AABC Commissioning Group

AIA Provider Number 50111116

Cover your BAS: Simple Steps to Address Cybersecurity Concerns in Your Building Automation Systems

Course Number: CXENERGY1819

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Optigo Networks

April 25, 2018

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CEO, Optigo Networks Inc.

Course Description

BACnet systems are shockingly vulnerable. Are yours secure? Ever thought about what an intruder could access if they unplugged a smart device and connected to the network with a laptop? Only six million commercial buildings in the US are believed to be unsecure. They have exposed building controllers, security cameras and access control systems that an entry level hacker could hack. This presentation covers common vulnerabilities in BACnet systems and provides common sense approaches to ensure your Building Automation System deployments don’t leave a building open to attack.

Learning Objectives

At the end of the this course, participants will be able to:

1. Understand real-world cybersecurity threats in the Building Internet of Things (B-IoT) and how these threats could be manipulated to create a terror related health, safety, welfare crisis at the facility level.

2. Learn about the essentials of asset protection and how to evaluate and ameliorate threats to structural, health, safety, welfare systems from within a facility and by outside attacks.

3. Discuss the three key principles to securing building networks.

4. Identify what can be done to secure the B-IoT, and basic actions that can be taken today such as testing the vulnerabilities of essential structural, health, safety, welfare systems, databases containing proprietary and/or classified information that could place internal and external personnel and the public at large at risk if breached.

Agenda

- Why cybersecurity matters
- “Demo”
- Basics of cybersecurity
- Secure building networks
- Conclusion

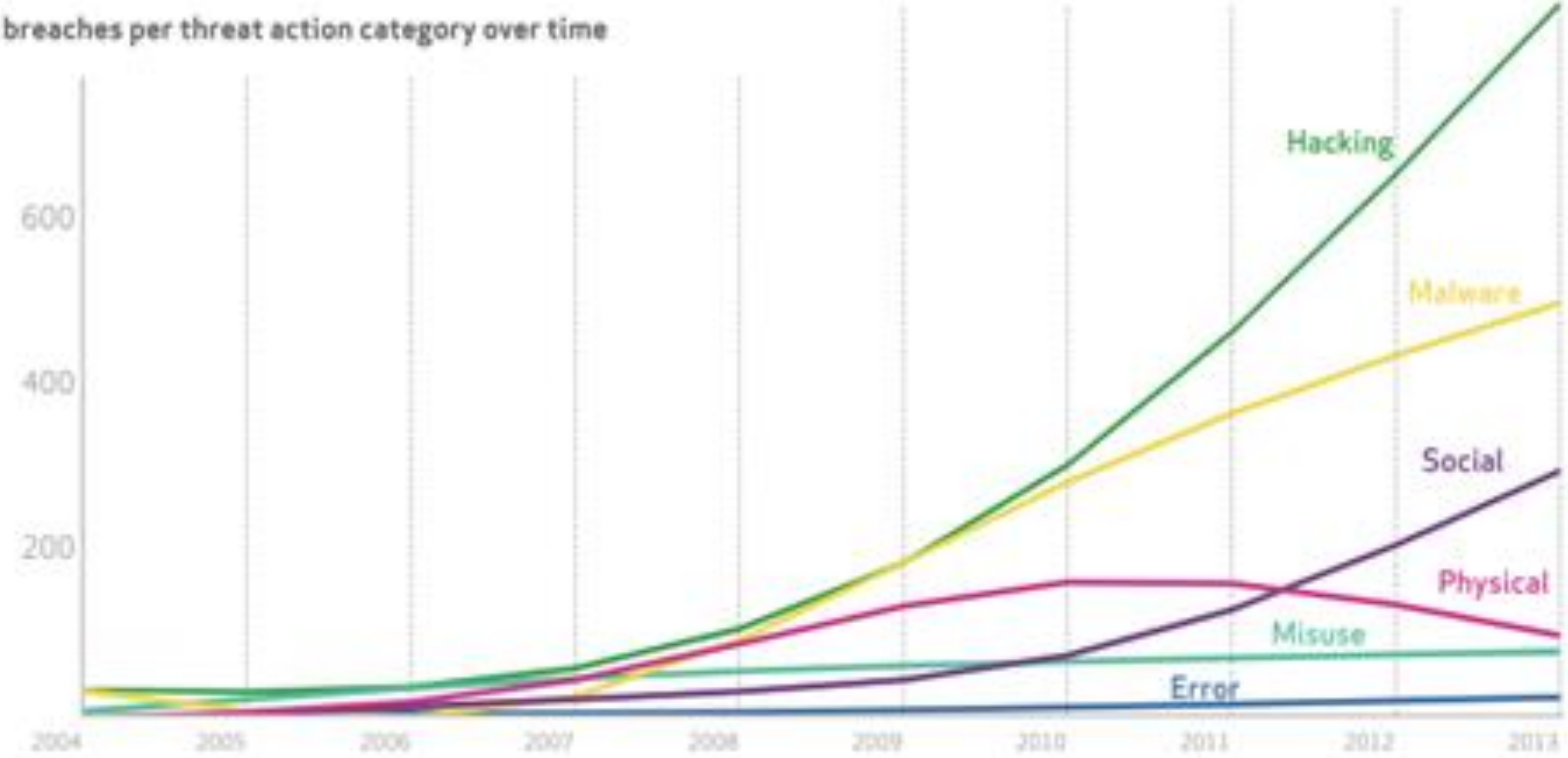
Why cybersecurity matters

“Cyber Crime Costs Projected To Reach $2 Trillion by 2019”

– Forbes, January 17, 2016

http://www.forbes.com/sites/stevemorgan/2016/01/17/cyber-crime-costs-projected-to-reach-2-trillion-by-2019/#6253ee2e3bb0

