Wi-Fi Protected Access for Protection and Automation

Presented to: ACSAC-22 2006
13 December 2006

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The good news and the bad news

- Who is CIGRE B5.22?
- What is Wi-Fi as defined by IEEE 802.11i?
- Lets get technical
  - WEP is not secure, so we now have WPA -> WPA2
  - Now we have 802.11i
  - Context is defined by limited-life keys
- What has this to do with Electric Power protection and automation?
  - Good question: we took a survey
  - What did we learn
- Defense in Depth
  - VLAN traffic separation
  - Radio planning to limit access

Who is CIGRE B5.22

- ”CIGRE” is one of the leading worldwide Organizations on Electric Power Systems
- Study Committees are the main players of the technical activities – B5 is responsible for power system protection, substation control, automation, monitoring and recording
- B5.22 was commissioned to
  - Survey applications using Wi-Fi
  - Assess the mitigation of security vulnerabilities offered by IEEE 802.11i
  - Recommend design requirements and prioritized security levels

What is Wi-Fi

- Typically a Wi-Fi “adapter card” is embedded or inserted into a computer
- Wi-Fi provides simple wireless broadband access
- “Wi-Fi” is a brand name coined by the Wi-Fi Alliance
- Wi-Fi products must be designed using an industry standard, known as IEEE 802.11
  - Each subgroup of 802.11is assigned a letter
  - “i” subgroup is responsible for developing an amendment to the 802.11 standard specifying security mechanisms for wireless networks

What's the difference between 802.11 a, b, g, & n

	Operating Band	Transfer Speed	Situation
802.11a	5 GHz	54 Mbps	Line of sight – one direction only Never accepted in the market
802.11b	2.4 GHz	11 Mbps	Omni-directional
802.11g	2.4 GHz	54 Mbps	"b" and "g" are interoperable
802.11n	Solves the instability and interference issues with b & g Adds multiple input/multiple output (MIMO) Orthogonal frequency-division multiplexing (OFDM) Uses several different receiver and transmitter antenna Increased data broadcast simultaneously		

WEP is not secure, so we have WPA -> WPA2

- Original IEEE 802.11 did provide a security method - Wireless Equivalent Privacy (WEP)
  - Hacking software “AirSnort” published on the web
  - WEP security was instantly rendered useless
- Wi-Fi Protected Access (WPA) was the result
  - Better data encryption
  - Ability to authenticate users on large networks using a separate authentication service such as Remote Authentication Dial-In User Service
  - WPA use of Pre-Shared Keys (PSKs) – this is the problem

Now we have 802.11i

- Defines a new type of wireless network called
  - Robust Security Network (RSN)
  - Transitional Security Network (TSN)
- RSN and WEP systems can operate in parallel
- WPA and RSN share a common architecture and approach
  - WPA has a subset of capability focused specifically on one way to implement a network
  - RSN allows more flexibility in implementation
  - RSN supports the Advanced Encryption Standard (AES) cipher algorithm

