# Current Research in Process Control Security Metrics

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**Ann Miller**
**University of Missouri – Rolla**

# Current Approaches and Issues

- **Based on results of audits, analyses, and assessments**
  - **Typically, use whatever is easiest to "count"**
  - **However, many times, much of the information cannot be accurately collected.**
  - **This results in many "guestimated" numbers.**
- **Based on risk avoidance**
  - **Downtime relatively easy to track**
  - **How to quantify possible IP loss?**
  - **How to quantify PR loss, even if no actual damage or loss of data?**
  - **Again, more unsubstantiated estimates.**

# Other Issues

- **Lack of a "single number"**
- **Lack of worthwhile ROI metrics for trade-off decisions.**
- **Most metrics do not consider state-dependence**
  - **Systems have differing security capabilities and/or characteristics depending on state, not just time.**
- **Lack of system-of-systems metric**
  - **Composability/interoperability issues for security**
    - **Even if system A has "quantifiable security level" *alpha* and system B has level *beta*, and the connection mechanism has level *gamma*, what is the level of A + B?**
  - **Of course, most SoS composed of many more than 2 systems**

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# Research Metrics Approaches

- **Substitution**
  - **Substitute actual, “close” values when you don’t have your own actual values**
- **Four-phase spiral approach**
  - **Iterate on the particular phase of the four-phase model (next slide) as more information is available or improved accuracy is needed**
  - **Experimentation with iteration as models developed**
- **Learn from other areas**
  - **Assurance cases for safety adapted for security**