Figure 8.
Number of breaches per threat action category over time



VERIZON 2014 DATA BREACH INVESTIGATIONS REPORT

“IBM's X-Force team hacks into smart building” – CSO Online

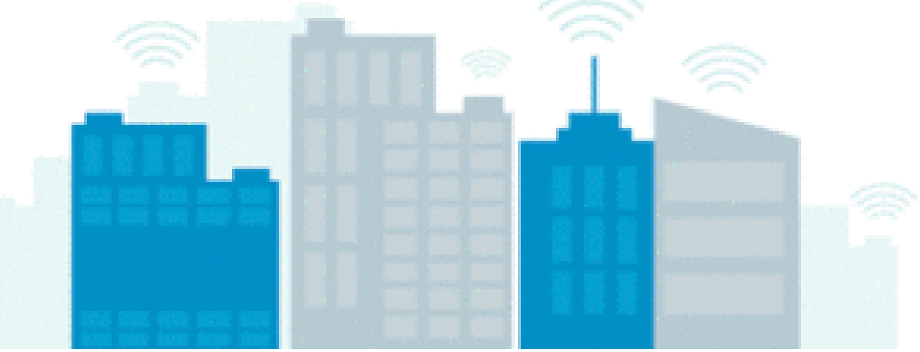
“take down a power plant by physically destroying a generator with just 21 lines of code” – Wired.com

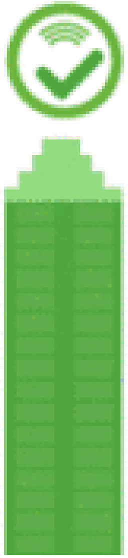
“Stuxnet reportedly ruined almost one-fifth of Iran's nuclear centrifuges.” – Wikipedia

Smart Buildings
A Back Door for Hackers?

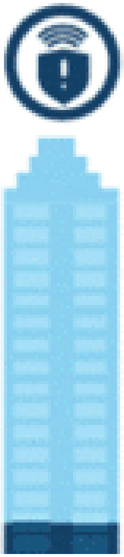
Connected Building Systems Fly under the Cybersecurity Radar, Creating "Shadow IoT"

206.2 MILLION Connected devices in use in commercial smart buildings[1]





84% Building Automation System managers with internet-connected systems[2]



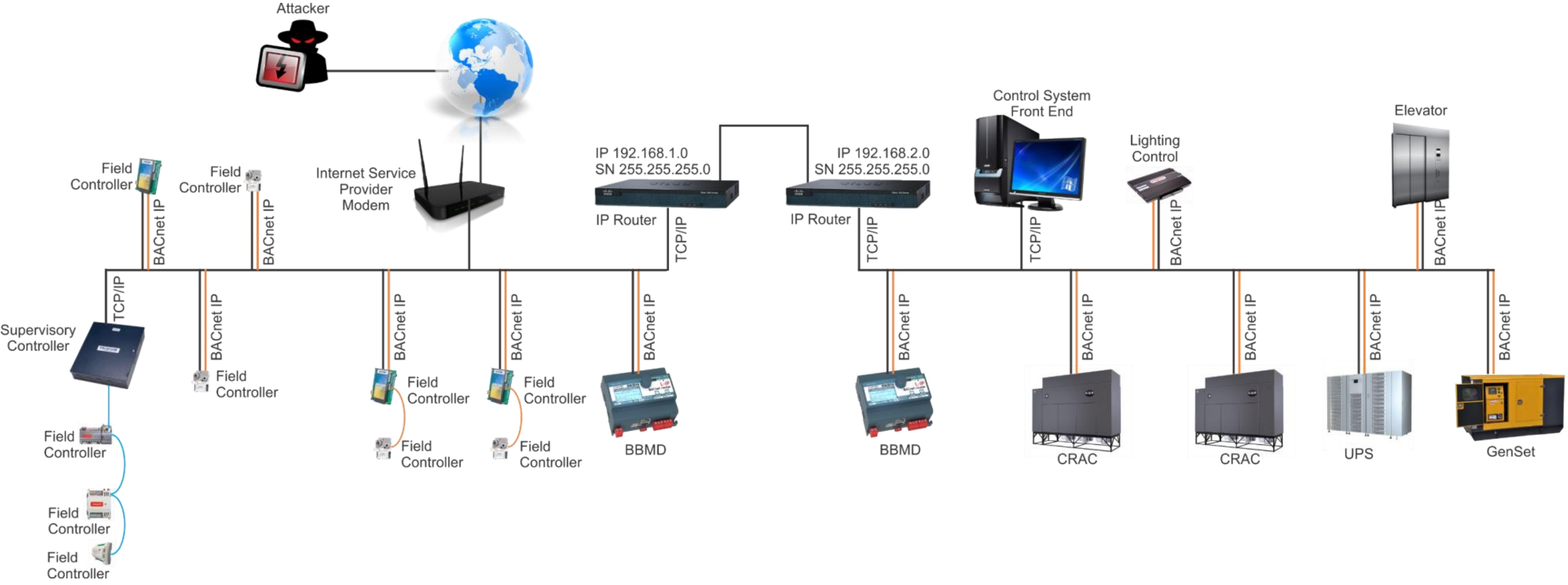
29% Building Automation System managers who are improving cybersecurity for their systems[3]

