Introduction to Wi-SUN FAN and Certification
March 2022
Introduction to Wi-SUN Alliance
What is Wi-SUN Alliance?

A global ecosystem of member companies seeking to accelerate the implementation of open standards-based Field Area Networks (FAN) and Internet of Things (IoT).

INTEROPERABLE

RELIABLE

SECURE
Wi-SUN Alliance delivers communications solutions for applications requiring secure, resilient and scalable networks, including:

- **Smart utilities**: Advanced Metering Infrastructure (AMI), Peak Load Management, Distribution Automation and Smart Metering
- **Smart cities**: Street Lighting, Infrastructure management, Smart Parking, Environmental sensing, traffic and transport systems
- **Smart home**: Smart thermostats, air cond, heating, energy usage displays and health and well-being applications
- **M2M**: Agriculture, structural health monitoring (e.g. bridges, buildings, etc.), monitoring and asset management
Over 300 members representing 46 countries
Growing global membership
A Complete Ecosystem from Silicon to Solutions
>100 Million Wi-SUN Capable Endpoints Deployed Worldwide
– Navigant Research
Wi-SUN Technical Profiles
Profile Specifications for Smart City/Utility Applications

FIELD AREA NETWORK (FAN) Profile

- FAN 1.0 Profile Specification approved
- Supports IEEE802.15.4g/4e PHY/MAC, 6LowPAN, and IPv6
- Supports multi-hopping operation and frequency hopping
- Supports encryption (AES) and authentication (802.1x)
- Specification is standardized as IEEE Std 2857 and ANSI 4957
- > 60 certified products from >20 vendors

HOME AREA NETWORK (HAN) Profile

- Profile Specification is approved (Wi-SUN profile for ECHONET Lite)
- Support IEEE802.15.4g/4e PHY/MAC, 6LowPAN, and IPv6
- Support encryption (AES) and authentication(PANA)
- Specification is standardized as TTC JJ300.10
- > 100 certified products

FAN: Communication Between Smart Meters and Distribution Automation

TEPCO B-ROUTE: Communication between Smart Meters and HEMS

HAN: Communication between HEMS controller and HAN device
Wi-SUN Field Area Networks (FAN)
Wi-SUN FAN Network and Use Cases

Network Operations Center

Public or Private WAN Backhaul

Cellular

Fibre

Ethernet

Wi-SUN FAN RF Mesh

Wi-SUN FAN RF Mesh

Wi-SUN FAN RF Mesh

Advanced Meter Infrastructure

EV Charging Infrastructure

Distribution Automation

Direct Load Control

SCADA

Distributed Generation

Outdoor Lighting

Traffic management

Parking

Structural health

Agriculture
FAN Stack Technical Overview

IPv6 protocol suite
- UDP
- 6LoWPAN Adaptation + Header Compression
- DHCPv6 for IP address management
- Routing using RPL
- ICMPv6
- Unicast and Multicast forwarding

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

MAC based on IEEE 802.15.4e + IE extensions
- Frequency hopping
- Discovery / Join
- Protocol Dispatch (IEEE 802.15.9)
- Several Frame Exchange patterns
- Optional Mesh Under routing

PHY based on 802.15.4g
- OFDM and FSK modulations, data rates, and regions
The Benefits of a Wi-SUN FAN Network

DELIVERS MARKET LEADING RESILIENCE AND RELIABILITY
- Intelligent self-healing mesh network automatically responds to changing environments

ENABLES HIGHEST LEVEL OF IOT SECURITY
- Supports latest IP-based security technologies for device authentication and encrypted communications

FACILITATES AN ECOSYSTEM OF NON-PROPRIETARY SOLUTIONS
- Certified products will seamlessly interact while leveraging shared network infrastructure

ENSURES FLEXIBILITY AND REDUCED COST
- Select from a broad range of solutions to maximize vendor choice and promote competition

PROVEN IN THE WORLD’S LARGEST OUTDOOR IOT NETWORKS
- More than 100M Wi-SUN capable devices awarded worldwide
Wi-SUN Test and Certification
Wi-SUN Alliance is the certification organization for large scale IoT Networks
What are the benefits of FAN Certification?

