# GETTING STARTED IN INDUSTRIAL (ICS/OT) CYBER SECURITY

**For OT & Automation Professionals**

Mike Holcomb, GRID, ISA 62443

v2023.1

# Acknowledgements

**To Michael Assante**
None of us would be here without you nor would the world be as safe. Rest in peace.

**To Rob Lee**
Thank you for all you do to encourage others to not only get into the ICS/OT cyber security field, but to enlist them in your vision of safeguarding civilization.

**To those in the ICS/OT community**
For all the owners, operators, engineers, automation professionals, technicians, cyber security team members and others that keep our facilities safe and operational, thank you for all of your dedication!

**To all those wanting to get into ICS/OT cyber security**
Don't be discouraged. You can play a big part in protecting the world around us!

# About the Author

Mike Holcomb is the Fellow of Cybersecurity and the ICS/OT Cybersecurity Global Lead for Fluor, one of the world's largest engineering, procurement, and construction companies. His current role provides him with the opportunity to work in securing some of the world's largest ICS/OT environments, from power plants and commuter rail to manufacturing facilities and refineries.

As part of his community efforts, Mike founded and leads the UpstateSC ISSA Chapter and BSides Greenville conference. He also wrote and taught all six cyber security courses for Greenville Technical College's cyber security program which focuses on helping educate the cyber security practitioners of tomorrow.

Mike also provides consulting services to outside parties through his company, UtilSec LLC.

# Introduction

“How do I get started in industrial cyber security?”

This is the most common question I receive.

To help answer this question, I wanted to write a quick start guide to share (while I work on a much longer book).

How you get started though depends on your background.  Are you an OT engineer or other professional?  Are you in IT cyber security?  Do you have no experience in either?

This guide is written for those of you with an OT background (e.g., engineers, operators, technicians, automation team members) that want to learn more about securing the facilities you work in today.

# Tips for Before You Get Started

Here are a few things to keep in mind:

**1. Take your time to learn**
Learning this field requires you to learn about IT cyber security which is considered a vast and varied discipline. It will take time!

**2. Be prepared to use Google (A LOT)**
Coming from an OT background, you will undoubtedly come across many acronyms and cyber security concepts that are new.  Don't be afraid to research!

**3. The ICS/OT cyber security community is an incredible resource and ally**
There are a lot of incredible people that make up this community that want to help you succeed in helping protect the environments that move the world around us!

Welcome...

# To protecting the world around us!

The world of ICS/OT is vast and often unseen.  Most people take their “always present” electricity, clean water, transportation, pharmaceuticals and other manufactured goods, for granted.

I know I did.

And now I keep working to fight the good fight and help others do the same!

## The Threats Increase Daily

Just like the IT world, OT is vulnerable.

Whether OT realizes it or not, the attackers do. The number of attackers is not only growing, but diversifying. Up to a few years ago, most OT environments only had to be concerned with nation-state adversaries.

Now every OT environment needs to be concerned with all the other types of attackers (e.g., ransomware groups, hacktivists, lone wolf operators).

As we say in the IT world...

**It's not a question of IF, but a question of WHEN!**

# OT & IT Have Very Different Objectives

When introducing IT cyber security to newcomers, we talk about the C-I-A triad which highlights the top priorities for IT.

**Confidentiality**
Ensuring sensitive data isn't disclosed in an unauthorized fashion.

**Integrity**
Making sure the data we have is not modified in an unauthorized manner.

**Availability**
Data must always be available to the company to function, including the systems and apps that make the data accessible.

In a typical enterprise environment, little concern is spent on physical and environmental safety.

## Cyber security priorities in ICS/OT are VERY different!

In OT networks, we are concerned first and foremost with ensuring the **physical safety** of on-site personnel. Besides keeping our people safe, we are also focused on **protecting the environment** around the facility.

After physical and environmental safety, then we focus primarily on ensuring the **continued operations** of the facility.

And then, depending on the owner's and operator's requirements, we can look at data integrity and confidentiality.

# An Abbreviated History of ICS/OT Major Events

The ICS/OT world has had its fair share of security incidents, some with potentially devasting consequences. Most incidents are not publicly disclosed and we will never know about them.

Here are just a few important public incidents to know about:

**2003: Davis-Besse Hit by SQL Slammer**
This power plant had to shut down part of its systems down due to a SQL Slammer infection that came from the Internet (via a unauthorized vendor connection). The environment was believed to be airgapped with no external connections.