Context is defined by limited-life keys

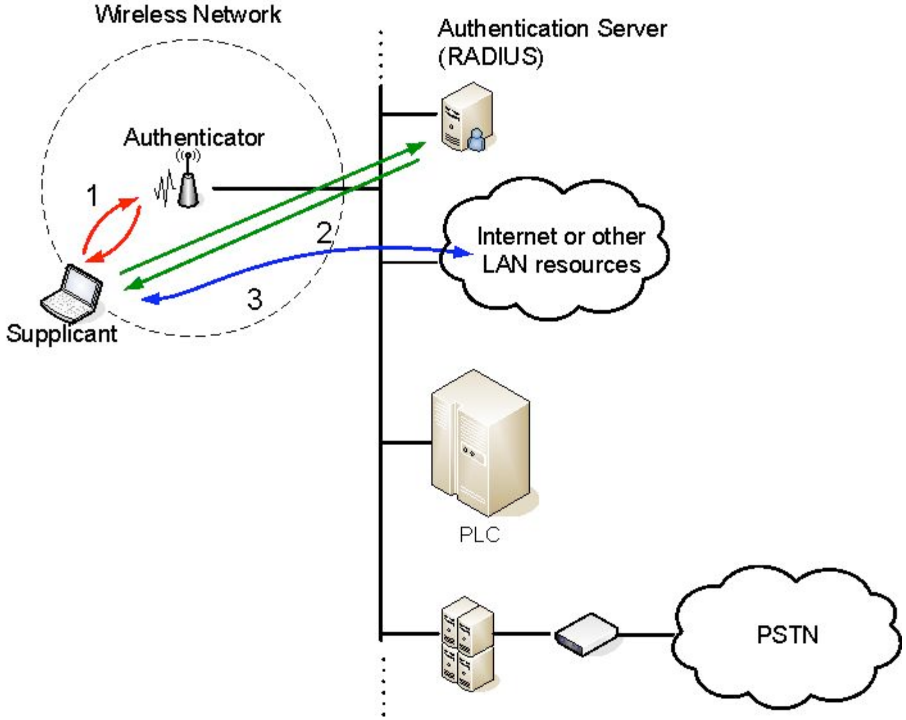
- Used to establish and maintain a security context between the wireless LAN devices - usually a mobile device and an access point
- This context is the “secret key” upon which security heavily relies
- RSN the security context is defined by the possession of limited-life keys – temporal keys
  - Creation of keys is done in real time as the security context is established, after authentication
  - Updated from time to time
  - Always destroyed when the security context is closed
- Authentication is based on some shared secret that cannot be created automatically
  - basis for all authentication methods is the entity to be authenticated possesses some special information in advance, which is called the master key
  - the master key is rarely, if ever, used directly; it is used to create temporal keys

Access control is critical some definitions

Supplicant: an entity that wants to have access

Authenticator: an entity that controls the access gate

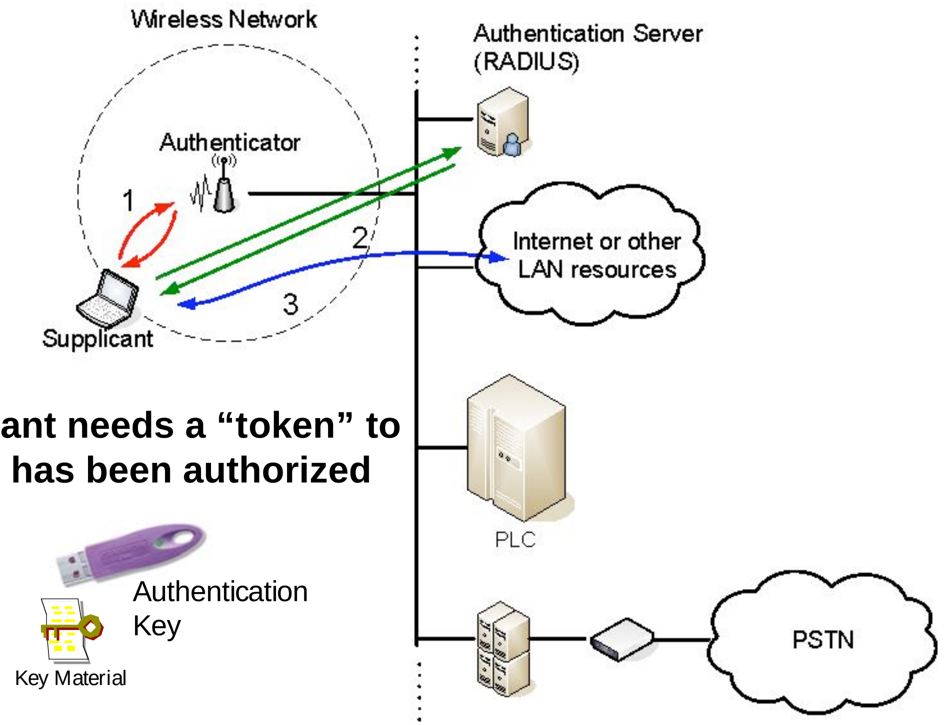
Authorizer: An entity that decides whether the supplicant is to be admitted


