Wi-Fi HaLow Solutions for IoT Applications

2024년 1월

NEWRATEK

CONTENTS

회사 개요 - 발자취

구 분	뉴라텍(본사)	NEWRACOM (미국 자회사)	
		본점	영업사무소
소재지	서울 강남구 대치동	미국 캘리포니아주(Irvine)	대만 타이페이
인력수	34명	35명	1명
임무 및 기능	▪ 본사 ▪ R&D, 제품 생산 및 국내 영업	▪ 자회사(100% 지분 보유) ▪ 글로벌 R&D 및 영업	▪ 아시아 지역 영업 및 고객 기술지원

창업/기반 마련 ('14 ~ '15)

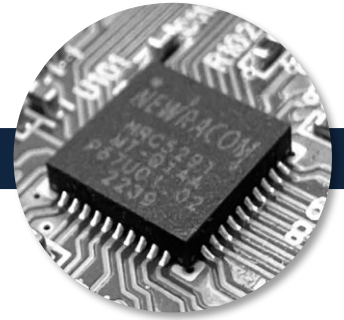
- ETRI(한국전자통신연구원)에서 분사(spin-off)
- 글로벌 연구 인력 확보 및 연구 개발 시작

기술/제품 개발 ('16 ~ '18)

- 장거리 Wi-Fi HaLow 상용 시제품 SoC 세계최초 개발
- IoT 시장을 겨냥한 저전력 Wi-Fi 4 SoC 제품 개발

영업/마케팅 개시('19 ~ '21)

- Wi-Fi HaLow 상용 제품 NRC7292 첫 출시 및 본격적 영업 시작
- TVWS NRC4791 상용 시제품 개발



칩 시장 출시/양산 ('22 ~)

- NRC7292 미국 시장 첫 출시
- NRC7394 양산 시작
- NRC5293 상용 시제품 출시

회사 개요 - WI-FI CHIP PRODUCTS

Long Range & Low Power for IoT Applications

IEEE 802.11ah (Wi-Fi HaLow)

NRC7394

(High Performance)

- Upgraded version of NRC7292
- Long-range coverage up to 1.5Km
- 1/2/4MHz Bandwidth
- Higher data rate: 150k~15Mbps
- WPA3 Security
- Power Saving: Legacy, WMM-P5
- WFA Certificate

NRC5293

(Ultra Low power)

- World's best Ultra Low Power SoC
- Long-range coverage up to 1Km
- Data rate: 150kbps-12Mbps
- WPA3 Security
- Power Saving: Legacy, WMM-P5
- WFA Certificate
- Coin Cell Battery

Long Range Rural & Remote Applications using

TV White Space (TVWS & WMTS Wi-Fi)

NRC4792

- Frequency: TV White Space (430~790MHz)
- WMTS(Wireless Medical Telemetry Service): 608~614MHz
- TVWS RF & 802.11ah Digital Baseband/MAC
- Longer-range coverage of 3Km+
- Power saving: Legacy, WMM-PS

Low Power for IoT Applications (upcoming)