The real kicker? Davis-Besse is a nuclear power plant.

# An Abbreviated History of ICS/OT Major Events (cont.)

**2010: Stuxnet**

The United States and Israel created the first known piece of malware to target ICS/OT systems. The malware known as Stuxnet was responsible for physically destroying many of the centrifuges used in Iran's nuclear arms program.

The incident launched a cyber arms race.

**2015 & 2016: Ukrainian Blackouts**

Russian adversaries targeted different power facilities to create blackouts in the Ukraine two years in a row.

At night. In the middle of winter.

Other similar ICS/OT-related attacks can be observed in the current Russian invasion of the Ukraine.

# An Abbreviated History of ICS/OT Major Events (cont.)

**2017: Trisis / Triton**

A Russian adversary compromised the SIS (Safety Instrumented System) at a petrochemical refinery in the Middle East. The SIS is designed to act as a failsafe to safely shut down a plant in the event a fault condition is detected.

The only reason an attacker would take control over the SIS is to cause an explosion and to do harm and/or kill.

**2021: Colonial Pipeline**

The IT systems at Colonial Pipeline were infected by ransomware resulting in the OT network which controlled the pipeline being taken offline. The result was that the largest gasoline pipeline in the United States was down for 10 days.

# Ten Steps to Getting Started

This guide focuses on the ten steps for IT cyber security professionals to get started with industrial (ICS/OT) cyber.

**Here are the prioritized ten steps:**

1. **Learn networking basics**
2. **Study IT cyber security fundamentals**
3. **Understand how to start applying cyber security concepts in ICS/OT**
4. **Explore training options for learning**
5. **Learn the standards and regulations**
6. **Gain hands-on experience**
7. **Network with the community**
8. **Stay current**
9. **Find an experienced mentor**
10. **Build relevant soft skills**
11. **Get certified**

# #1. Learn networking fundamentals

Coming from an OT cyber security background, this is the most critical step for many. If you already understand IT networking - great!  Many OT professionals do not though.

You need to understand the basics of network connectivity before you can better understand how to defend such networks.

It is fundamental that you understand how each of the main network types communicate:

1. The Internet
2. The IT network
3. The OT network

Not just the three individually, but how they interact (or don't) with each other.

Just Remember...

# 99% of cyber attacks in ICS/OT involve traditional IT assets AND TCP/IP networks

**So it is essential that you nail the networking basics, especially the fundamentals of how TCP/IP operates!**

**Plus don't forget about UDP which gets overlooked for some reason in ICS/OT!**

# Free Resources for Learning About Networking

**Here are some links on getting started learning about networking:**

**Cisco Networking Academy**
netacad.com/courses/networking

**Microsoft Network Fundamentals**
learn.microsoft.com/en-us/training/modules/network-fundamentals/

**Network Direction YouTube Channel**
youtube.com/@NetworkDirection

**Network Chuck YouTube Channel**
youtube.com/user/NetworkChuck

**Neso Academy YouTube Channel**
youtube.com/user/NesoAcademy

**Once attackers are on the OT network, how do we identify and contain them before they threatens life, the environment and operations?**

# Cyber Security is Essential

Cyber security can often be described as a mile long and an inch deep.

At least when you're just starting out.

Then it can becomes a mile long and a mile deep very quickly!

It is critical to understand the fundamentals of IT cyber security.

- Most attacks against OT come from the IT network
- How do we prevent attacks from being successful?
- How do we detect and respond to attacks that slip through our defenses?

## What is the best way to start?

# Get Security+ Certified

I see more and more engineers and automation professionals getting the Security+ certification which is great!

The process of studying for, and obtaining, the Security+ certification from CompTIA provides a path for learning the required fundamentals of cyber security.

Additionally, CompTIA is vendor agnostic so the content and associated exam aren't biased to any specific vendor.

Not only does the process of getting certified help you learn the cyber security basics, but it also helps you demonstrate your knowledge and passion.

Many can study, but much fewer get certified which is unfortunate for them.

