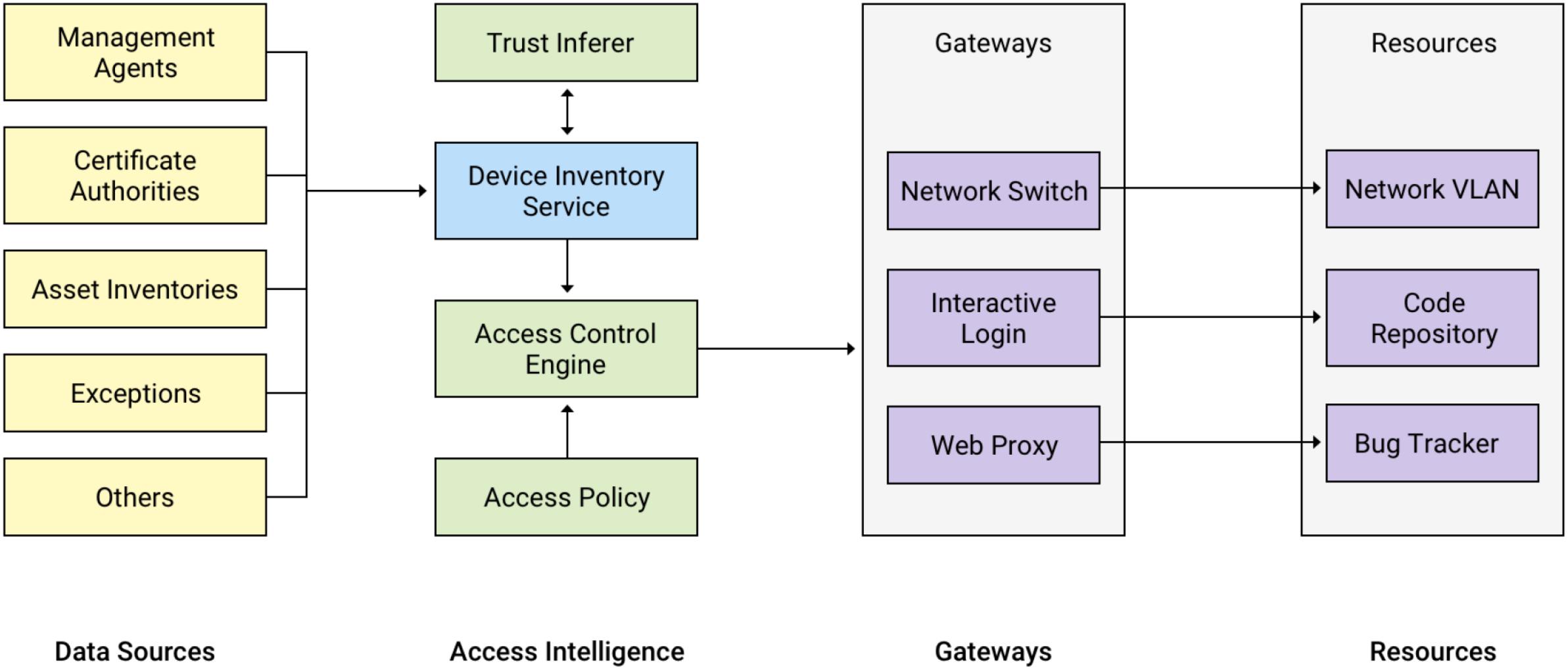
ZTN Components (Theory)

- Control Plane
  - Processes requests from data plane devices that want to access or grant access (to) network resources
  - User, device authentication & authorization done here
  - Stronger authentication to higher risk resources done here
- Data Plane
  - Components include applications, firewalls, proxies, routers that process network traffic
  - Handles high traffic rates

ZTN Client-Control Plane Interaction (Theory)



Zero Trust Networks, Fig. 2-5



BeyondCorp Infrastructure Components

ZTN Authorization Architecture

- Enforcement
  - Critical to place these as close to endpts as possible
  - Reference a policy, decide and enforce application of this
- Policy Engine
  - Has power to make decision to grant/reject resource requests
  - Best defined in logical network terms

