Security at the Edge For Emerging Distributed Sensor Networks

Leadership in Embedded Security Workshop
Computing Community Consortium
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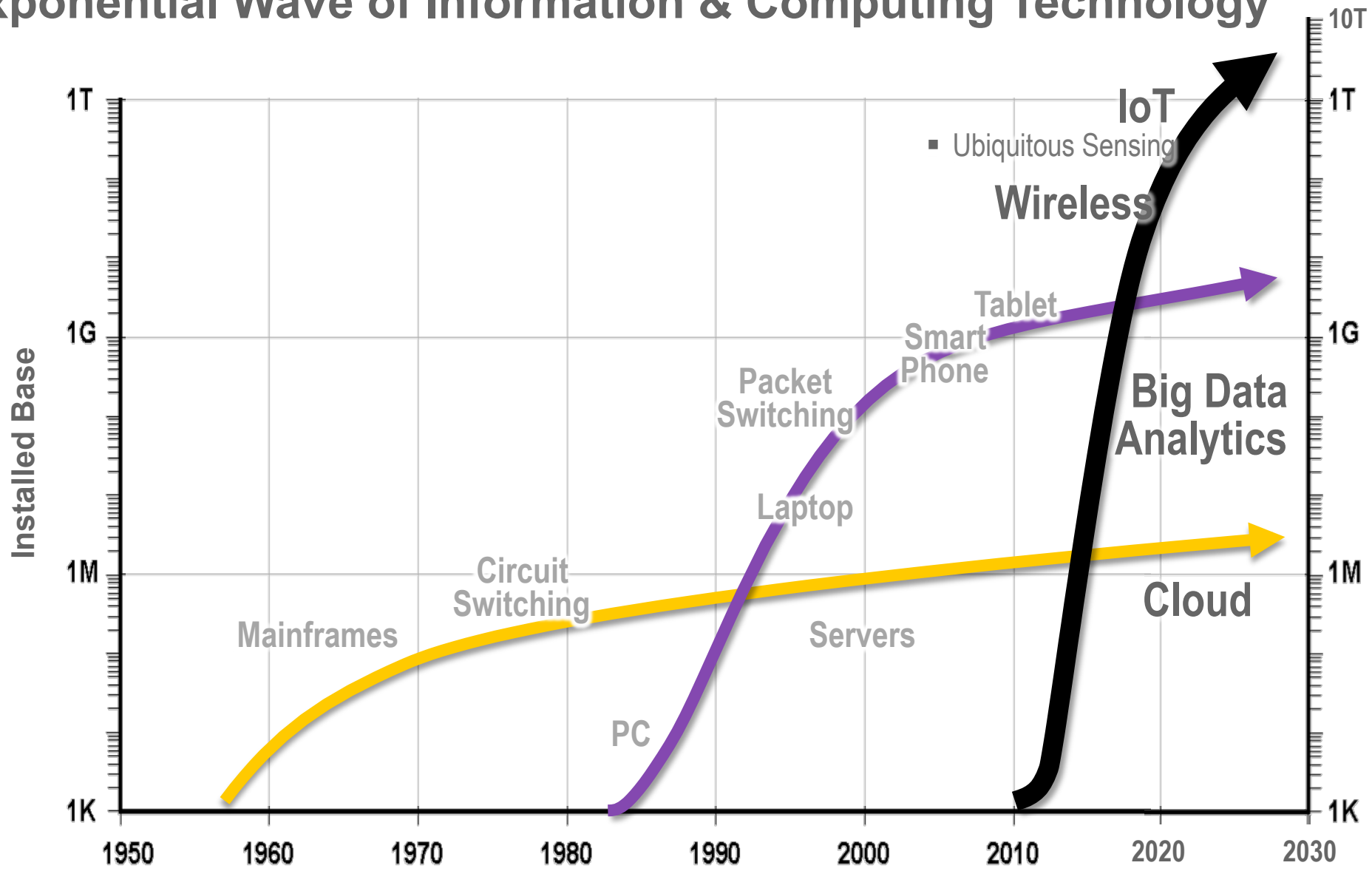
3rd Exponential Wave of Information & Computing Technology