# Learning the Security+ Basics

Here are some resources to help get you started on your IT cyber security journey with Security+:

***CompTIA Security+ Study Guide: Exam SY0-0=601***
by Mike Chapelle
ISBN: 978-1119736257

**The Professor Messer YouTube Channel**
youtube.com/@professormesser

**FREE CompTIA Security+ Course w/ Network Chuck**
https://tinyurl.com/5n7u673d

# Other Resources for Learning About IT Cyber Security

Here are some other resources on learning about cyber security:

1. **IT Cyber Security Books**
2. **IT Podcasts**

**These are for getting started quickly! More resources are listed as you read on!**

# Top IT Cyber Security Books

***"The Cuckoo's Egg: Tracking a Spy Through the Maze of Computer Espionage"*** by Cliff Stoll

***"Sandworm: A New Era of Cyberwar and the Hunt for the Kremlin's Most Dangerous Hackers"*** by Andy Greenberg

***Incident Response & Computer Forensics, Third Edition*** by Jason Luttgens, Kevin Mandia and Matthew Pepe

***The Hacking Exposed Series*** by Multiple Authors

***Social Engineering: The Art of Human Hacking*** by Chris Hadnagy

**Amazon's Top Cyber Security Books**
tinyurl.com/3btbfe8v

# IT and OT cyber security can be VERY different.

# Both have more in common than not.

Now that you have a good understanding of IT networking and cyber security principles, it's time to apply them to ICS/OT environments!

# #3. Explore Training Options for Learning

Getting started or further developing your knowledge can be frustrating.

And expensive... but doesn't have to be!

Formal courses and other content exist to help you learn, just not to get certified.

While getting certified can help demonstrate your passion and growing knowledge of the ICS/OT cyber security world to get your first job in the field, growing that knowledge in the first place is what is most important!

That’s why getting certified is the very last step suggested in this book!

Next you’ll find some free, and not so free, resources to get started with.

# Free ICS/OT Cyber Security Training Resources

Here are some free resources to get you started on your learning path:

**1. ICS Training Available Through CISA**
The Cybersecurity & Infrastructure Security Agency in the US makes some incredible courses available for free.

You do not need to be a US citizen to learn.

cisa.gov/ics-training-available-through-cisa

**2. UtilSec YouTube Channel**
All of my content that I put out on LinkedIn makes its way to my YouTube channel. Including a walkthrough of this book!

youtube.com/@utilsec

# My Favorite ICS/OT Cyber Security Podcasts (So Far...)

**Control Loop**
thecyberwire.com/podcasts/control-loop

**Unsolicited Response**
unsolicitedresponse.libsyn.com

**The (CS)2AI Podcast Show**
cs2ai.org/podcast

**The Industrial Security Podcast**
industrialdefender.com/podcast

**The PrOTect OT Cybersecurity Podcast**
waterfall-security.com/ot-insights-center/?type=podcast

**The ICS Village Podcast**
hack-the-plant.simplecast.com/

# Not Quite Free ICS/OT Cyber Security Training Resources

In addition to the free training, other options exist for low to substantial costs:

**Dragos Academy**
dragos.com/dragos-academy/

**ISA / IEC 62443**
rb.gy/ap3wa

**SANS ICS Training**
rb.gy/66a6y

**ICS Village**
icsvillage.com/events

**Check out more resources in the Certification section!**

# #4. Learn the Standards and Regulations

There are two main standards that are used to establish cyber security management programs in ICS/OT environments.  Learn them!  Live them!

**1. ISA/IEC 62443**
The gold standard, 62443 is internationally recognized by most entities.

**rb.gy/mo3r1**

**2. NIST 800-82**
The United States' NIST provides an accepted framework for managing ICS/OT cyber security in this document release.

IT professionals should feel more comfortable with NIST to start.

**csrc.nist.gov/pubs/sp/800/82/r3/final**

# #5. Gain Hands-on Experience

The first time you are on-site at an industrial facility will be an eye-opening experience, helping to truly show the impact and importance of such sites.

But not everyone has the chance to visit a plant right away let alone have other opportunities for gaining real world experience.

Here are some ways to get experience:

- Build a home lab for testing
- Learn to program PLCs

**Be sure to think of other ways to gain experience coming up in Step #6!**

# Build a Home Lab for Testing

Here are some suggestions on building your home lab for learning ICS/OT:

**1. Keep Your Lab Network Isolated**
To ensure the rest of the world stays safe from your experiments, and vice versa, keep your lab air gapped - just as any good ICS/OT network should be!

**2. Start Small and Build From There**
A home lab can take on a life of its own, and a costly one at that. Grow only as your resources allow you to.

**3. Use Physical Assets When You Can**
While it is always best to use the real thing, ICS assets don't come cheap - even off of eBay!