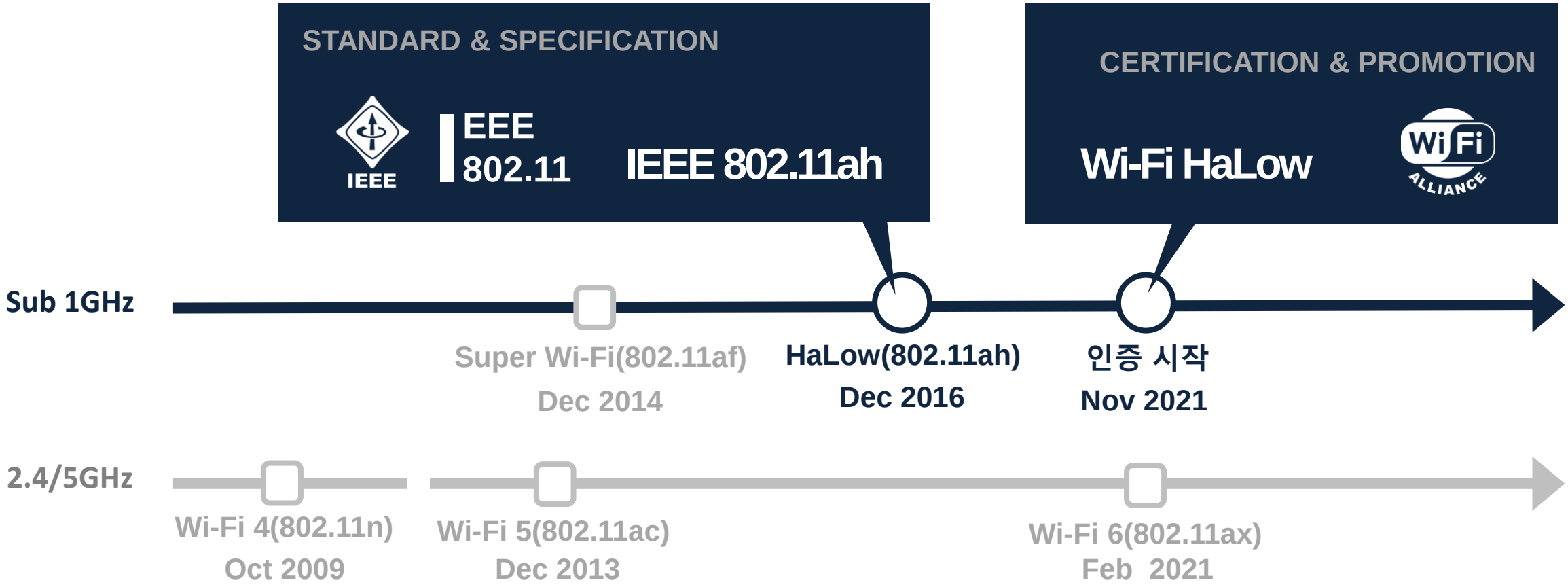
IEEE 802.11ax (Wi-Fi 6)

NRC929X

- 2.4/5GHz IEEE 802.11ax
- Ultra Low power SoC
- 20/40MHz Bandwidth only for IoT Applications
- Security: WPA/WPA2/WPA3
- Implements 802.11ax power saving features for battery powered applications