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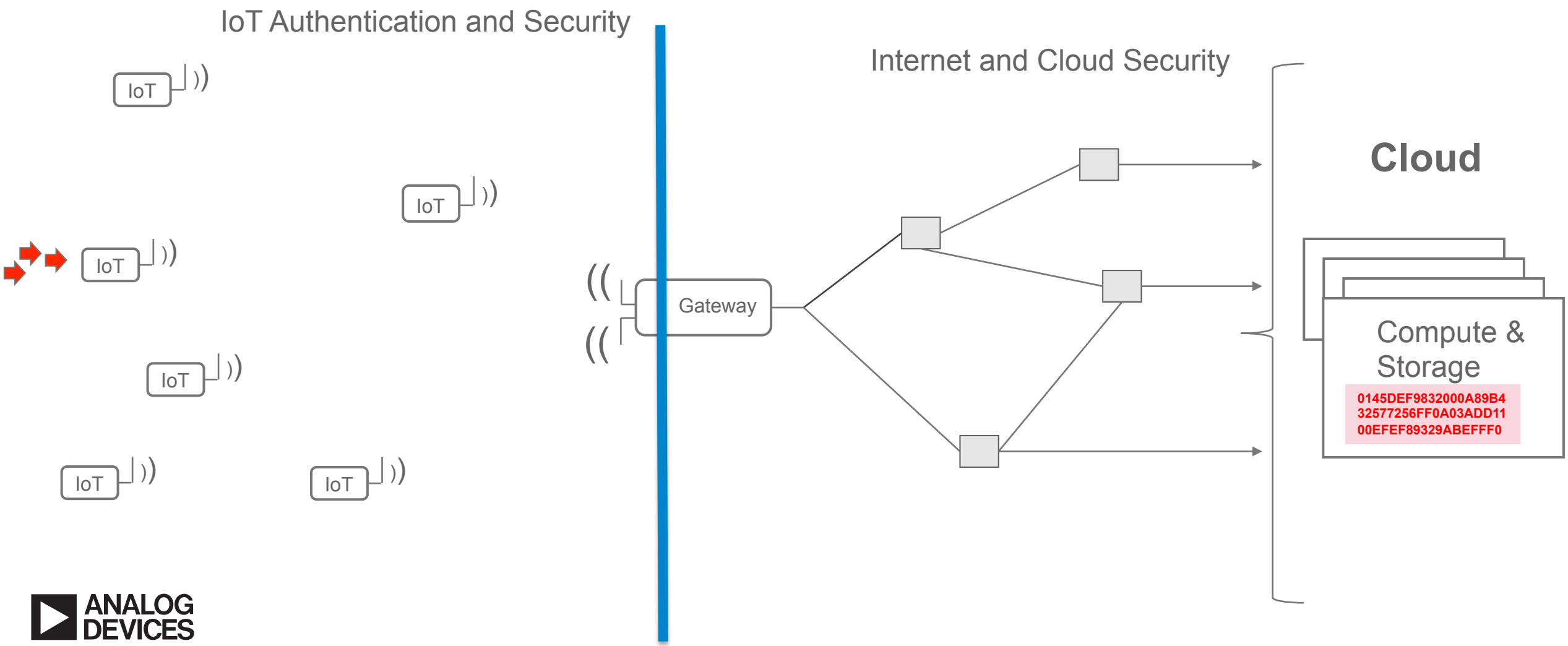
Analog **Physical Signal to** *Digital* **Information**