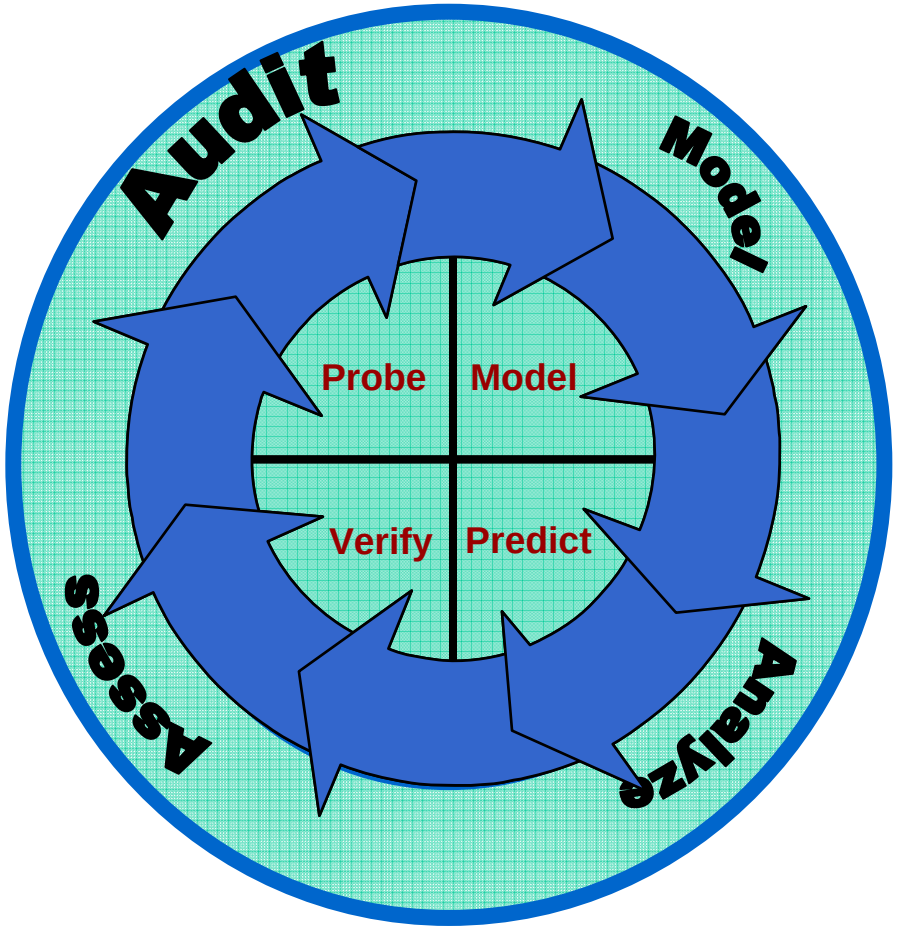
# Substitution Approach

- **Probabilistic risk assessment, yet important data missing for the fault tree (Erickson)**
  - **Basic events:**
    - **Several databases and handbooks exist to help with the estimation of failure probabilities (Bellcore; DOD; Gertman and Blackman; RAC).**
    - **Within some specific communities of interest, failure data for systems and components are available, including summaries of licensee event reports (for oil and gas: SINTEF).**
  - **Operator error: Data exist on the frequency of human error in common tasks found in an industrial environment (Henley and Kumamoto; Shooman).**
  - **Communications links, routers, etc.: much material available on web, from vendors and other trustworthy sources.**

# Spiral Approach Based on 4-Phase Model

**Audit**

- Passive and active network discovery
- COTS components
- Reachability




**Model**

- Mathematically based model of system, network, or program
- Architecture
- Network
- System-of-Systems

**Analyze**

- First round:
  - •Fault-tree analysis with environmental and run-time assumptions
- Protocol+Vulnerability analysis

**Assess**

- First round:
  - •List of exploitable weaknesses
  - •Determine type of attacks
- Threat-based
- Threat+Vulnerability-based

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# Extension: 4 Phase Model in Conjunction with Experimentation as Iterations

Improve

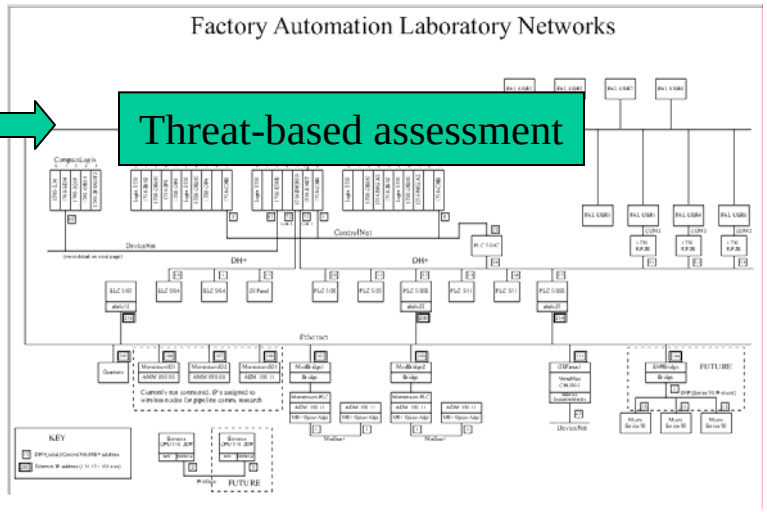
- **Determine network topology and host configurations**
- **Passive & active network discovery/reachability**
- **Differentiate between internal and external views**

**Off-the-shelf tools: Nessus, Ethereal, Snort, Netcat, TCPDump, Hping2, Dsniff**

Model ↓ ↑ Experiment

**Mathematical analysis**

Threat-based assessment




Experiment ↓ ↑ Model

Protocol Analysis
Infrastructure Analysis

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# Learn from Another Area

- **Adapt assurance case for security from safety cases**
- **Joint EU-US Workshops (Bloomfield) to determine best ways to provide compelling arguments and convincing evidence**
  - **Confidentiality, availability, integrity**
  - **People, processes, environment, technology**
  - **Other**
- **Advantage: a substantive body of knowledge on which to build**
- **Disadvantage: not a single number**

# Assurance Case for Safety

- **Definition: A documented body of evidence that provides a demonstrable and valid argument that a system is adequately safe for a given application and environment over its lifetime.**
- **Reality: Large documents with complex internal interdependencies and numerous analyses throughout the lifecycle of the product.**
  - **Rest on explicit and implicit assumptions**
  - **Product and process issues**
  - **Analyses depend on suitability of models**

