Building Smart Communities with Open Standards IoT

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Setting the Stage

- When we talk about the internet, most people think about what they see, namely the world wide web, but that is just an application running on the internet that makes it easy to use.

- The actual internet is really just a network connecting various points allowing the exchange of data and, except for the last 100meters, is mostly wired

Setting the Stage

- The Internet of Things is same idea but vastly larger

26+ BILLION devices will be connected by 2020
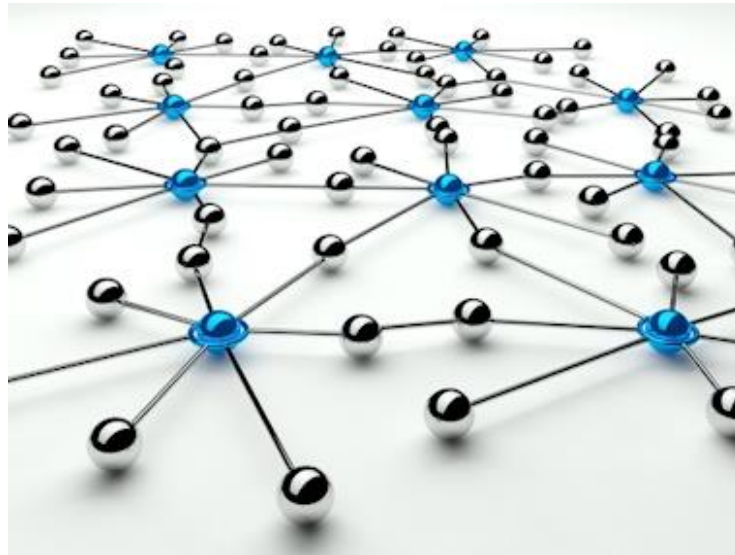
$4-11 Trillion Economic Impact

54% of top performer companies will invest more in sensors this yr

Sources: Gartner, PwC, McKinsey

- Since there are so many things it is mostly wireless.
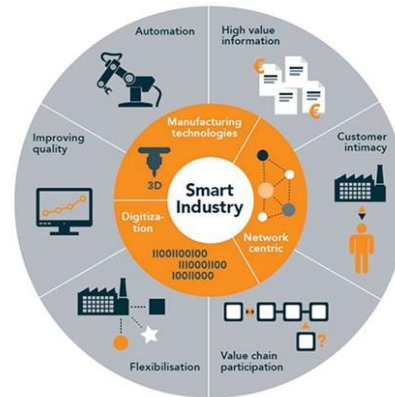
Setting the Stage

- The idea of an IoT is to connect things, and to allow the exchange of data which can then be converted into information for a variety of uses

- I am going to talk about the IoT Network and the special needs for IoTs supporting Smart Communities not specific applications

Some General IoT Use Cases
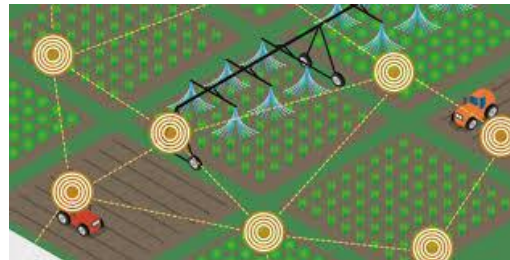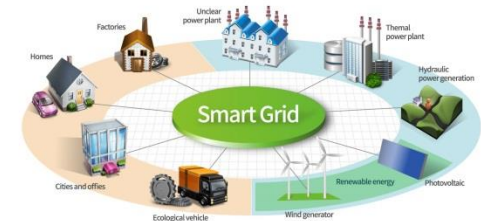
- Smart home

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- Smart industry

- Smart health

- Smart agriculture

- Smart Grid

IoT Network Needs

- IoT networks need to function well in a variety of environments

- For wireless networks, this can be challenging

- Today IoTs are largely used in smart buildings, but tomorrow it is smart cities and smart communities.