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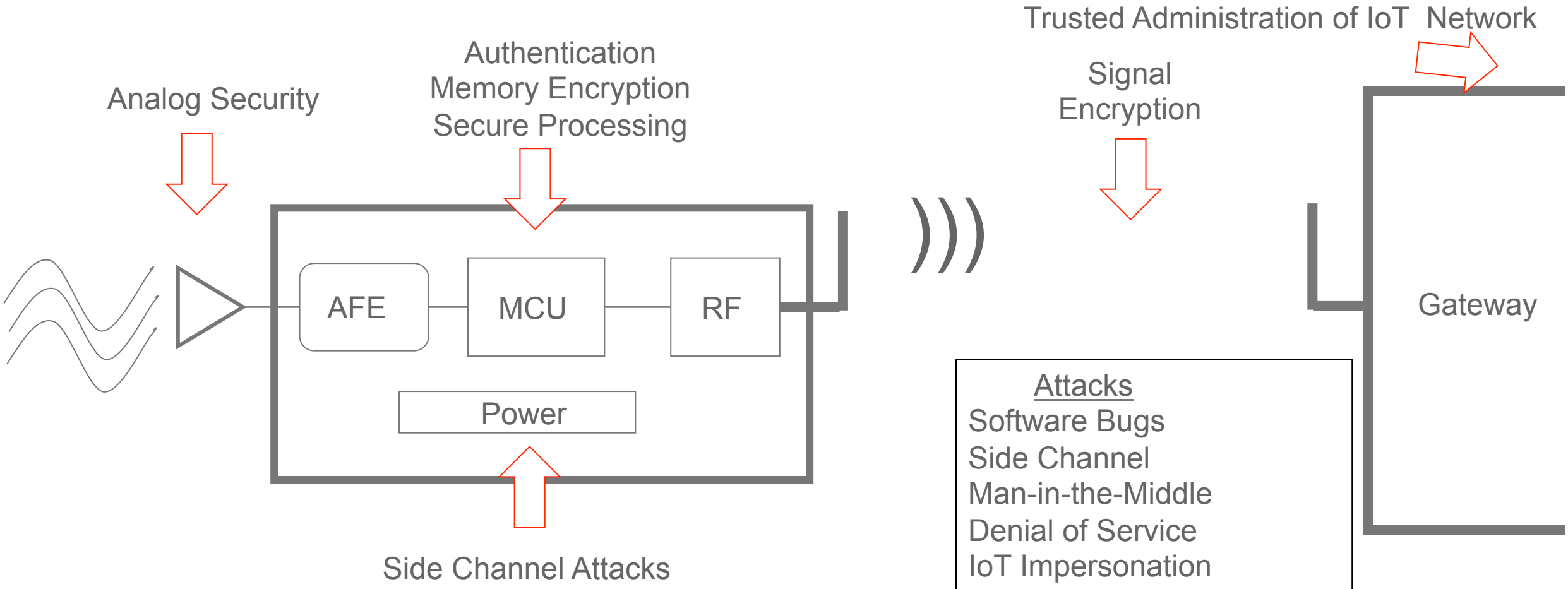
Security Threats & Defenses



Attacks
Software Bugs
Side Channel
Man-in-the-Middle
Denial of Service
IoT Impersonation
Hardware bugs
Social engineering
Tampering with HW or SW

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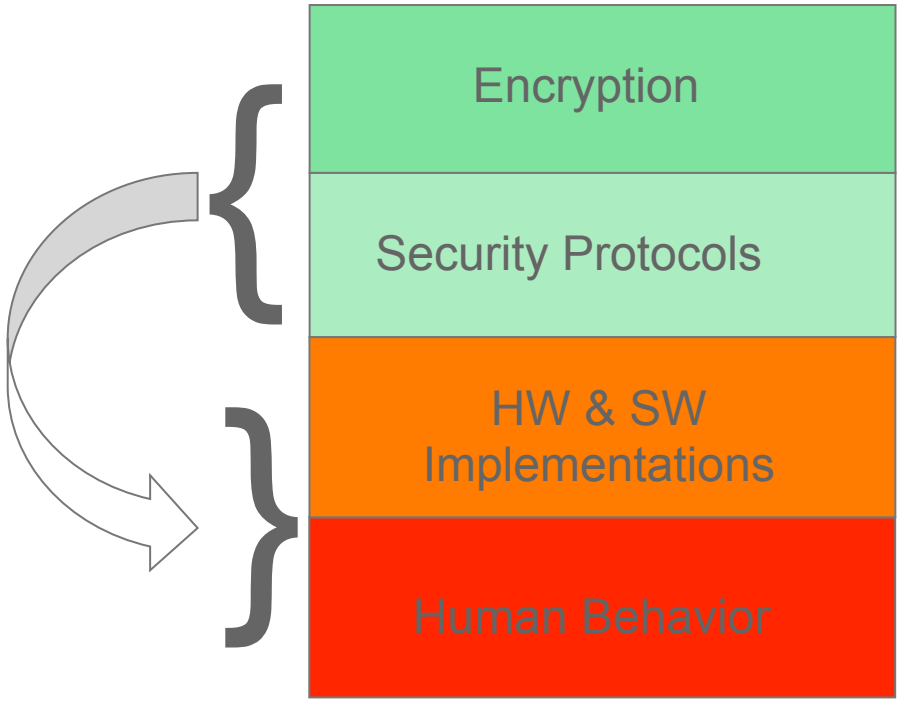
High(est) Level View of Security Risks