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# Types of Claims in *Safety Cases*

- **Different attributes of system and of sub-systems, including:**
  - **Reliability**
  - **Availability**
  - **Security**
  - **Functional correctness**
  - **Accuracy**
  - **Time response**
  - **Robustness to overload**

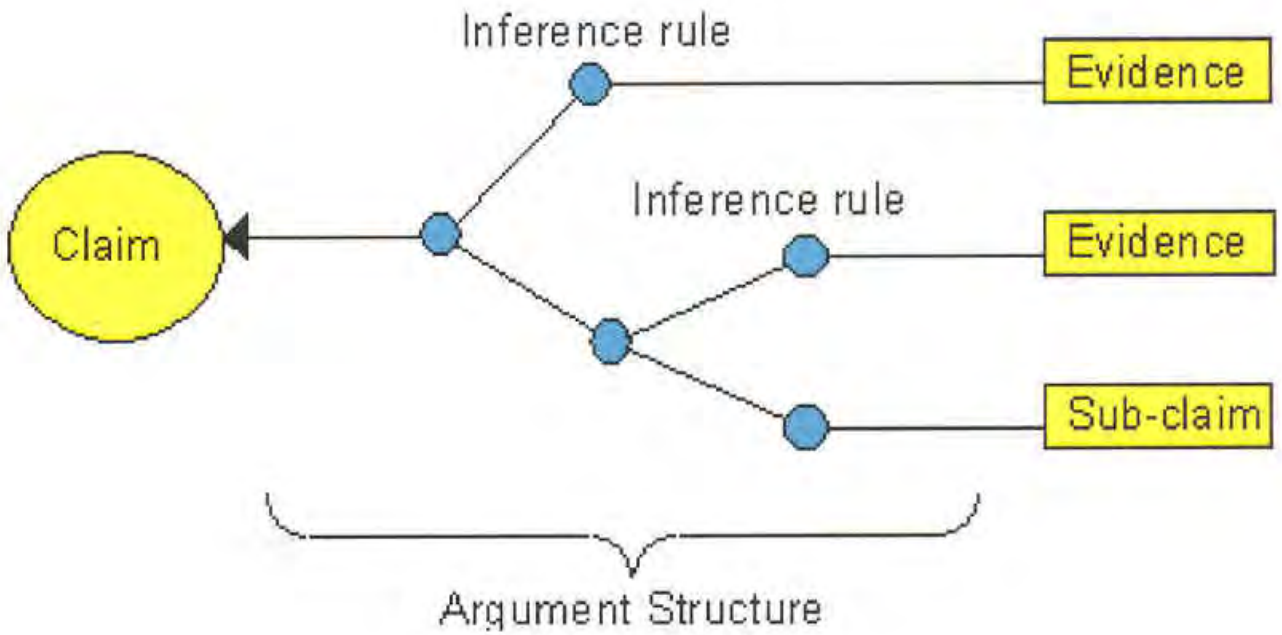
# Assurance Case

- **The motivation for an assurance case is to:**
  - **Provide an assurance viewpoint with focus and rationale - for efficient analysis and evaluation**
  - **Provide a reviewable approach - so that all stakeholders can be involved**
  - **Demonstrate discharge duty to public and shareholders**
  - **Allow inter-working between standards and innovation**
- **The emphasis should be on the behavior of product, not merely the process used to develop it.**

# Assurance Case

- **To implement an assurance case, we need to:**
  - **Make an explicit set of claims about the system**
  - **Produce the supporting evidence**
  - **Provide a set of safety arguments that link the claims to the evidence**
  - **Make clear the assumptions and judgments underlying the arguments**
  - **Allow different perspectives and levels of detail.**

# Assurance Case



# Research in Process Control Security Metrics

- **Critical need because these are critical systems**
- **Teaming between government, industry and academia can achieve more than any one group independently**
  - **Issues include non-attribution and anonymity in data collection and dissemination**

# References: 1 of 2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