Wireless Network
Authentication Server (RADIUS)
Authenticator
1
2
3
Supplicant
Internet or other LAN resources
PLC
PSTN

PLC: Program Logic Controller – field device
PSTN: Public Switched Telephone Network

Access control – how it works

1. Authenticator is alerted by the supplicant
2. Supplicant identifies itself
3. Authenticator requests authorization from the authorizer
4. Authorizer indicates YES or NO
5. Authenticator allows or blocks access



Supplicant needs a “token” to prove it has been authorized

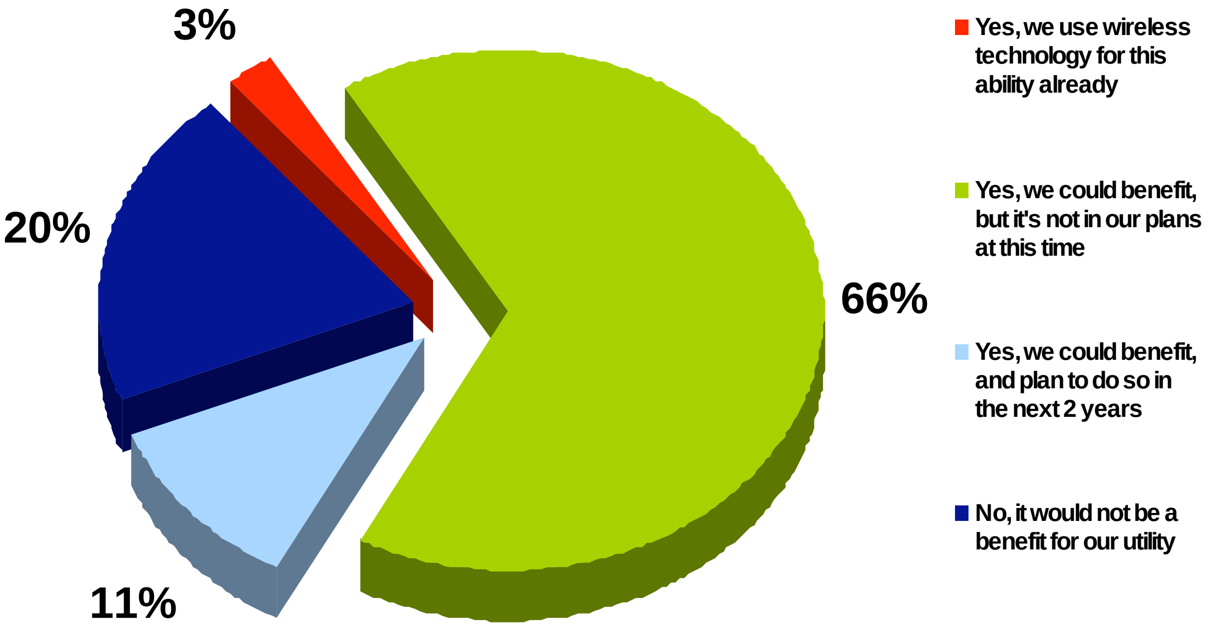
Three protocols used for WPA and RSN

- IEEE 802.1X – foundation for WPA and RSN
- EAP: Extensible Authentication Protocol (RFC2284)
- RADIUS: Remote Authentication Dial-in Service
  - Method of choice for WPA
  - Optional for RSN

The results from the survey are in

- The survey was sent to approximately 400 electric power utilities
  - serving at least 50,000 customers
  - having at least 20 electric power distribution and/or transmission substations
- More than 80 utilities from 32 countries participated
- The situation today
  - Little difference in current practices regarding Wi-Fi adoption and use
  - Utility officials are not likely to use Wi-Fi at the present time
    - for sensitive mission-critical applications
    - such as protection and automation activities in electric power substations