- Encryption
  - Two types: Symmetric key encryption & Public Key encryption
  - Deep mathematical foundation
  - Critical toolset for security
  - Research opportunity: quantum secure PKI
- Security Protocols
  - Enable secure communication between parties
  - Not deep mathematics
  - Complicated but robust logic.
- Implementation in Hardware and Software
  - Dozens of bugs/weaknesses per 1000 lines of code
  - Basis for many successful attacks. Big Problem
- Human Behavior
  - Social engineering: fraud, trickery and impatience. **Very Big Problem**



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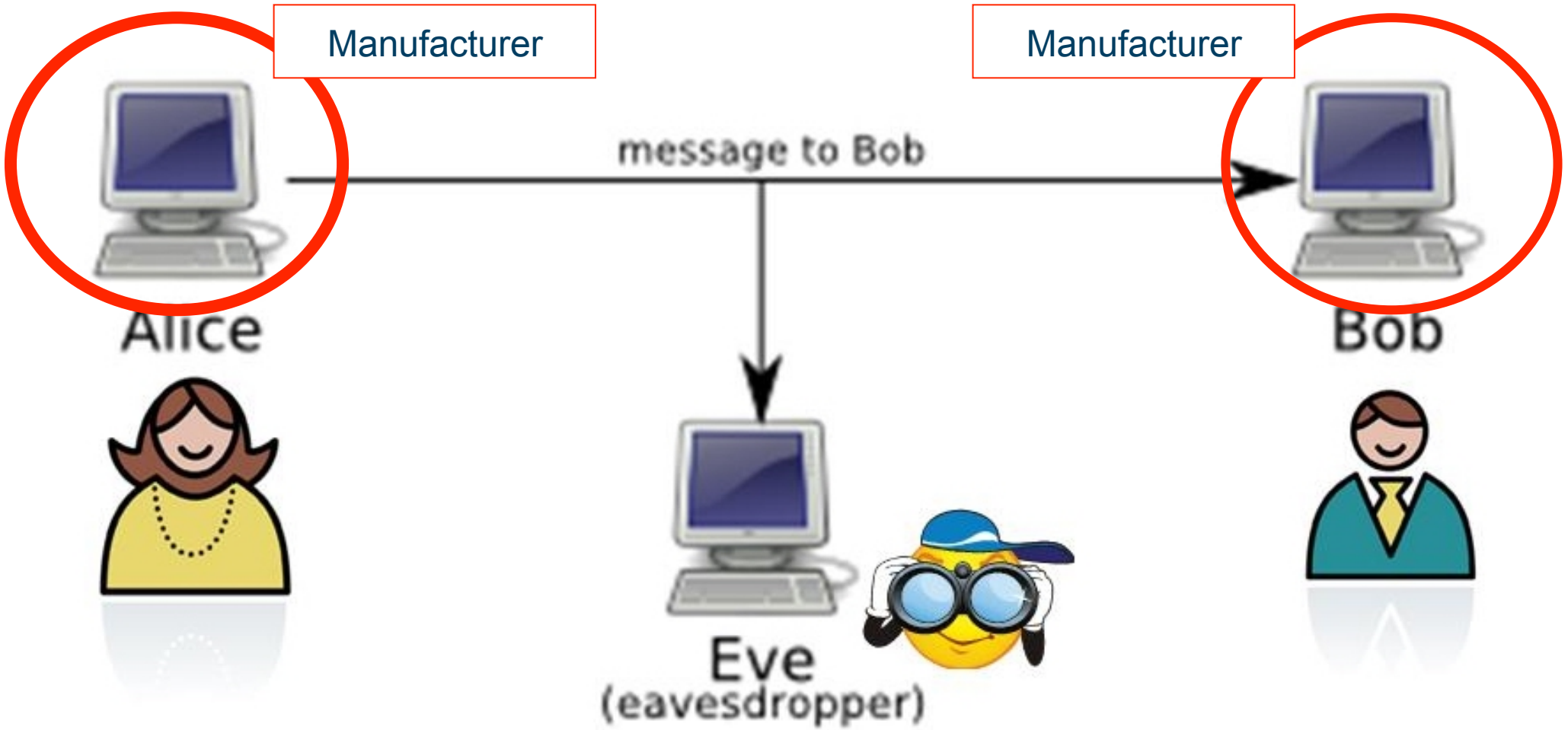