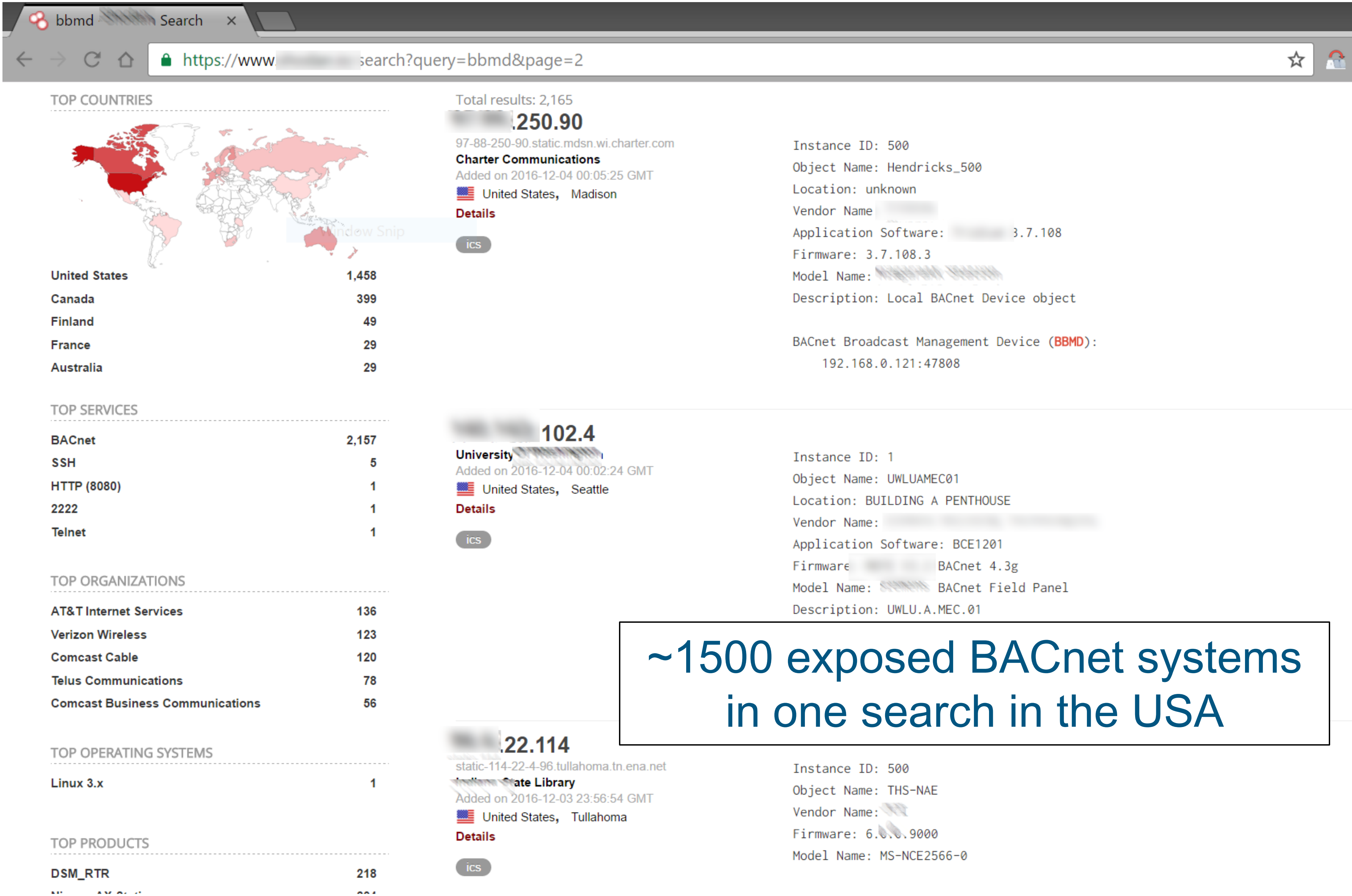
Types of hackers

- Script kiddies
- Hacktivist
- Cyber criminals
- National states / sponsored

Demo

Typical building automation systems





TOP COUNTRIES

United States	1,458
Canada	399
Finland	49
France	29
Australia	29

TOP SERVICES

BACnet	2,157
SSH	5
HTTP (8080)	1
2222	1
Telnet	1

TOP ORGANIZATIONS

AT&T Internet Services	136
Verizon Wireless	123
Comcast Cable	120
Telus Communications	78
Comcast Business Communications	56

TOP OPERATING SYSTEMS

Linux 3.x	1

TOP PRODUCTS

DSM_RTR	218

Total results: 2,165

[redacted].250.90

97-88-250-90.static.mdsn.wi.charter.com

Charter Communications

Added on 2016-12-04 00:05:25 GMT

United States, Madison

Details

ics

```
Instance ID: 500
Object Name: Hendricks_500
Location: unknown
Vendor Name [redacted]
Application Software: [redacted]3.7.108
Firmware: 3.7.108.3
Model Name: [redacted]
Description: Local BACnet Device object

BACnet Broadcast Management Device (BBMD):
    192.168.0.121:47808
```

[redacted]102.4

University [redacted]

Added on 2016-12-04 00:02:24 GMT

United States, Seattle

Details

ics

```
Instance ID: 1
Object Name: UWLUAMEC01
Location: BUILDING A PENTHOUSE
Vendor Name: [redacted]
Application Software: BCE1201
Firmware [redacted] BACnet 4.3g
Model Name: [redacted] BACnet Field Panel
Description: UWLU.A.MEC.01
```