# Build a Home Lab for Testing (cont.)

**4. Virtualize for Reduced Costs**
Save yourself some money and use virtualization where you can.

**5. Use the Right Tool for the Right Job**
Don't forget to consider IT-related tools for learning ICS/OT. Wireshark is an excellent example of a traditional IT tool used in the world's largest ICS/OT networks.

**6. Leverage Simulations**
When resources are tight, use solutions that emulate assets you can work with and learn from.

# Learn to Program PLCs

One of the best ways to learn about ICS/OT environments is from the ground up. You can start with programming a PLC which is the most commonly used type of control system.

You can look at using either software that simulates a PLC or purchase a real PLC.

I'm a big fan of the CLICK PLCs from Automation Direct. Fully functional, used in production environments and low cost!

# PLC Programming Resources

Here are some free resources to get you started:

**PLC Academy**
plcacademy.com

**AutomationDirect PLC Training**
automationdirect.com/programmable-logic-controllers/plc-training

**PLC Basics Playlist**
youtube.com/watch?v=ReTtgzN-Dmc&list=PLIn3BHg93SQ85ymy4VvtmRGxo2Stps2Iv

**Learn PLC Programming in 7 Hours**
youtube.com/watch?v=c4cEeA6mdq0

**Use an Arduino and OpenPLC Software to Emulate a Real PLC for Programming**
rb.gy/63hca

# #6. Network With the Community

The ICS/OT cyber security community is growing every day along with the many “veterans” you can learn from and share with.

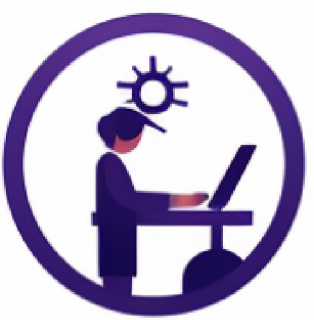
- **Professional associations**
- **Conferences**
- **ISACs**
- **Social media**
- **CTF Challenges**

# Professional Associations

Here's a list of groups associated with ICS/OT cyber security:

**ISA (International Society of Automation)**
www.isa.org

**C2SAI (Control System Cyber Security Association International)**
www.cs2ai.org



# Conferences

Here's a list of great conferences which focus on ICS/OT cyber security:

**Control Systems Cyber Senate**
cybersenate.com

**Dragos Industrial Security Conference**
dragos.com/event/disc-2023/

**Hack the Capitol**
icsvillage.com/htcevents

**ICS Village at Defcon (and other events)**
icsvillage.com

**S4**
s4xevents.com

**SANS ICS Summit**
sans.org/cyber-security-training-events/ics-security-summit-2024/

# ISACs

Information Security and Analysis Centers are built around individual sectors. Membership is limited to those that work in the associated area.

Participate with the appropriate ISAC. Not all are free and/or inexpensive.

A few popular ones for ICS/OT:

**E-ISAC (Electricity)**
eisac.com

**ONG-ISAC (Oil & Gas)**
ongisac.org

**ST-ISAC (Surface Transportation)**
surfacetransportationisac.org

**Find a comprehensive list at**
nationalisacs.org

# Social Media

So many thought leaders and professionals that want to share can be found on social media.

Here are some great active people to follow on LinkedIn:

1. Anna Rebeiro
2. Dale Peterson
3. Danielle Jablanski
4. Dawn Capelli
5. Derek Harp
6. John Kingsley
7. Jonathon Gordon
8. Marcel Rick-Cen
9. Michael Holcomb
10. Pascal Ackerman
11. Rob M. Lee
12. Roya Gordon
13. Shiv Kataria
14. Tony Turner

# CTF Challenges

CTFs can be great ways to get hands-on experience in ICS/OT cyber security.

Keep an eye out for any that come up.

Organizations like SANS and Dragos open their ICS/OT CTFs to everyone virtually.

Dragos' next 2-day CTF is coming up on Nov. 2nd.

Be sure to check it out!

dragos.com/event/capture-the-flag-2023/

# #7. Stay Current

This can be a struggle for some people, especially once they have the role they want.

Yet, it is extremely important that you keep up-to-date with the latest cyber security news.

The attack landscape is always changing.

Always keep an eye out for the latest attack, and review older ones.