- What works well inside (Home Area Network (HAN)) will not necessarily work well outside (Field Area Network (FAN)).

- Although network layer protocols are often the same, the communications needs are different

IoT Network Requirements

- Desirable Attributes for both Home and Field Area Networks include:
  - No new wires
  - Secure
  - Easy to install and maintain (mesh, self organizing, self healing)
  - Ability to scale easily to thousands of nodes
  - Reliable (mesh, multiple channels, demonstrated interference tolerance)
  - Very Energy Efficient (long battery life/energy harvesting)
  - Low Cost (open standard)
  - Able to support Constrained Devices
  - Interoperability

FAN Requirements

- Added FAN Challenges over in Building Networks:
  - Longer Distances
  - Terrain issues
  - Structures
  - Foliage
  - Weather
  - Need for Higher Data Rates
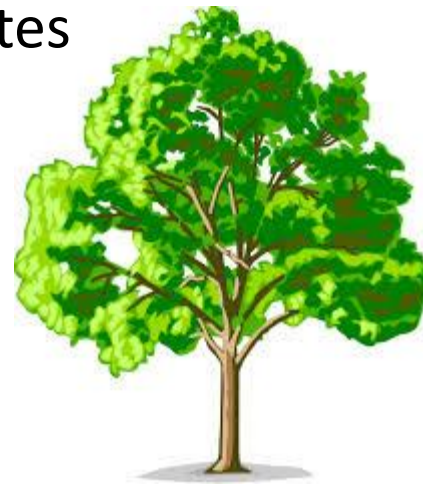
Additional FAN Considerations

- Smart Community applications are often built independently, a piece at a time, and used for a long time

- Over time, various pieces may need to be directly integrated

- To meet these needs, Open Standards are strongly desired, and…

- Certification programs are needed to ensure Multi-Vendor Interoperability

Standards Development
The Need for IEEE 802.15.4g

- In 2008 there were no wireless communications standards for Peer to Peer Field Area Networks

- There were a number of proprietary Field Area Network solutions; many were based on a common technology

A standard was needed - IEEE802.15.4g

Standards Development
IEEE 802.15.4g - Scope

- Initial Focus was on Smart Utility Network Communication

- Standard was later optimised for Large Scale outdoor Wireless Mesh Networks – i.e. Field Area Networks

- Goal was to take proven technology and create a standard to meet FAN needs and allow interoperable products globally

- First published in March 2012 and revised in 2015

IEEE 802.15.4g feature summary

- Features and Outcomes
  - Takes advantage of proven technology
  - Backward compatibility with installed base of 10's of millions of meters using 802.15.4
  - Great flexibility
    - Multiple data rates
    - Robust error detection
    - Optional forward error correction
    - Supports direct use of an IP network layer without 6LowPan
  - Support for Global and Regional frequency bands
    - 902-928 MHz in US and many other regions
    - 902-907.5 & 915-928 MHz in Brazil
    - 920MHz Japan
    - 868.3 MHz Europe

What was still needed?

- Specifying the communications functionality for each "Smart" Application
  - Options make interoperability more difficult to achieve
- A testing and certification process
  - IEEE802 writes standards, it does not describe testing
- An Industry Alliance provides the forum
  - to select and document required options and features
  - to define testing and certification
- The Wi-SUN Alliance was organized to address these issues

What is Wi-SUN Alliance?