[redacted].22.114

static-114-22-4-96.tullahoma.tn.ena.net

[redacted] State Library

Added on 2016-12-03 23:56:54 GMT

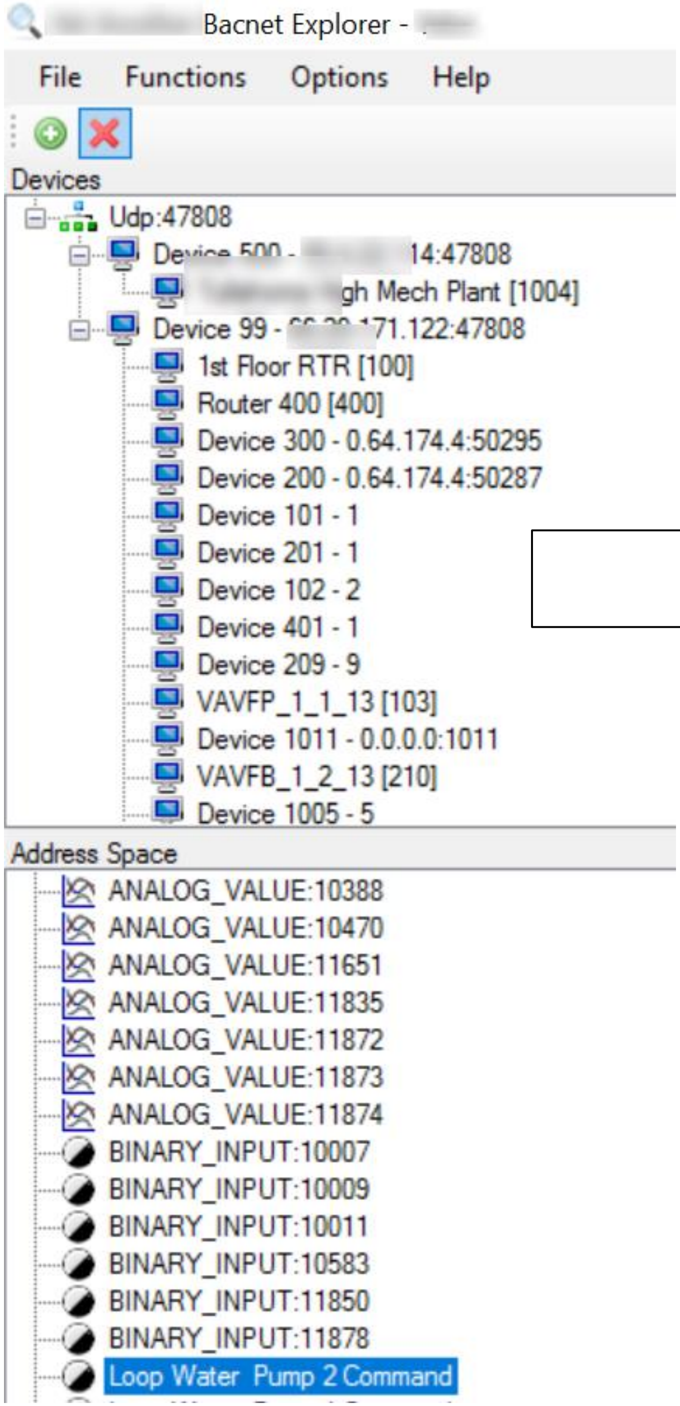
United States, Tullahoma

Details

ics

```
Instance ID: 500
Object Name: THS-NAE
Vendor Name: [redacted]
Firmware: 6.[redacted].9000
Model Name: MS-NCE2566-0
```

~1500 exposed BACnet systems in one search in the USA



[redacted] Bacnet Explorer - [redacted]

Devices

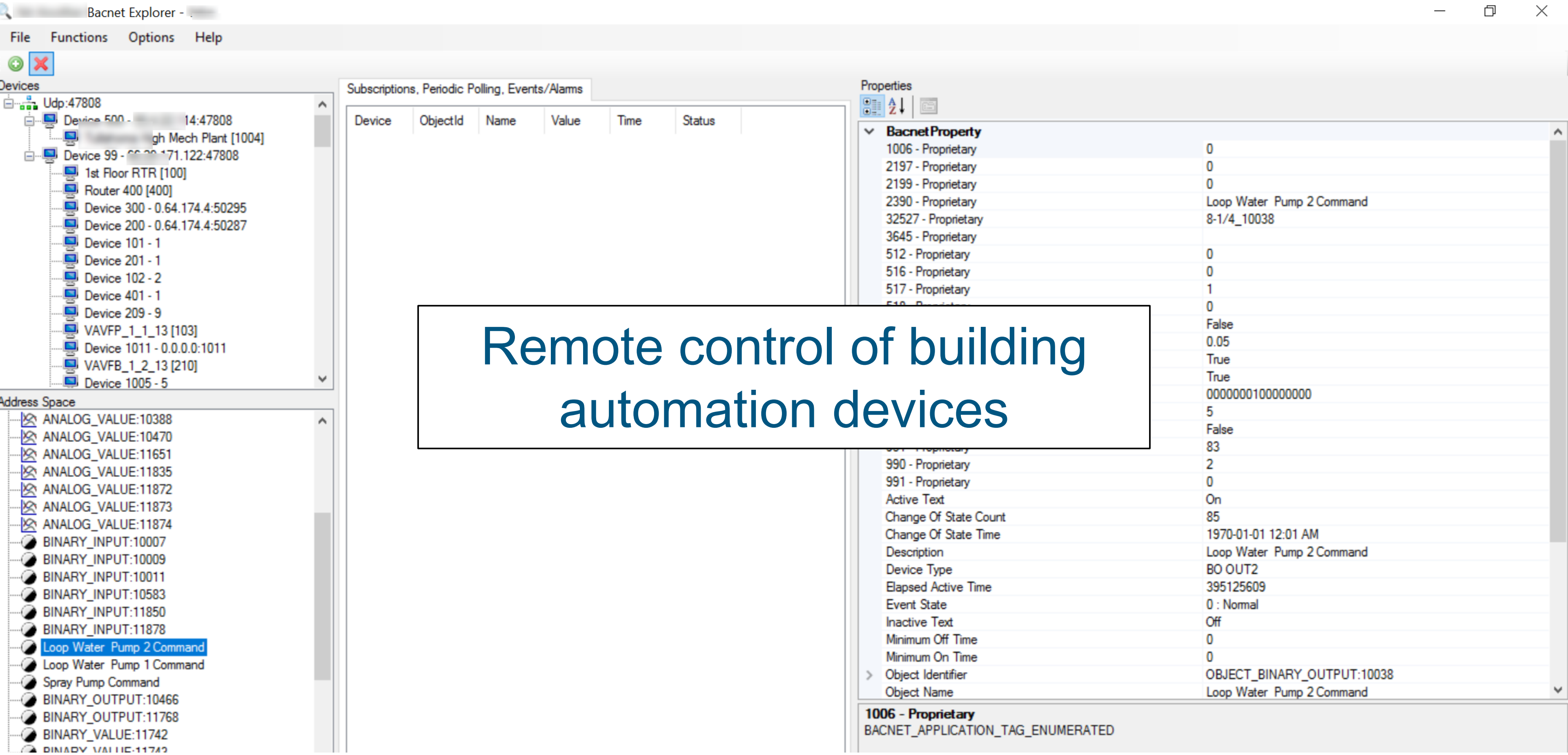
```
Udp:47808
  Device 500 - [redacted]14:47808
    [redacted]gh Mech Plant [1004]
  Device 99 - [redacted]171.122:47808
    1st Floor RTR [100]
    Router 400 [400]
    Device 300 - 0.64.174.4:50295
    Device 200 - 0.64.174.4:50287
    Device 101 - 1
    Device 201 - 1
    Device 102 - 2
    Device 401 - 1
    Device 209 - 9
    VAVFP_1_1_13 [103]
    Device 1011 - 0.0.0.0:1011
    VAVFB_1_2_13 [210]
    Device 1005 - 5
```