The “Silent Third Party”: Manufacturer’s HW/SW Platform

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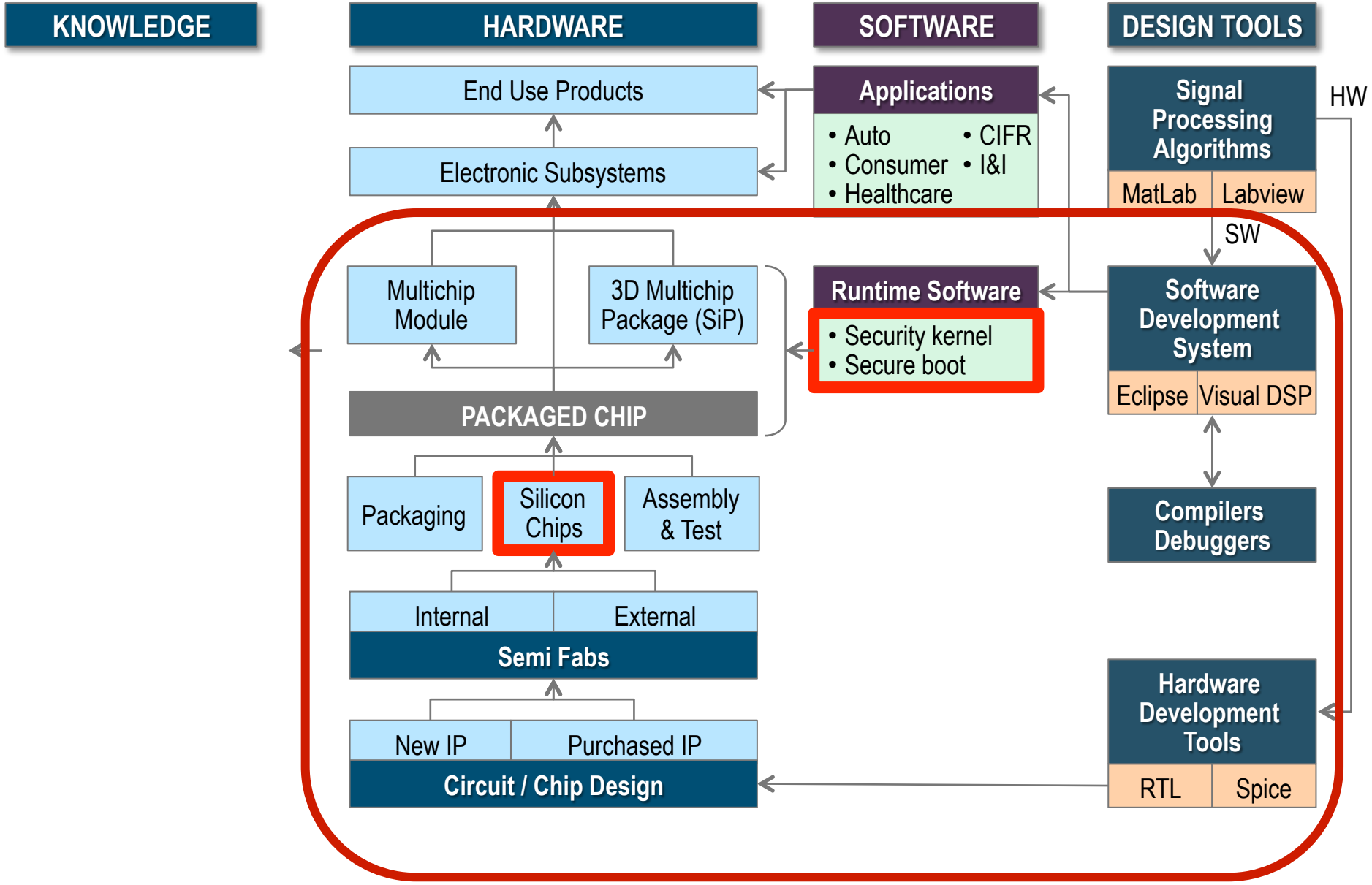
Embedded Node Ecosystem