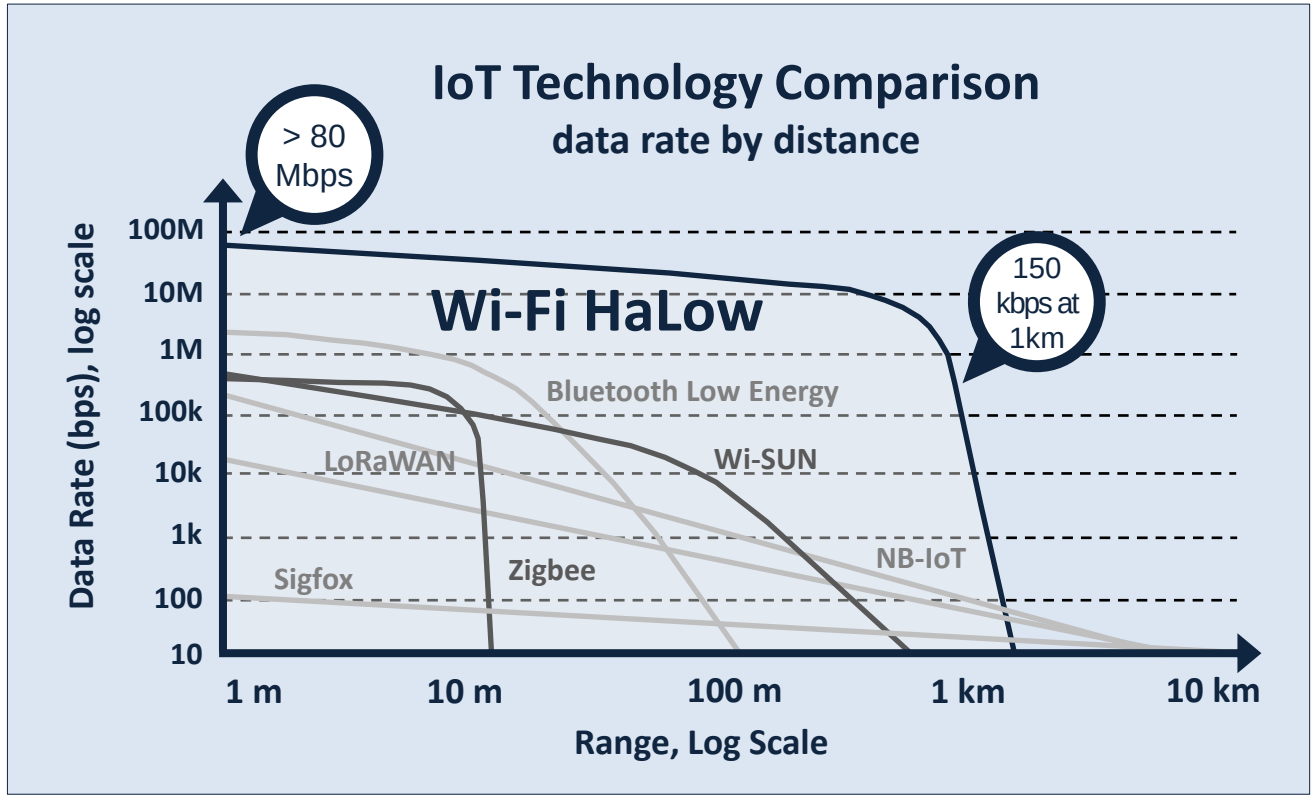
Wi-Fi HaLow - 표준 및 인증

- IEEE는 Sub 1GHz 대역에서 장거리 와이파이 서비스를 위한 802.11ah 표준을 2016년 12월에 완료
- Wi-Fi Alliance는 이 표준을 "Wi-Fi HaLow"라 부르고 2021년 11월부터 HaLow 기반의 칩 설계자들과 제품 개발자들을 위한 글로벌 인증 업무을 시작



Wi-Fi HaLow - 타 IoT 표준과 비교

IoT 표준 비교 – 도달거리 및 전송속도



Source: "Wi-Fi HaLow: Wi-Fi for IoT Applications" by Wi-Fi Alliance, May 2020.

Wi-Fi와 Bluetooth 커버리지의

100배

LoRa Throughput의

300배

LP-WAN (Sigfox, NB-IOT, Lora, Wi-Sun)
표준보다 더 높은 에너지 효율

400%

Wi-Fi HaLow - Low power(1)