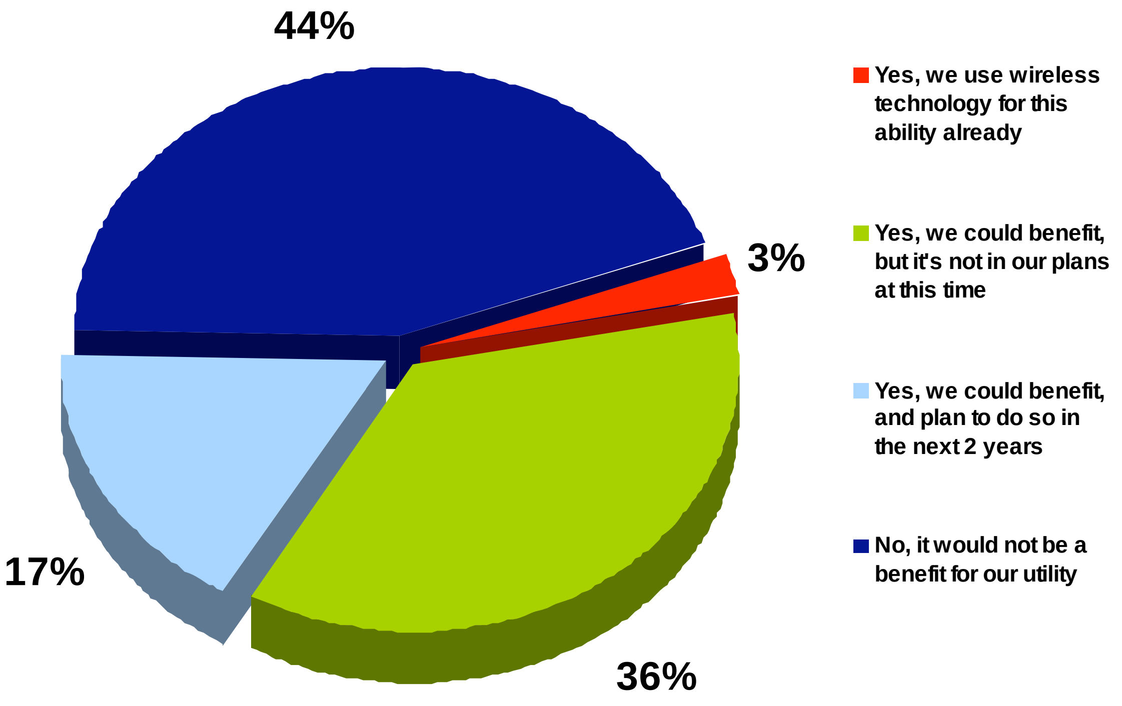
Don’t despair
Look at the market opportunity



***Two-thirds* indicated that the utility could benefit from having a capability to obtain IED technical support at any time and regardless of location**