- ecosystem
- less risk
- standards
- interoperability
- non-proprietary
- new features
- time to market
- cost savings

For utilities, smart cities, FAN Certification ensures interoperability, which results in accelerated time to market.
Testing and Certification Details
Testing Methodology

- Two Part Testing
  - Conformance component – assessing Device Under Test for conformance to the specification using specialized test environment
  - Interoperability component – assessing Device Under Test for interoperability with reference implementations
- All certification testing is conducted by a Wi-SUN appointed Independent Test Laboratory – Third Party Testing
- Test Laboratory prepares Test Report
- Device Under Test must pass all relevant tests to be eligible for certification
Test Programs

Physical Layer
- North America, Latin America, Australia, SE Asia
- Europe and India

FAN Profile
- FAN 1.0
- FAN 1.1 in Phase 2
- Supporting multiple regulatory domain globally
- North America, Latin America, Australia, South East Asia
- Europe and India in Phase 2
FAN Certification Testing Overview

• FAN Conformance Test Bed
  • **Test Bed Controller**
    • Script driven TBC to automate FAN device certification
      • TBC controls test bed as certification test plan is executed upon a Device Under Test
  • Test Bed Units
    • 14 TBUs constitute the test bed
      • Test Bed Units from multiple vendors
      • TBUs implement the API used by the Test Bed Controller
  • Wireshark protocol decoder
    • Wireshark protocol decoder is integrated into the TBC and test bed
FAN Certification Test Bed Overview
Test Lab Members (9)

Allion, JEMIC, TELEC, TUV Rheinland are Wi-SUN Approved Test Labs
Membership
Membership Levels

Promoter Membership
• Direct the activities of the organisation
• A seat on the Board of Directors
• Final approval of specifications

Contributor Membership
• Monitor and contribute to technical profile specifications and test specifications
• Input requirements to the certification program to ensure alignment with both currently deployed systems and future needs
• Attend member meetings and interoperability events
• Develop and certify interoperable products based on open standards
• Contribute to an eco-system of interoperable products

Adopter Membership
• Attend member meetings
• Participation in alliance workshops and developers' conferences
• Approved use of Wi-SUN Alliance logo on promotional materials
• Access to Wi-SUN Alliance marketing collateral and e-newsletter
• Access to a world-class ecosystem of members

Observer Membership (Test Lab/Certification Body)
• Reserved for Test labs and certification bodies
How do I join?

1. Contact us here to express your interest in joining the Wi-SUN Alliance

2. You will be asked to provide your logo for the Wi-SUN site and you will be supplied the Wi-SUN logo to use on any of your materials

3. You will receive a welcome pack with further information on the Alliance, resources available to members and a timeline of future events which may be of interest to you
For more information or questions contact:

info@wi-sun.org
www.wi-sun.org

Follow us:

www.linkedin.com
Wi-SUN Alliance Group
@WiSunAlliance
Backup Slides for further information
Field Area Network Technology Overview
Key Themes of the FAN Technology Stack

• Leverage existing standards
• IP protocol suite
• IEEE 802.15.4 sub-GHz wireless
• Enterprise class security
• Interoperability
• Multi-service capabilities
Wi-SUN FAN Secure Network Architecture

- Network Discovery
- Device hardening with 802.1AR and hardware security chip or PUF
- Network hardening tools
- Certificate-based identities
- Role based Access Control
- 802.1x-based access control for meters, routers, grid devices
- Frequency hopping RF
- Link-layer encryption in RF Mesh
- Group-based key generation and management (mesh)
- Network-layer encryption for WAN Backhaul (IPSec)
- Over the air upgradable devices

Secure Device Identity via Digital Certificates
Strong user identities with Role-Based Access
Time-stamped logs, correlation at SIEM
Separation of AMI vs. non-AMI traffic, segmentation

Secure storage for encryption keys
Secure encryption keys
Network-layer encryption (IPSec)
Link-layer encryption (AES-128)

Copyright © 2022 Wi-SUN™ Alliance
FAN Stack Technical Overview

IPv6 protocol suite
- UDP
- 6LoWPAN Adaptation + Header Compression
- DHCPv6 for IP address management
- Routing using RPL
- ICMPv6
- Unicast and Multicast forwarding