IoT 기술들간 에너지 효율 / 배터리 수명 비교

에너지 효율 비교

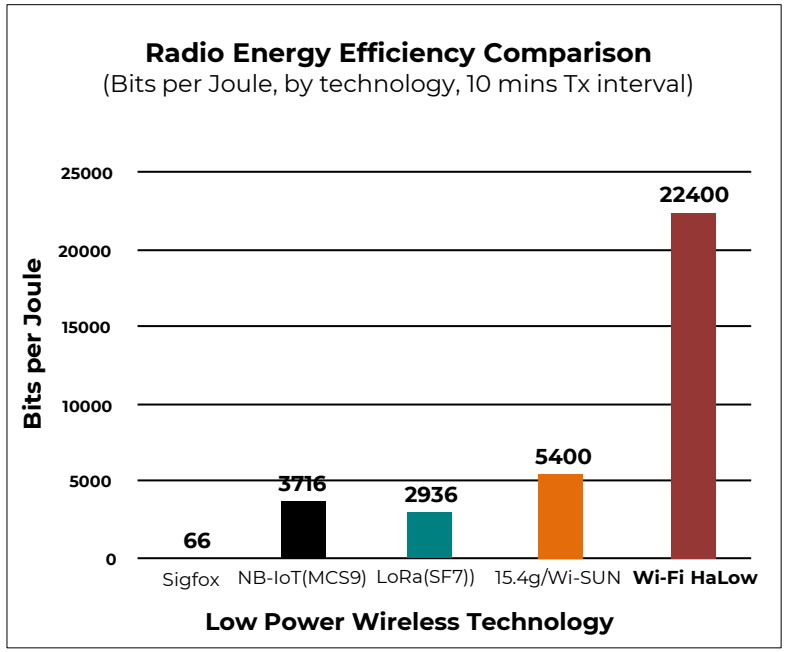
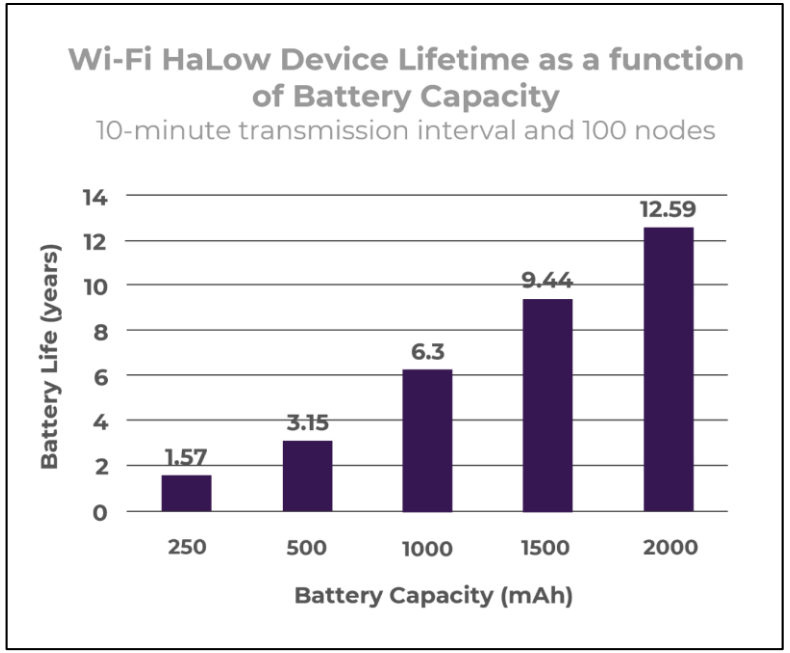


Figure 6. Wi-Fi HaLow demonstrates at least four times (4X) more energy efficiency than several other well-known IoT technology options.

배터리 수명 비교



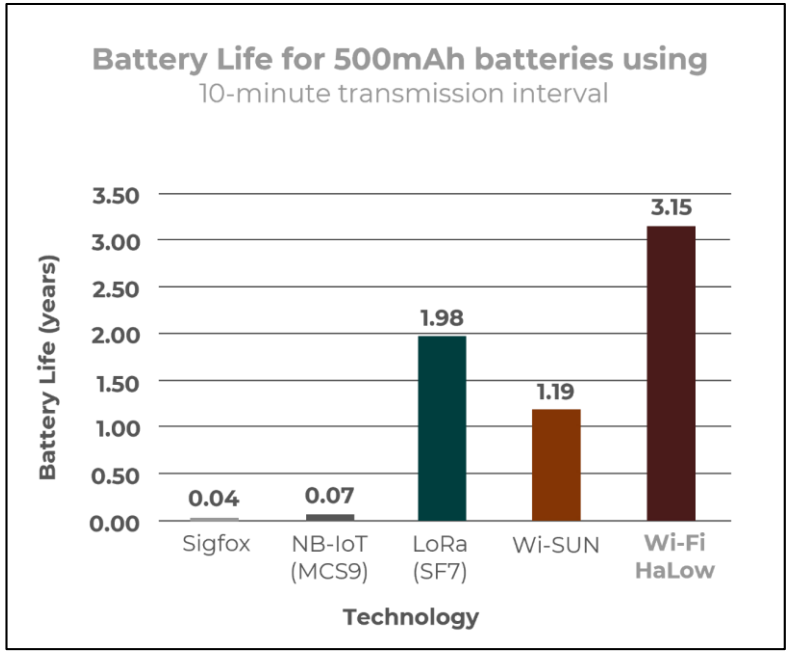


Figure 7. Charts demonstrating Wi-Fi HaLow battery life based on battery capacity (left) and transmission frequency (right)