Address Space

```
ANALOG_VALUE:10388
ANALOG_VALUE:10470
ANALOG_VALUE:11651
ANALOG_VALUE:11835
ANALOG_VALUE:11872
ANALOG_VALUE:11873
ANALOG_VALUE:11874
BINARY_INPUT:10007
BINARY_INPUT:10009
BINARY_INPUT:10011
BINARY_INPUT:10583
BINARY_INPUT:11850
BINARY_INPUT:11878
Loop Water Pump 2 Command
```

No login

Remote control of building automation devices



[redacted] Bacnet Explorer - [redacted]

Devices

- Udp:47808
  - Device 500 - [redacted]14:47808
    - [redacted]gh Mech Plant [1004]
  - Device 99 - [redacted]171.122:47808
    - 1st Floor RTR [100]
    - Router 400 [400]
    - Device 300 - 0.64.174.4:50295
    - Device 200 - 0.64.174.4:50287
    - Device 101 - 1
    - Device 201 - 1
    - Device 102 - 2
    - Device 401 - 1
    - Device 209 - 9
    - VAVFP_1_1_13 [103]
    - Device 1011 - 0.0.0.0:1011
    - VAVFB_1_2_13 [210]
    - Device 1005 - 5

Address Space

- ANALOG_VALUE:10388
- ANALOG_VALUE:10470
- ANALOG_VALUE:11651
- ANALOG_VALUE:11835
- ANALOG_VALUE:11872
- ANALOG_VALUE:11873
- ANALOG_VALUE:11874
- BINARY_INPUT:10007
- BINARY_INPUT:10009
- BINARY_INPUT:10011
- BINARY_INPUT:10583
- BINARY_INPUT:11850
- BINARY_INPUT:11878
- Loop Water Pump 2 Command
- Loop Water Pump 1 Command
- Spray Pump Command
- BINARY_OUTPUT:10466
- BINARY_OUTPUT:11768
- BINARY_VALUE:11742
- BINARY VALUE:11743

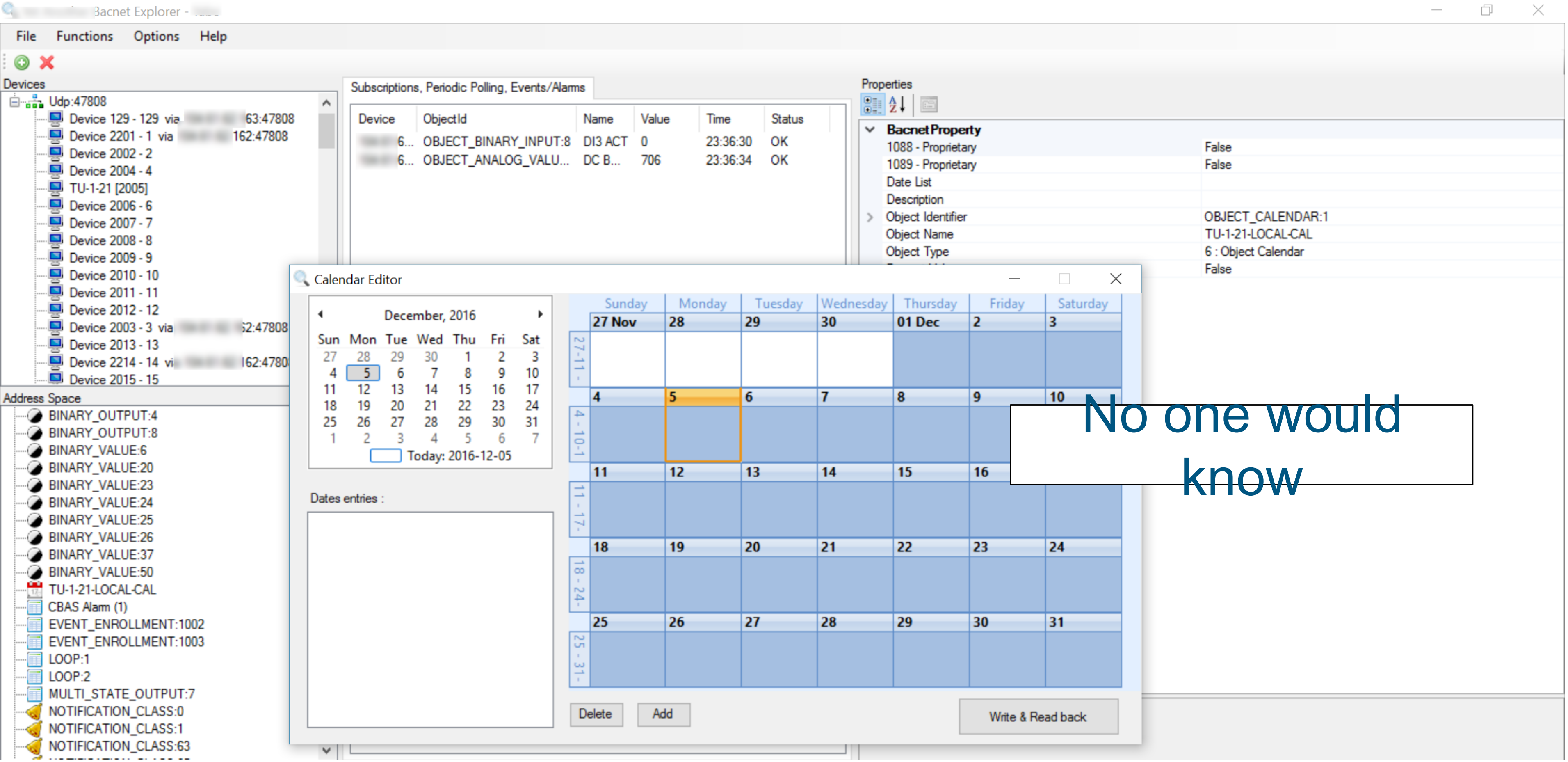
Subscriptions, Periodic Polling, Events/Alarms