Standardization body	Industry Alliance	Commercial trademark
IEEE802.11 Wireless LAN	WiFi Alliance	WiFi
IEEE1901 Wireless MAN	HomePlug Alliance	HomePlug
IEEE802.15.4g Wireless SUN	Wi-SUN Alliance	Wi-SUN
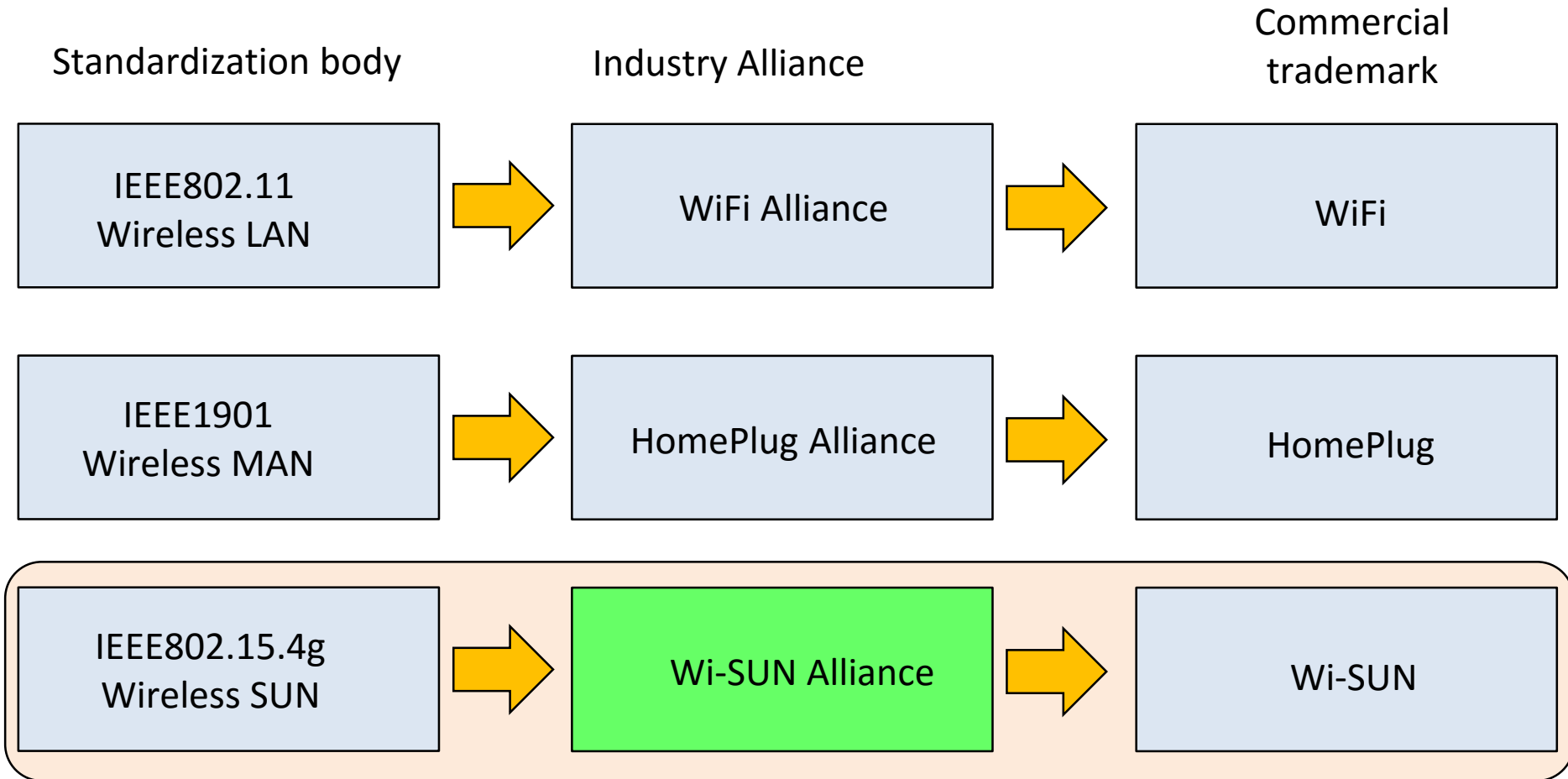
Wi-SUN Alliance Background

- Established in April 2012

- Incorporated as Not for Profit Organization (501c) in Delaware, US

- Regional support in Singapore, Europe, India, Japan

- Now working to establish regional support in China

- Approximately 100 member companies Worldwide, including Utilities, Government Institutions, Product Vendors, Silicon Vendors and Software Companies