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

MAC based on IEEE 802.15.4e + IE extensions
- Frequency hopping
- Discovery / Join
- Protocol Dispatch (IEEE 802.15.9)
- Several Frame Exchange patterns
- Optional Mesh Under routing

PHY based on 802.15.4g
- OFDM and FSK modulations, data rates, and regions
Wi-SUN PHY Overview
Wi-SUN PHY
For FAN

- FAN 1.0 – FSK: data rates to 300 kbps
- FAN 1.1 – FAN 1.0 + OFDM: data rates to 2.4 Mbps

Wi-SUN PHY

SUN FSK
- Multi data rates up to 300 kbps
- Robust error correction

SUN OFDM
- Data rates support up to 2.4 Mbps
- High spectrum efficiency

- Global Regional frequency bands support
- Flexible Channel Plan usage
- Optional forward error correction
- Robust RF requirements to mitigate interference

Copyright © 2022 Wi-SUN™ Alliance
Wi-SUN PHY

Global Spectrum

- Multi regional spectrum support provided by same radio/silicon
- Simplified PHY certification and interoperability
Wi-SUN FAN v1.0 TBC
Introductory Webinar
March 22, 2022
About QualityLogic

A Wi-SUN Alliance Test Tool Partner
QualityLogic’s Role in the Smart Energy Industry

- **QualityLogic focuses on DER Communications Testing and Certification**
  - IEEE 2030.5, OpenADR (Approved Certification Test Tools), UL 1741 SB, Wi-SUN FAN Routers
  - Standards Training & Consulting

- **QualityLogic is a Contributor to Standards Development**
  - Member of Wi-SUN Test and Certification Work Group
  - Member of IEEE 1547 Work Group, UL 1741 STP
  - Member of IEEE 2030.5 Work Group
  - Member of SunSpec IEEE 2030.5 Profile Work Group

- **Active in Other Standards and Certification Program Development**
  - UL 3001, CSIP, SAE, OpenADR, MESA-DER, UL 1741 SC, SunSpec/SAE J3072 Profile for IEEE 2030.5
Test Lab Partners

- These are leading independent certification labs in the world.
- They rely on QualityLogic for training, test automation tools and support.
A Few Smart Grid Customers

- SMUD
- Energy Queensland
- Itron
- Cisco
- SunPower
- Enphase
- SolarEdge
- IBM
- Horizon Power
- Chrysler
- LG
- Schneider Electric
- Sunrun
- NEC
- Xcel Energy
- PPL Electric Utilities
- Hilo by Hydro-Québec
- SDG&E
- Stem
- Siemens
- Tabuchi Electric
- Philips
- Fuji Electric
- Fronius
- AutoGrid
- AEP Electric Power
- Panasonic
- SMA
- Goodwe
- QualityLogic
The FAN V1.0 TBC Product

For Pre-certification and Certification Testing of FAN Routers
FAN 1.0 Certification Methodology

- Observe the DUT (router or BR) interoperate with other certified routers (TBUs) in a controlled test bed environment
- The TBUs can be configured and controlled using a Wi-SUN test API hosted on a server (TBAs) provided by each certified device vendor
- The Test Bed Controller (TBC) utilizes the APIs to create test scenarios that force the DUT through permutations of startup and normal operations behaviors
- Traffic is captured via over the air sniffers and the API traffic subscription functionality
- The TBC validates that each test scenario completes its expected execution flow, and that sufficient captured traffic is available to do conformance analysis
- Captured traffic is analyzed for conformance by the test operator
**Big Picture**

**TBC**
- 68 Test Cases
- PyTest Framework
- GUI Interface
- Test Logs
- Configuration files
- Window 10 Mini-PC

**Test Bed**
- 2 border routers
- 12 routers
- dhcpv6 Servers (v4 v6)
- AAA server
- Test Bed Adapters
- Sniffers
- DUTs

Connectors:
- Ethernet
- USB
Test Bed Overview

Interconnected via RF cables, splitters, and attenuators
API and Test Bed Adapter