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Complexity is the Enemy of Security

Challenges faced by the Silent Third Partner in Security

	Complexity	Maximum Complexity of Trustworthy "Kernel"
▶ Software	10^{12} bits	less than 10K lines of code
▶ Hardware	10^{10} transistors	less than 10K logic gates
▶ People	10^{3} people	1 team of less than 10 people.

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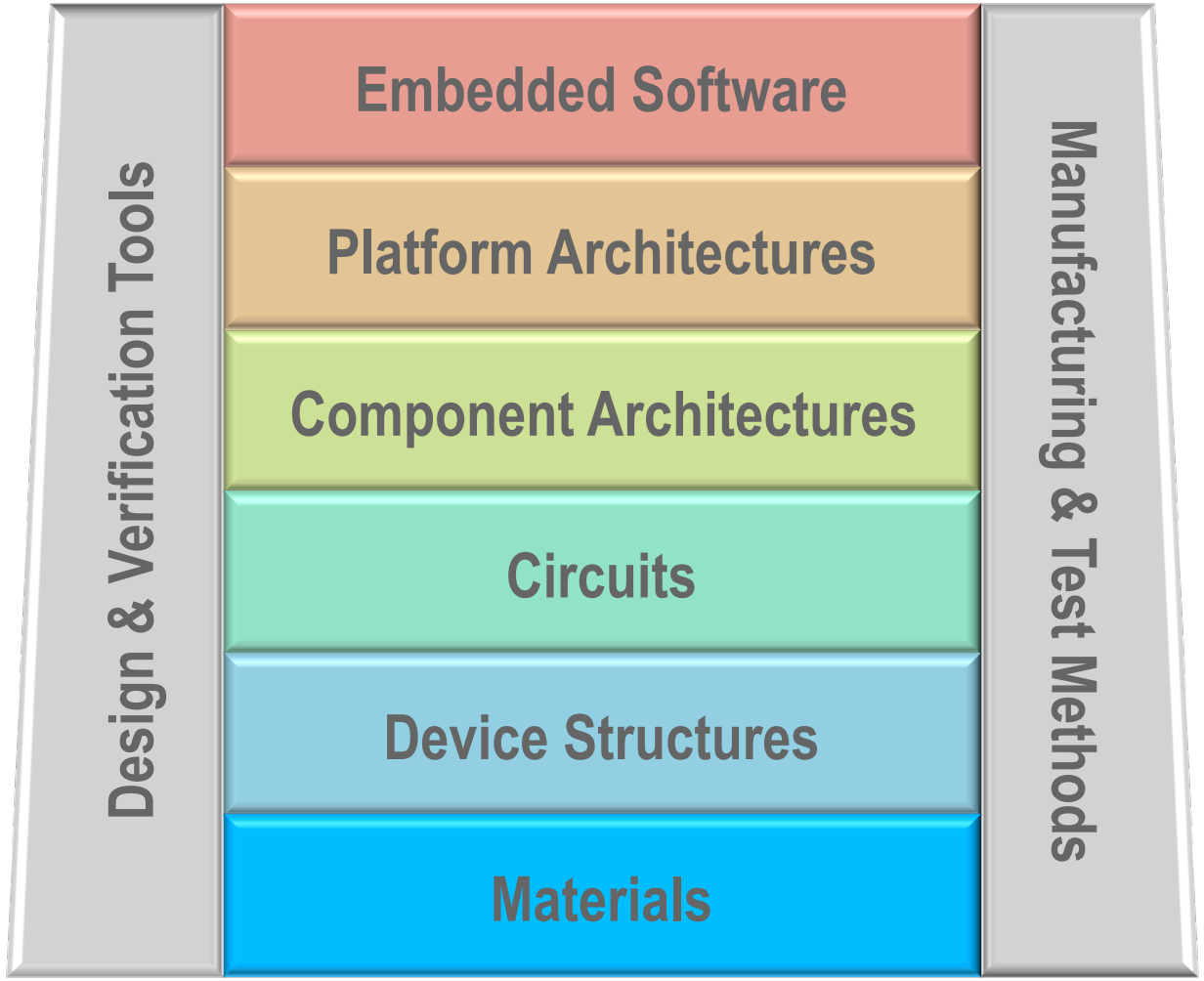
Authentication is particularly critical in Distributed Edge Nodes