Source: 'Wi-Fi CERTIFIED HaLoW Technology Overview' Nov. 2021, Wi-Fi Alliance

Wi-Fi HaLow - Low power(2)

IoT 기술들간 경쟁력 비교

LP WAN IoT Technology Comparison

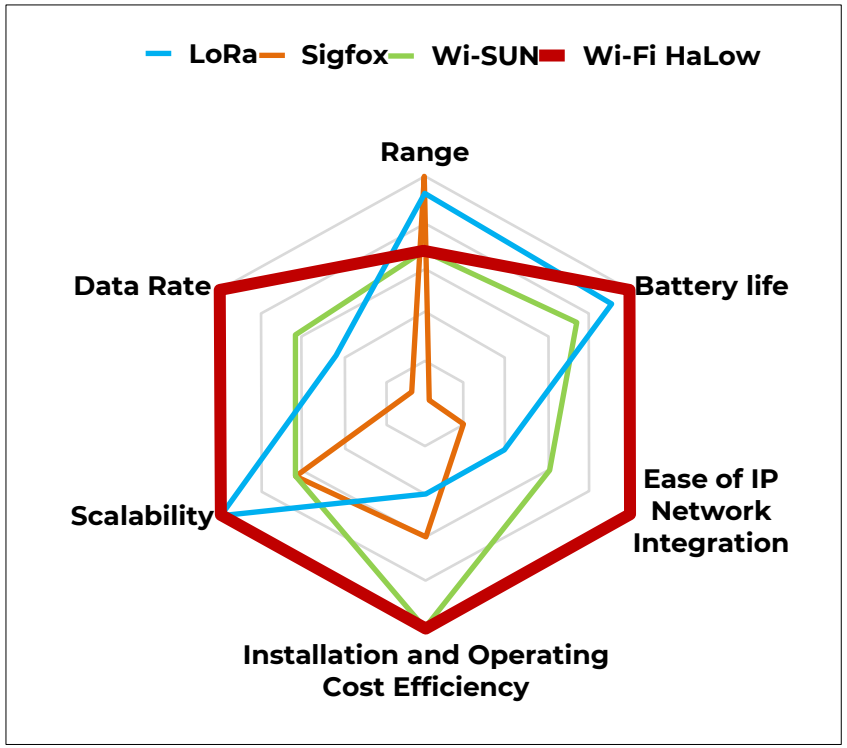


Figure 3. Compared to other low power WANs, Wi-Fi HaLow excels in most measured attributes