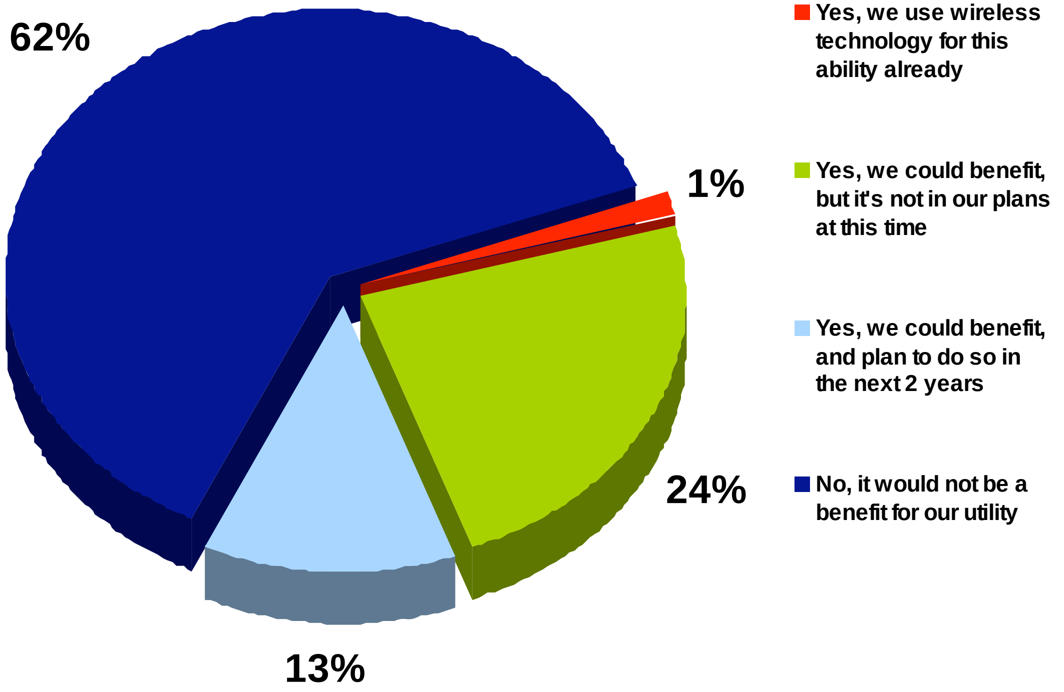
More good news

Local access without entering the substation



- 36% could benefit - but had no plans to implement a solution
- 17% could benefit will implement a solution Q1 of 2008
- 44% need some education

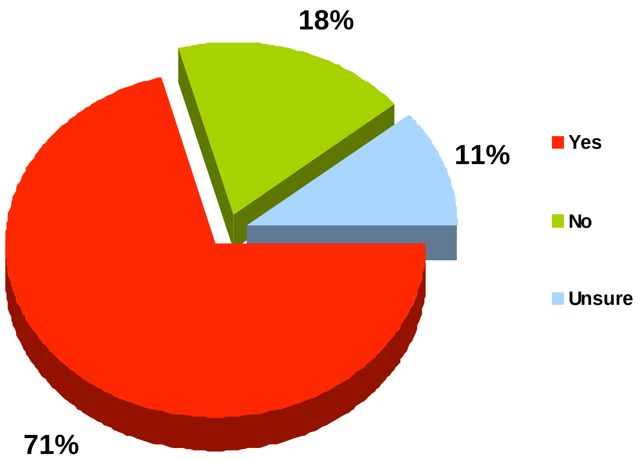
Hard to reach IEDs are of interest



- 24% could benefit but had no plans to implement at this time
- **13% said they could benefit and plan to implement a local access capability to reach IEDs by May of 2008**