Device	ObjectId	Name	Value	Time	Status

Properties

Bacnet Property	
1006 - Proprietary	0
2197 - Proprietary	0
2199 - Proprietary	0
2390 - Proprietary	Loop Water Pump 2 Command
32527 - Proprietary	8-1/4_10038
3645 - Proprietary	
512 - Proprietary	0
516 - Proprietary	0
517 - Proprietary	1
518 - Proprietary	0
	False
	0.05
	True
	True
	0000000100000000
	5
	False
Proprietary	83
990 - Proprietary	2
991 - Proprietary	0
Active Text	On
Change Of State Count	85
Change Of State Time	1970-01-01 12:01 AM
Description	Loop Water Pump 2 Command
Device Type	BO OUT2
Elapsed Active Time	395125609
Event State	0 : Normal
Inactive Text	Off
Minimum Off Time	0
Minimum On Time	0
Object Identifier	OBJECT_BINARY_OUTPUT:10038
Object Name	Loop Water Pump 2 Command

1006 - Proprietary
BACNET_APPLICATION_TAG_ENUMERATED



Devices

- Udp:47808
  - Device 129 - 129 via [redacted]63:47808
  - Device 2201 - 1 via [redacted]162:47808
  - Device 2002 - 2
  - Device 2004 - 4
  - TU-1-21 [2005]
  - Device 2006 - 6
  - Device 2007 - 7
  - Device 2008 - 8
  - Device 2009 - 9
  - Device 2010 - 10
  - Device 2011 - 11
  - Device 2012 - 12
  - Device 2003 - 3 via [redacted]52:47808
  - Device 2013 - 13
  - Device 2214 - 14 vi[redacted]162:4780
  - Device 2015 - 15

Subscriptions, Periodic Polling, Events/Alarms

Device	ObjectId	Name	Value	Time	Status
[redacted]6...	OBJECT_BINARY_INPUT:8	DI3 ACT	0	23:36:30	OK
[redacted]6...	OBJECT_ANALOG_VALU...	DC B...	706	23:36:34	OK

Properties

Bacnet Property	
1088 - Proprietary	False
1089 - Proprietary	False
Date List	
Description	
Object Identifier	OBJECT_CALENDAR:1
Object Name	TU-1-21-LOCAL-CAL
Object Type	6 : Object Calendar
	False

Address Space

- BINARY_OUTPUT:4
- BINARY_OUTPUT:8
- BINARY_VALUE:6
- BINARY_VALUE:20
- BINARY_VALUE:23
- BINARY_VALUE:24
- BINARY_VALUE:25
- BINARY_VALUE:26
- BINARY_VALUE:37
- BINARY_VALUE:50
- TU-1-21-LOCAL-CAL
- CBAS Alarm (1)
- EVENT_ENROLLMENT:1002
- EVENT_ENROLLMENT:1003
- LOOP:1
- LOOP:2
- MULTI_STATE_OUTPUT:7
- NOTIFICATION_CLASS:0
- NOTIFICATION_CLASS:1
- NOTIFICATION_CLASS:63

Calendar Editor

December, 2016

Sun	Mon	Tue	Wed	Thu	Fri	Sat
27	28	29	30	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31
1	2	3	4	5	6	7