PAN and LAN IoT Technology Comparison

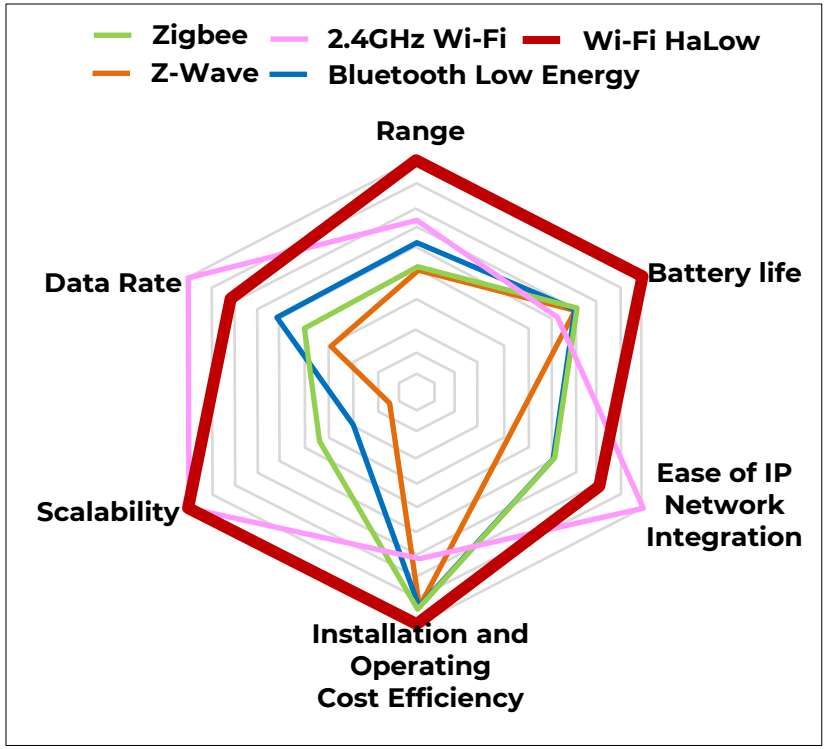


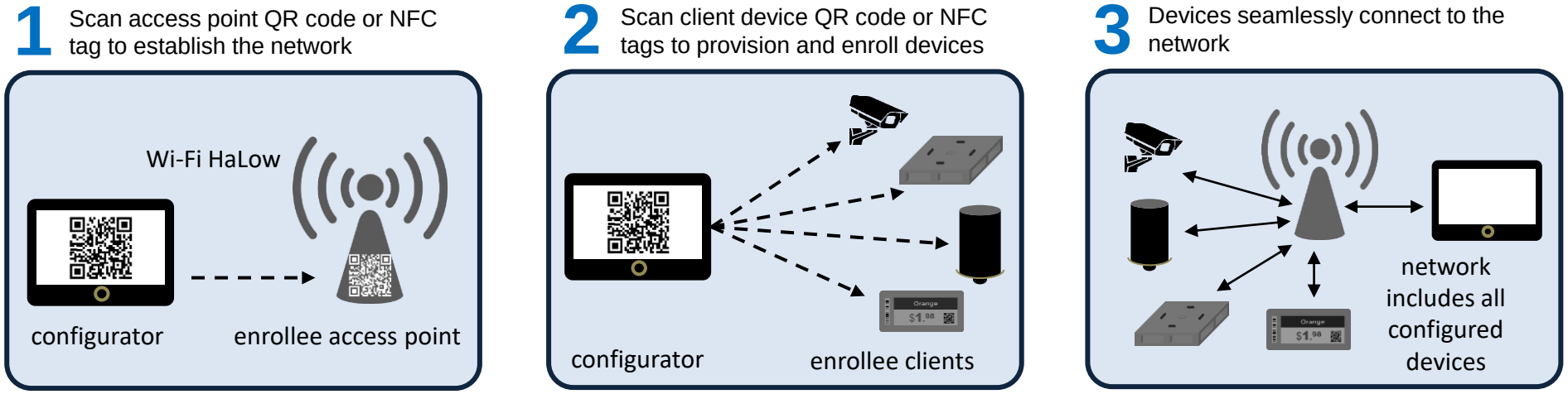
Figure 4. Wi-Fi HaLow meets key requirements when compared to other IoT technology options

Source: 'Wi-Fi CERTIFIED HaLoW Technology Overview' Nov. 2021, Wi-Fi Alliance

Wi-Fi HaLow - Security

- HaLow는 가장 최신의 Wi-Fi 보안 표준인 WPA3를 채택
- WPA3는 보안 강화를 위해 몇가지 개선사항들을 도입
  - SAE(Simultaneous Authentication of Equals) 사용을 위해 authentication/association 프로토콜 변경
  - 엔터프라이즈 (EAP) 인증 시 사용 키를 192 비트로 증가
  - Wi-Fi CERTIFIED Enhanced Open™이라 하는 OWE(Opportunistic Wireless Encryption) 의 추가
  - Wi-Fi CERTIFIED Easy Connect™라는 Device Provisioning Protocol을 사용하여 헤드리스 기기의 간소화된 온보딩이 추가

< Wi-Fi CERTIFIED Easy Connect™ >



NRC7394 – Chip Product

High Throughput (Upgraded version of NRC7292)