**Do you understand how each one works?**

**How do you protect against such an attack?**

**Is your organization protected?**

# Resources for Staying Current

Here are a few of my favorite resources for staying current on ICS/OT cyber:

**Dragos Blog**
dragos.com/blog

**Mandiant Blog**
mandiant.com/resources/

**Industrial Cyber**
industrialcyber.co

**Bleeping Computer**
bleepingcomputer.com

**Security Week**
securityweek.com/category/ics-ot/

**SANS Internet Storm Center**
isc.sans.org

# #8. Find an Experienced Mentor

Working with someone who has done much of what you want can help fast track your progress.

Keep the following in mind with a mentor:

- Don't be afraid to ask someone to be your mentor. If they say 'no,' don't take it personally. Keep asking others!
- Set goals with your mentor on what you want to accomplish.
- Define expectations for both parties including how often you'll meet and the required commitment level.
- Be sure to work with someone that seems to genuinely want to help.
- Make sure your mentor has the time. Even if they want to help, they might be too busy to be an effective mentor.
- Work with your mentor on exploring the other steps in this guide.

# #9. Build Relevant Soft Skills

Besides the technical knowledge, there are many soft skills that will benefit you:

**Be an empathetic facilitator**
One of the most difficult aspects of ICS/OT cyber security is getting IT cyber security professionals and ICS/OT team members to work together.

Look at cyber security from the other team's perspective and "build bridges" to where we are all on the SAME team!

**Explore other skills**
Active listening, problem solving, flexibility/adaptability, patience, cultural awareness, negotiation and integrity and others will only help you in the long run.

# #10. Get Certified

Industry certifications cannot replace the need for hands on experience, but can help demonstrate the knowledge you have been building throughout your ICS/OT cyber security journey.

There are two main certification paths that are recognized the most by the ICS/OT community:

- ISA/IEC 62443 Expert Series
- SANS ICS Certifications

Other certification paths which are growing in recognition are available from other providers such as Exida and TÜV Rheinland.

**NOTE:** I have completed all of the ISA/IEC and SANS courses and exams, but do not have personal experience with any others.

# ISA/IEC 62443 Expert Series

- The 62443 Standard from ISA/IEC is considered THE standard for securing ICS/OT environments.
- ISA / IEC provides a certification path of four courses.
- Once you complete all four courses, you become a certified ISA/IEC 62443 Expert.
- Courses are more designed to teach OT professionals cyber security.
- You must take each course before you can take the associated exam.
- Each course/exam costs ~$2,000 USD.

**NOTE:** The courses do not make you an "expert" in 62443 or ICS cyber security, but can be a great starting point!

# SANS ICS Certifications

- The SANS Institute is the world leader in cyber security education.
- SANS offers three ICS cyber security courses today created and taught by global thought leaders such as Rob Lee, Tim Conway and Justin Searle.
- Each course is independent and has its own focus.
- Courses are more designed for both IT cyber security and OT professionals.
- You do not have to take each course before you can take the exam.
- Each course/exam costs ~$10,000 USD.

**NOTE:** I took the GRID course in-person with Rob Lee and found it was the most valuable course of my 30 year career.



# Certification Resources

**ISA 62443 Expert Series**
rb.gy/ap3wa

**SANS ICS Training**
rb.gy/66a6y

**Exida**
rb.gy/ce758

**TÜV Rheinland**
rb.gy/1nmc1

# The End (For Now...)

The journey into ICS/OT cyber security is not a simple path, but it is a very rewarding one.

As the world continues to become increasingly automated and interconnected, the number of cyber threats and attacks against ICS/OT networks only continues to grow.

There will be an ICS/OT cyber attack which results in catastrophic consequences.

And the world needs you to help prevent it!

# Thank You for Reading!

Thank you for taking the time to read through this guide (or at least to skim it)! I hope you found it helpful in getting started on your journey into ICS/OT cyber security!

No matter where you live in the world, the global community needs you in helping to protect critical infrastructure and other specialized OT environments!

If you have any questions, comments or suggestions, please do not hesitate to reach out. I would love to hear from you!

Mike Holcomb
linkedin.com/in/mikeholcomb
michael@utilsec.com

# ALSO AVAILABLE...

# GETTING STARTED IN INDUSTRIAL (ICS/OT) CYBER SECURITY

**For IT Cybersecurity Professionals**

Mike Holcomb

# LIKE THIS?

- COMMENT
- REPOST
- SAVE
- FOLLOW
- CONNECT

MIKE HOLCOMB

HELPING YOU SECURE ICS/OT