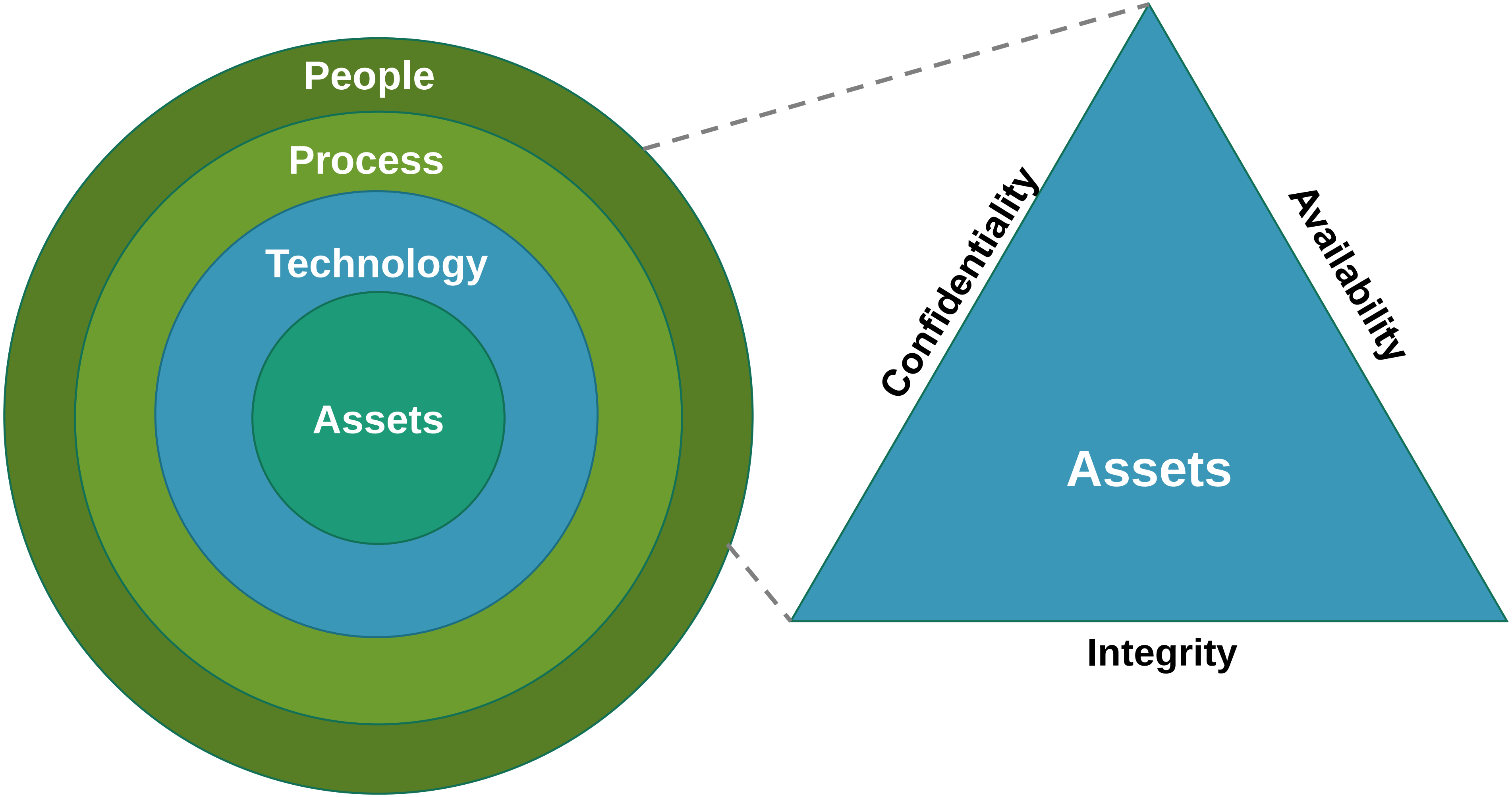
Today: 2016-12-05

Dates entries :

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
27 - 11 -	27 Nov	28	29	30	01 Dec	2	3
4 - 10 -	4	5	6	7	8	9	10
11 - 17 -	11	12	13	14	15	16	
18 - 24 -	18	19	20	21	22	23	24
25 - 31 -	25	26	27	28	29	30	31