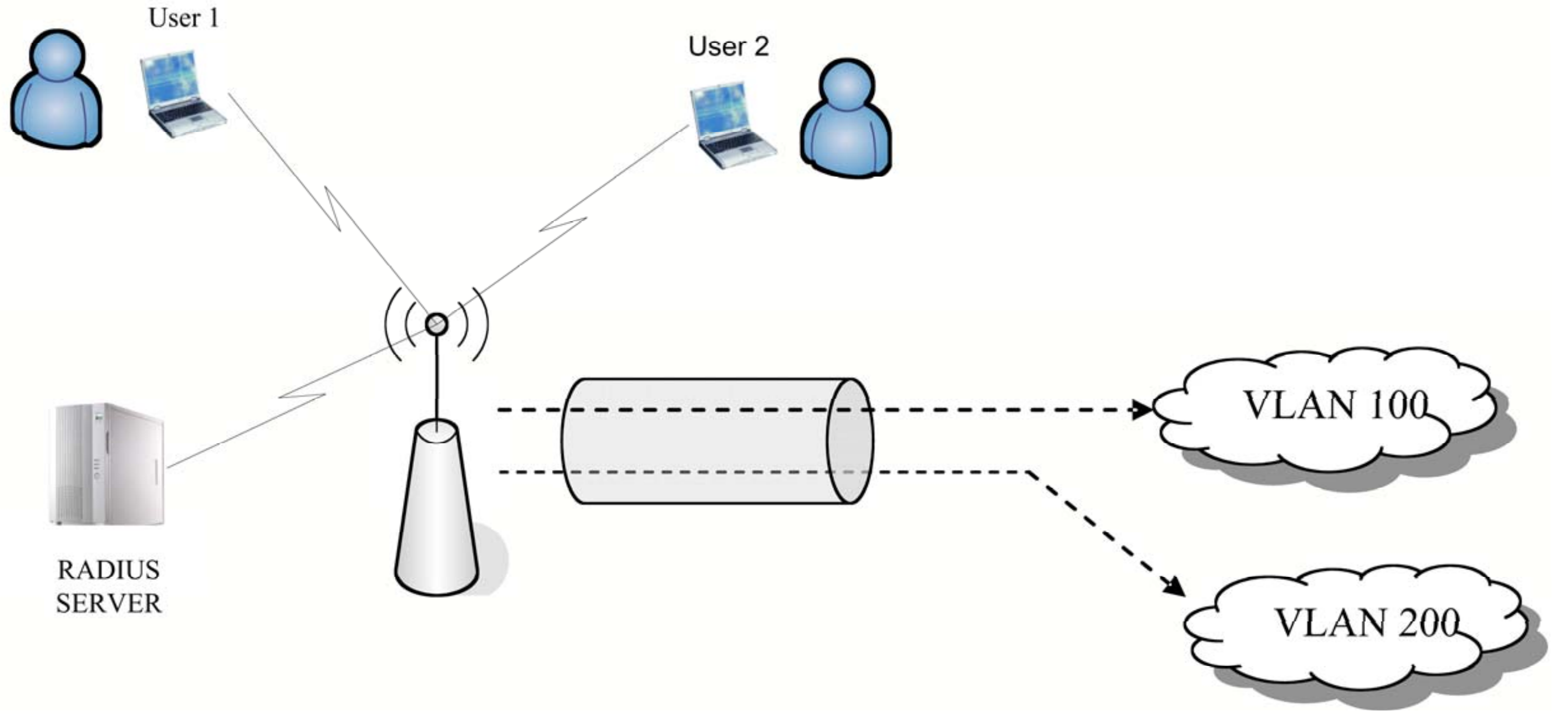
The issue is security

- **43% - decision was based on the company's security policy**
- **22% - published articles discussing the risks of wireless use affected their decisions**
- **10% - own experience, or other utility experiences, justified their position not to use wireless communications in the substation**
- **19% - security did not have an effect on their decision not to use wireless approaches**



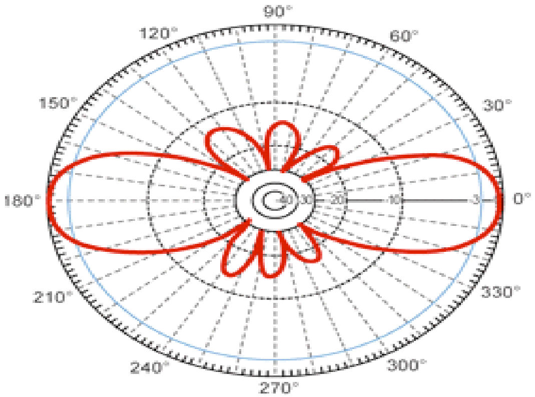
71% indicated that security issues do have an effect on their decision not to use wireless communications in the substation