- **Experience from Authentication in traditional Distributed Systems**
  - Public Key Encryption proven essential for remote authentication
    - Example: Kerberos from N-S TTP protocol to PKI protocol.
  - Two factor authentication often used for intermittent sensitive interactions

- **What is different about Authentication for Distributed Edge Nodes?**
  - Two Factor authentication difficult when no trusted agent present at Edge Node. More reliance on continuous connectivity or repeated authentication
  - Often Edge Node is severely power constrained. E.g. battery powered or energy harvested from environment
- **Energy efficient strong authentication protocols required.**

Embedded System Technology Stack



Embedded application secure update mechanism

Secure boot/kernel (<< 10K instructions)

Trusted HW Zone. (<< 10K gates)

Encryption IP

Root of Trust

Security from side channel attacks

Tamper proof package

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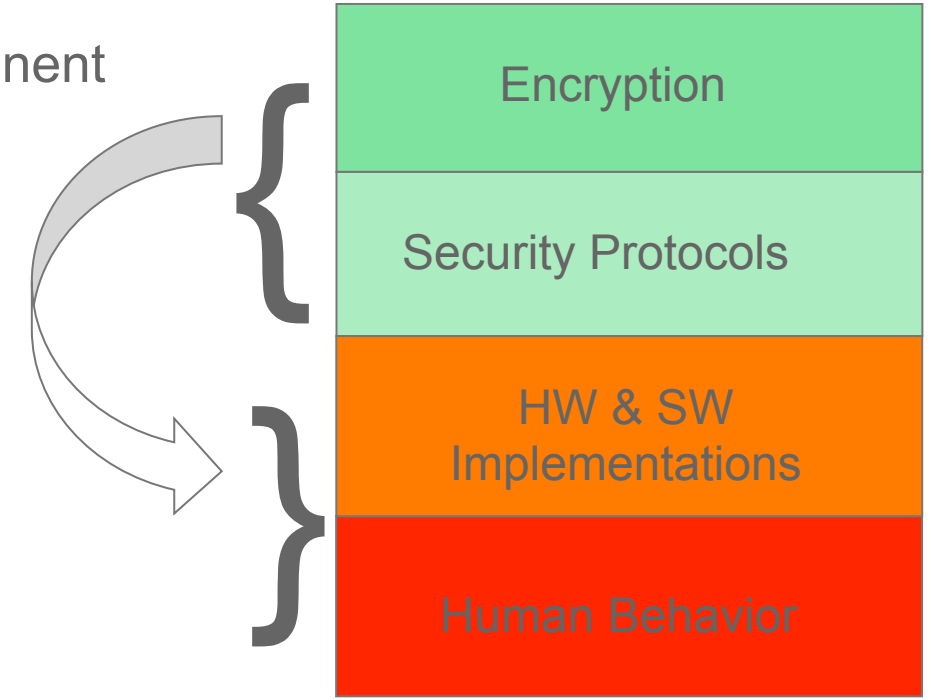
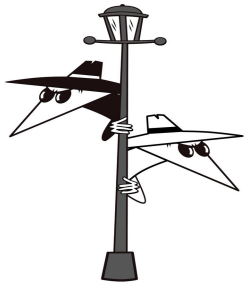
If You Remember Nothing else today:

- **Security is a capability of the system** not a component
  - System is only as secure as it's weakest link
  - Encryption is just one of the necessary links
- **Complexity is the enemy of Security**
  - What (1)hardware, (2)software and (3)humans must be trusted?
- **There is no silver bullet**
  - Continual Arms Race of attack/defend/attack/ ….
- **Authentication of IoT nodes is critical**
  - It begins with a secure Root of Trust





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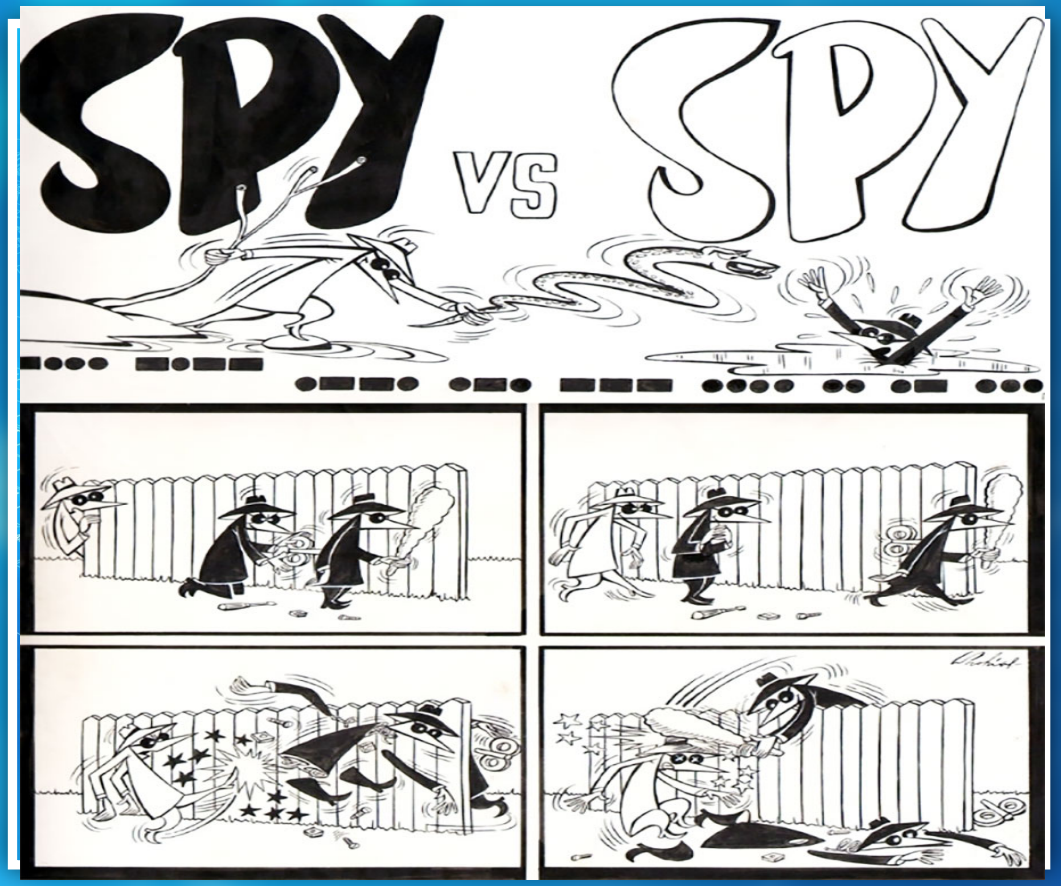

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