- Over 90 certified products
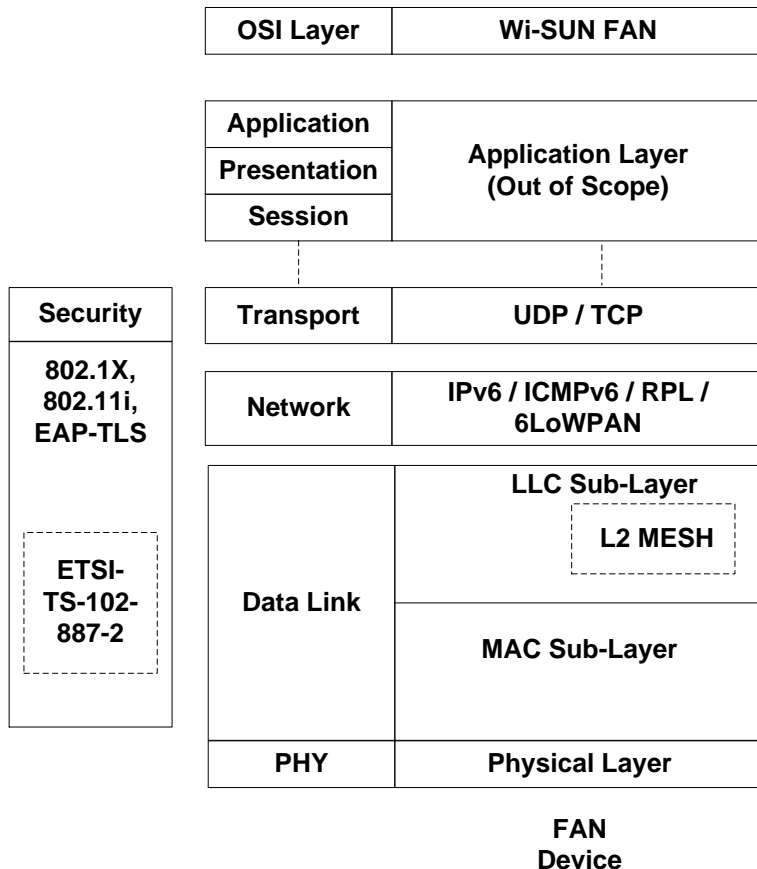
Wi-SUN Alliance Scope

- Communications Profile Definitions based on Open Standards for Field Area, Smart Utility and related networks

- Interoperability Testing + Certification Authority for Peer to Peer Wireless Mesh currently based on IEEE 802.15.4g and IPv6

- Current focus is on enabling multi-vendor FANs and communications for Smart Utility Networks

- Marketing support and training programs to promote understanding and adoption

What Wi-SUN Alliance does not do…

- It is not a Standards Organization like IEEE802

- It does not specify Application Layer profiles

Wi-SUN FAN Stack Overview

OSI Layer	Wi-SUN FAN

Security		
802.1X, 802.11i, EAP-TLS		
ETSI-TS-102-887-2		

Application	**Application Layer (Out of Scope)**	
Presentation		
Session		
Transport	**UDP / TCP**	
Network	**IPv6 / ICMPv6 / RPL / 6LoWPAN**	
Data Link	**LLC Sub-Layer**	
	L2 MESH	
	MAC Sub-Layer	
PHY	**Physical Layer**	

FAN Device

IPv6 protocol suite

- TCP/UDP
- 6LoWPAN Adaptation + Header Compression
- DHCPv6 for IP address management.
- Routing using RPL.
- ICMPv6.
- Unicast and Multicast forwarding.

MAC based on IEEE 802.15.4e + IE extensions

- Frequency hopping
- Discovery and Join
- Protocol Dispatch (IEEE 802.15.9)
- Several Frame Exchange patterns
- Optional Mesh Under routing (ANSI 4957.210).