VLAN for traffic separation

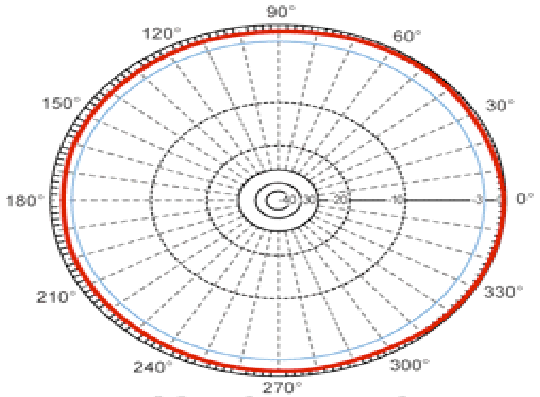


- Adds a tag in all user originated frames {VLAN100 or VLAN200}
- IEEE 802.1x used to assign each user to a VLAN
- Radius server configures access points to support VLAN assignment

Antenna pattern shaping to limit access



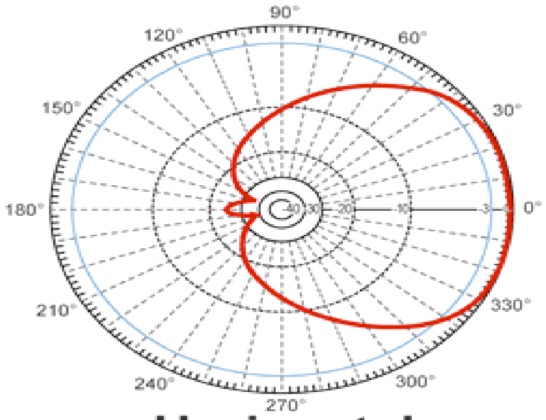
Vertical



Horizontal

Ideal omni-directional gain pattern

Sector panel shaped gain pattern



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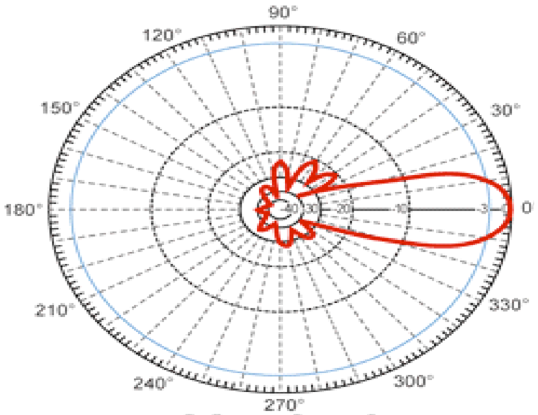