TBC

Vendor TBA

Router A  Router B  Router C  Router D

Router E  Router F  Router G  Router H

Router I  Router J  Router K  Router L

Rank 1

Rank 2

Rank 3
Over the Air Sniffers

OTA Sniffer 1
Raspberry Pi

OTA Sniffer 2
Raspberry Pi

LBR A

Router A
Router B
Router C
Router D

Router E
Router F
Router G
Router H

Router I
Router J
Router K
Router L

LBR B

Rank 1
Rank 2
Rank 3

TBC
Captured Packet Steam

Raspberry Pi
Captured Packet Steam

Steam
Traffic Subscriptions

Renesas TBA
Runs on TBC
Manual Start

Cisco TBA
Raspberry Pi
Start via Putty

Nissin TBA
Raspberry Pi
Auto Starts

API

LBR A
Router A
Router E
Router I

Router B
Router F
Router J

Router C
Router G
Router K

Router D
Router H
Router L

Rank 1
Rank 2
Rank 3
DHCPv6 and AAA Server

Mesh

LBR A
LBR DUT
LBR B

Router A
Router B
Router C
Router D

Router E
Router F
Router G
Router H

Router I
Router J
Router K
Router L

Router DUT

AAA Server
Raspberry Pi
Auto Start
Wi-SUN and GlobalSign Certs

dhcpv6 Server
Raspberry Pi
Auto Start
Config Table
Test Bed Controller (TBC)

- **The TBC is what QualityLogic sells.**
  - Customer’s build their own test bed based on Wi-SUN’s formal documentation.
  - QualityLogic offers a service to assist with this process.

- **TBC Key Features**
  - 68 test cases as defined in the Wi-SUN FAN 1.0 certification and interop test specifications
  - GUI and command line interfaces for test execution
  - Capture of OTA, router subscription, and API traffic
  - Test case Python scripts are viewable and editable (for debugging)
  - Provisions for fully automated regression testing if DUT support Wi-SUN API
  - Documentation, videos, and utilities to assist with TBC integration into your test bed
Live Demo of the TBC
Final Thoughts

- The Wi-SUN TBU API opens-up the opportunity to extend the TBC beyond its role as a conformance test execution tool.

- If a larger population of routers supported the Wi-SUN API, the TBC could be enhanced to support automated interoperability testing:
  - Support for an arbitrary number of vendors TBU units
  - Dynamic control of traffic patterns and modulations
  - Dynamic control antennation between routers
  - More diverse traffic types
  - Etc.
Getting the TBC
FAN V1.0 Test Bed Controller

- Commissioned by Wi-SUN Alliance as a joint Wi-SUN-QualityLogic development project
  - Goal to make the TBC Controller available at reasonable pricing to accelerate Wi-SUN technology adoption
- The IP is owned by the Alliance but distributed and supported by QualityLogic
  - The TBC is available directly from QualityLogic
Getting the TBC

- The QualityLogic Wi-SUN FAN v1.0 Test Bed Controller is available from QualityLogic
  - Comes installed on a pre-configured micro-PC that can be plugged into your Test Bed
  - For more information see Wi-SUN Test Tools – QualityLogic

- TBC is licensed in perpetuity with an annual Maintenance Contract that gets free or discounted updates

- The TBC is priced reasonably, and Wi-SUN Contributor Members receive a significant price discount
  - Pricing is set to provide a significant benefit to Contributor Members while
  - Encouraging companies to become Contributor Members

- The TBC comes with
  - 2-hours of free technical support from QualityLogic in the first 60 days
  - Free updates for 60 days after licensing – after that a Maintenance Contract is required for updates
The FAN v1.0 certification Test Bed is complex to build and includes over 40 (including 14 routers) components that must be assembled and tested to operate correctly.

- Test Bed routers and components periodically updated/replaced

**QualityLogic provides a Wi-SUN FAN v1.0 Turnkey Test Bed as a service.**

- Includes procurement, pre-assembly configuration and testing, shipping, and support for re-assembling and
- Shippable globally and with detailed instructions on assembly, operation, and troubleshooting.
- Initial start-up support.

**A QualityLogic Turnkey Wi-SUN Test Bed conforms to the most current version of the FANWG Certification Test Bed Specification.**

**For more information contact info@qualitylogic.com**