PHY based on 802.15.4g

- Various data rates and regions

Security

- 802.1X/EAP-TLS/PKI Authentication.
- 802.11i Group Key Management
- Optional ETSI-TS-102-887-2 Node 2 Node Key Management

Supports a variety of IP based app protocols :
DLMS/COSEM, ANSI C12.22, DNP3, IEC 60870-5-104, ModBus TCP, CoAP based management protocols.

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Collaboration with other organizations

Wi-SUN Alliance:

- Defines PHY/MAC/Transport layer profiles to support Field Area and Smart Utility

- Develops test specifications and test plans as part of a Certification Program for those profiles

- Cooperates with other Industry Alliances when appropriate to support Application Layer Interoperability.
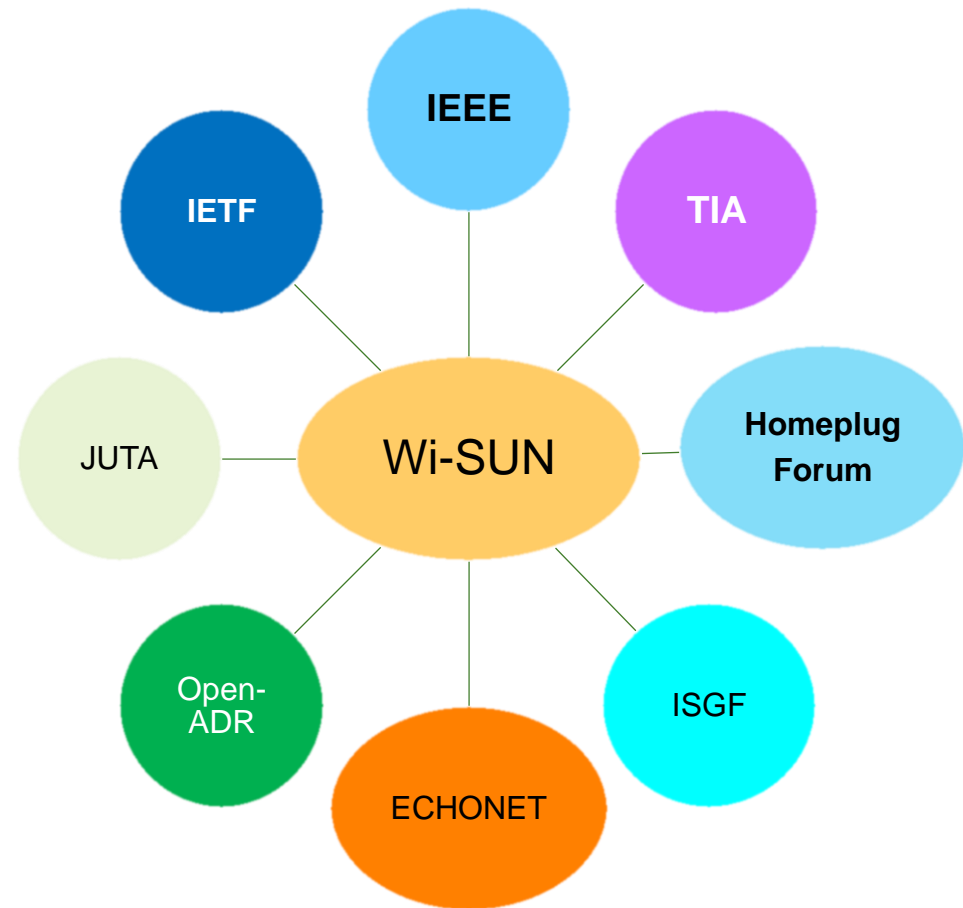
Wi-SUN FAN Summary

- Open standards (IEEE and IETF)
- Simple infrastructure
- Low cost, low complexity
- Strong security (802.1x, 802.15.9 etc)
- Proven technology
- Long range (Sub GHz)
- Reliable and resilient (Mesh, Sub GHz, Channel Hopping, etc)
- Energy friendly
- Robust certification program
- Multi-vendor interoperability
- Support for Global frequency bands

Thank you for your kind attention
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