ZTN: Trusting Devices

- Device Certificates
  - Used to create, validate Device Inventory DB
  - HSM, TPM , X.509 certs
  - Used in all communications to enterprise services
- Define in SW
  - Clean images (CIS Benchmark scored)
  - SSO to validate users wanting access to enterprise stuff
- Use/create device certificates

ZTN Authorization Components

- Trust Engine
  - Google BeyondCorp a pioneer in this area
  - New concept – calculates a trust score of components based on historical behavior
- Data Stores
  - 2 types: Inventory, Historical
  - Ex: User inventory stores relevant user info (AD, LDAP)
  - Ex: Device inventory has info on every device connected to the network (CSC #1)

ZTN Trust: Users

- Informal identity
  - Standard use – pseudonymous accounts
- Authoritative identity
  - MFA
- Trust scores determine if additional authentication is required
- Single Sign-on

ZTN Trust: Network Traffic

- Traditional net filtering, monitoring - significant factor in ZTN.
- Its application is non-traditional
- Net flow authentication/authorization a key component
- How to trust net traffic – Single Packet Authorization(SPA)
  - How do you allow a trusted connection but dropping others?
  - Preauthentication, SPA
  - Fwknop - http://www.cipherdyne.org/blog/2012/09/single-packet-authorization-the-fwknop-approach.html

ZTN Trust: Network Traffic

- Where to apply ZTN controls in the network stack
  - TLS – used mostly application layer protocols
  - IPsec – used mostly to secure traffic (VPN). Well positioned to provide secure comms for all traffic
- Filtering
  - Host – filter traffic at the host. Handles inbound traffic
  - Bookend – apply policy in both directions. Egress filtering
  - Intermediary – “traditional” FW placement

ZTN: Requirements

- All network flows must be authenticated before processing
- All network flows should be encrypted before xmission
- Authentication, encryption (A&E) must be done at the endpoints
- All net flows must be enumerated so access can be enforced

ZTN: Requirements

- The strongest A&E suites should be used
- Authentication should not rely on public PKI providers. Private PKI systems should be used
- Devices should be scanned, patched and rotated regularly

Some Suggestions

- Start small – ZTN a lab or smaller departmental net
- Build a system diagram of your network traffic patterns
- Profile your traffic
  - Do you know where your inbound traffic originated?
  - Where does your outbound traffic go?
- Do you trust your network?

ZTN and Today's Network

- Assume net is hostile & hackers already inside
  - Monitor outbound traffic with threat intel data
  - Configure host based FW/IDS
  - Profile your net traffic
    - Direct lateral movement between hosts is rare? y/n
- Log, Log, Log

ZTN and the 20 Critical Security Controls

- HW Inventory
- SW Inventory
- Continuous Vuln Mgmt
- Controlled use of Admin Priv
- Secure config for devices
- Log Analysis, maintenance
- Email, Browser Security
- Malware Defenses
- Limit Ports, Protocols, Services
- Data Recovery
- Secure config for net device
- Boundary Defense

ZTN and the 20 Critical Security Controls

- Data Protection
- Need to Know
- Wireless Access Control
- Acct Monitoring, Control
- Security Training
- Application Software Security
- Incident Response & Mgmt
- Penetration Testing and Red Team Exericises

Summary

- Need an architecture that can handle:
  - Data mobility, protection
  - Cloud, containers, serverless apps
- What will the tech environment be in 5 yrs? 10yrs?
- We've been doing pieces of ZTN for years.

References

- "Zero Trust Networks", Gilman, Barth, http://shop.oreilly.com/product/0636920052265.do
- "Building Security into Your Network's DNA: The Zero Trust Approach", John Kindervag, 2010
- "Single Packet Authorization: A Comprehensive Guide to Strong Service Concealment using fwknop", Michael Rash, http://www.cipherdyne.org/fwknop/docs/fwknop-tutorial.html#design