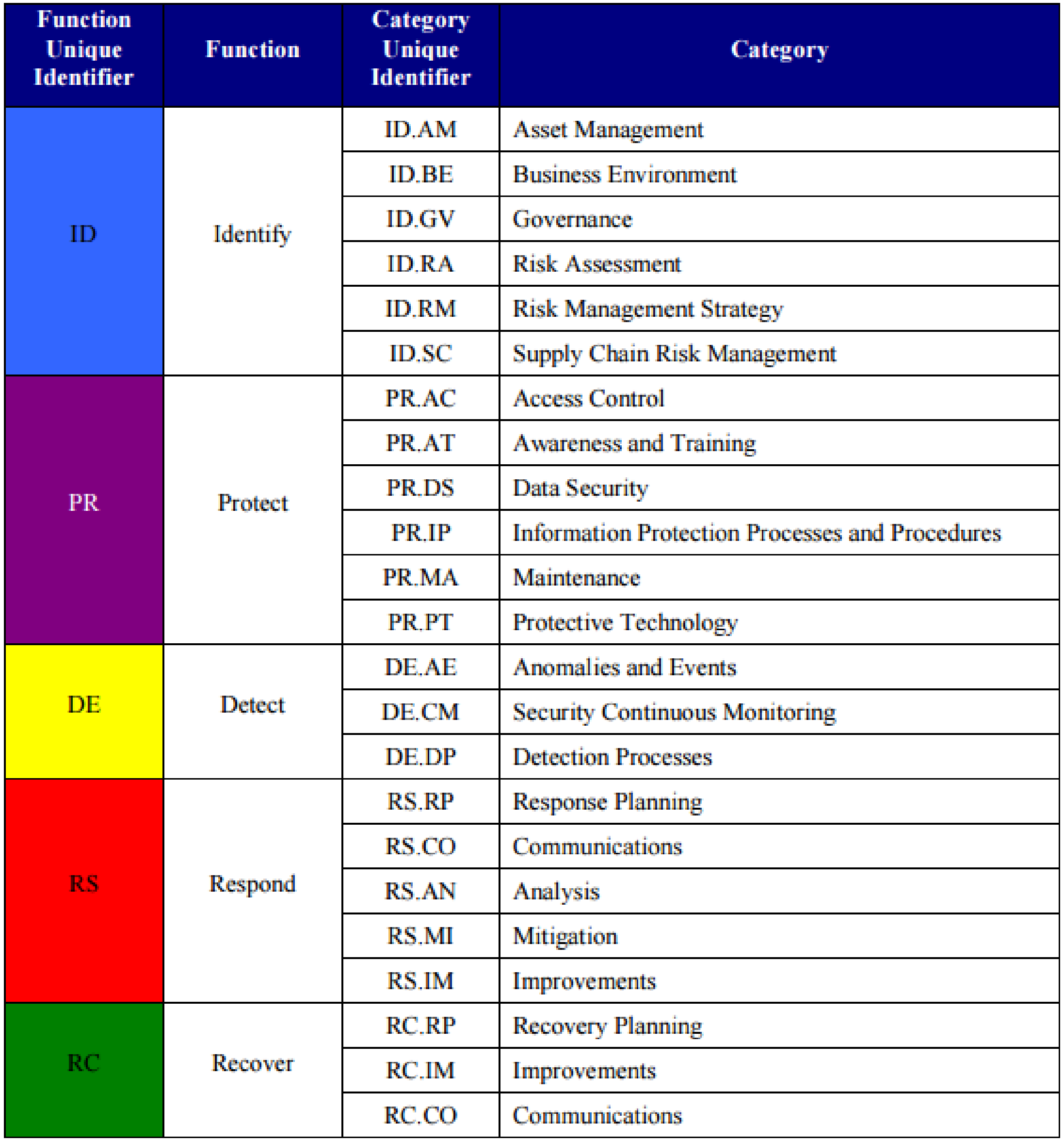
No one would know

Basics of cybersecurity


People
Process
Technology
Assets
Confidentiality
Availability
Assets
Integrity

Resources

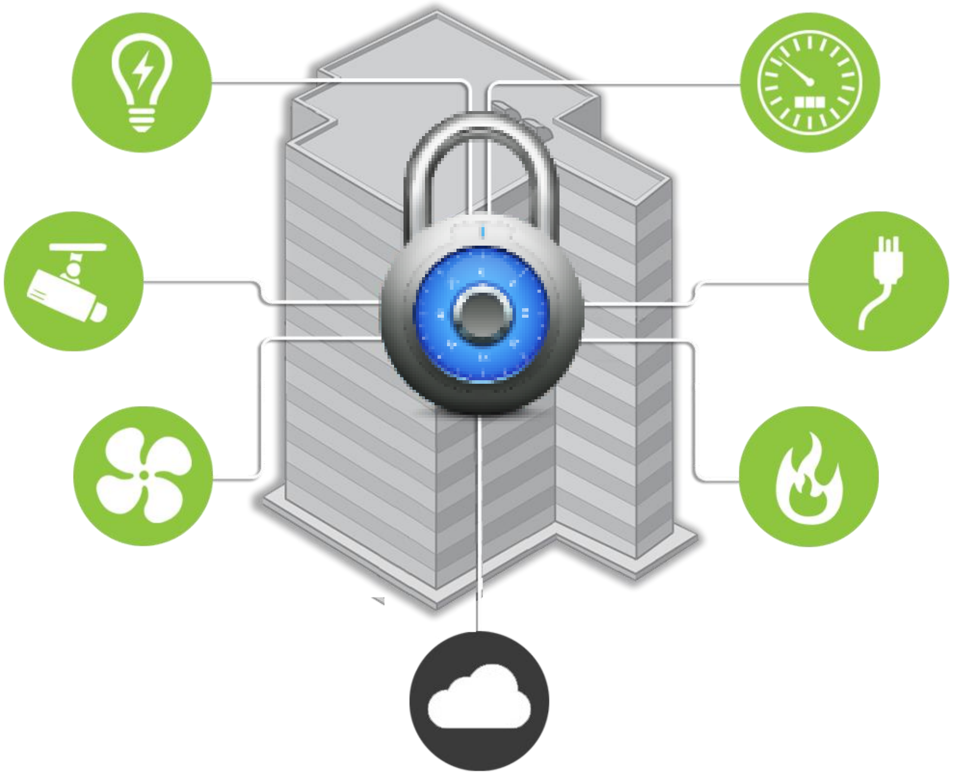
Table 2: Function and Category Unique Identifiers



Function Unique Identifier	Function	Category Unique Identifier	Category
ID	Identify	ID.AM	Asset Management
		ID.BE	Business Environment
		ID.GV	Governance
		ID.RA	Risk Assessment
		ID.RM	Risk Management Strategy
		ID.SC	Supply Chain Risk Management
PR	Protect	PR.AC	Access Control
		PR.AT	Awareness and Training
		PR.DS	Data Security
		PR.IP	Information Protection Processes and Procedures
		PR.MA	Maintenance
		PR.PT	Protective Technology
DE	Detect	DE.AE	Anomalies and Events
		DE.CM	Security Continuous Monitoring
		DE.DP	Detection Processes
RS	Respond	RS.RP	Response Planning
		RS.CO	Communications
		RS.AN	Analysis
		RS.MI	Mitigation
		RS.IM	Improvements
RC	Recover	RC.RP	Recovery Planning
		RC.IM	Improvements
		RC.CO	Communications

Secure building networks

Protecting B-IoT by securing the network



Why the network? Because…

- Common to all systems
- Everything* goes through it
- Scalable
- IoT communications is predictable

3 Key Principles to Secure Building Networks

1) Isolation

- Dedicated networks
- VLAN
- VRF
- Firewall
- …

2) Observability

- Reports
- Logs
- Notifications
- Monitoring
- …

3) Controllability

- Port control
- Port security
- ACL
- …

Take action today

1) Isolate your Building Systems from IT

- Dedicated Building Network
- Separate VLAN for each service and vendor

2) Observe what is happening

- Ask for regular reports of # of connected devices and # of disconnected ports
- Review network management log files for user login

3) Control the flow of information

- Disable unused ports
- Set MAC filtering/security rules

Conclusion

- Cybersecurity is serious and needs to be addressed
- Protect the network, protect the system
- Start today
- Q&A

This concludes The American Institute of Architects Continuing Education Systems Course

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