Vertical

The answer to two questions

1. **Are the security mechanisms adequate**

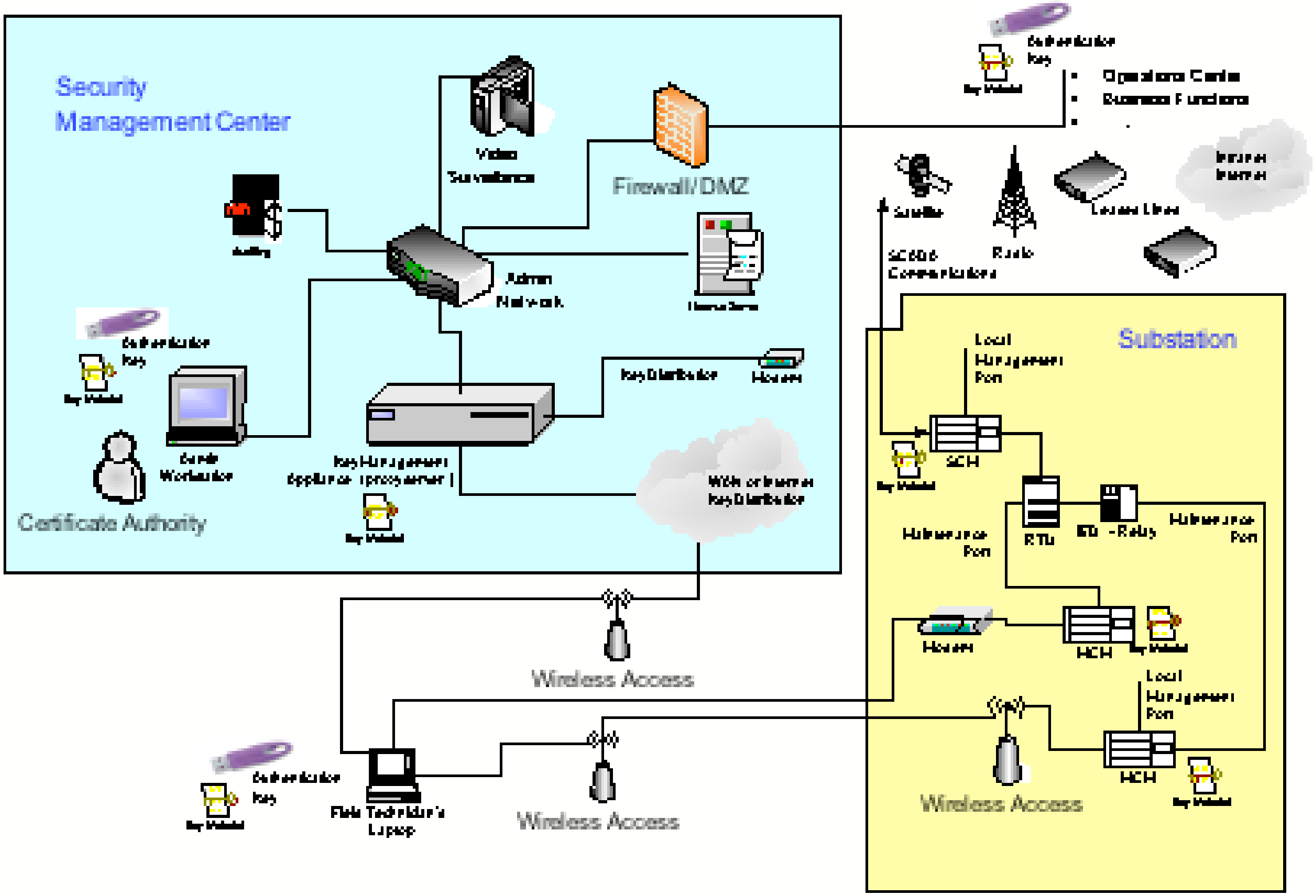
   YES, but utilities need to enforce two principles

   - **The principle of least privilege**
   - **The principle of deny everything not-specifically-allowed**

2. **Given the organizational complexities of power system operations can a system that relies on limited-life keys be efficiently managed**

   - **Depends on the degree of complexity**
   - **Closed self-contained operations – YES**
   - **Open federated operations – NO**

An effective security management scheme



Now for the quiz

- **I use 802.11 – am I secure?**
  - **If you use WEP** **NO**
  - **If you use WPA with passphrases** **YES**
  - **If you use 802.11i** **YES**
- **Does 802.11i address access control?** **NO, Use 802.1x**
- **I'm a small utility – can I efficiently manage the keying material?**
  - **If you implement a Security Management Center** **YES**
  - **If you use a trusted third-party security manager** **YES**
- **I don't want "stovepipe" solutions - does 802.11i fit with a comprehensive solution?**

Yes, because 802.11i implements a layered schema which is scaleable

What about me!

- I'm a large complex utility and I need to control access and use privileges
  - Between internal organizations
  - With business partners
  - With support organizations
  - With ISO, government and regulatory agencies
- Good news: 802.11i is secure – that's not the problem
- Good news: If you can force a hierarchical management scheme, a well defined solution is available
- Bad news:
  - ISO, Government, and Regulatory agencies are the problem
  - You have a management nightmare on your hands
  - A federated, not a hierarchical, scheme is needed
  - A well understood federated management scheme does not exist

Thank you for your attention

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