CPU

- ARM Cortex-M3 for Wi-Fi & Applications
- High performance XIP with internal cache memory

Communication Peripherals

- GPIO X 26
- SPI X 2
- UART X 2
- I2C X 2
- 4 channel 10-bit ADC X 1

RF Transceiver

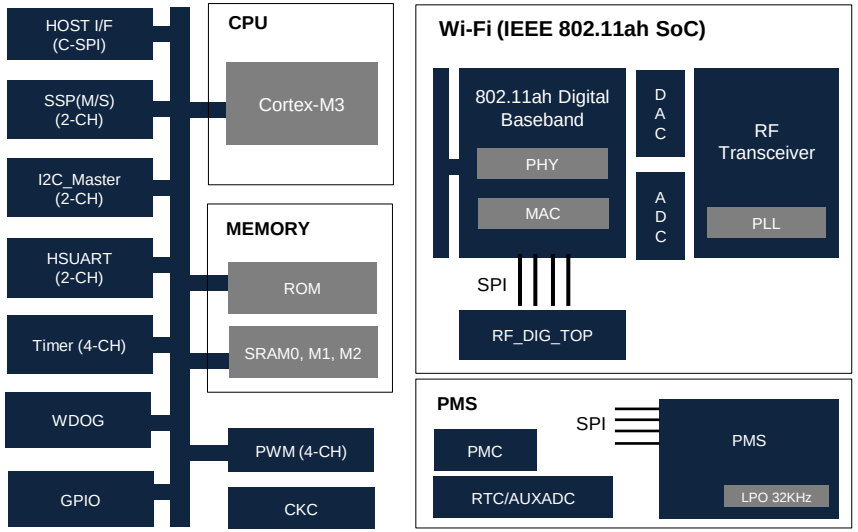
- Single-ended RF ports
- Frequency band: 850 ~ 950MHz
- Linear Tx output power: 17dBm
- Tx gain range: 35dB
- Rx noise figure: <6dB
- Max. input level: -10dBm
- 10bits ADC & DAC

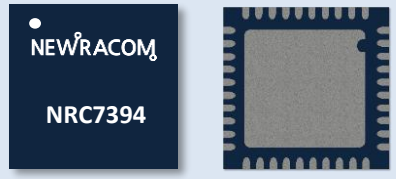
Memory

- 32-KB Boot ROM
- Up to 1024KB System SRAM
- XIP with cache (2 ways, 16KB)
- SRAM retention

Chip Security

- Secure Boot





NRC7394 KEY FEATURES

High Performance

- 최대 전송 속도 : 15Mbps
- AP 당 최대 관리자 수 : 256,000 디바이스
- AP 당 동시 최대 접속자 수: 8,191 디바이스

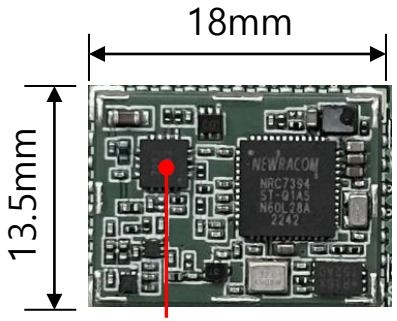
Key Features

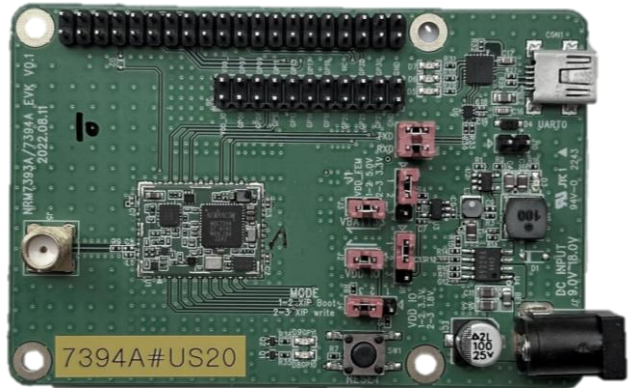
- Compliance with IEEE 802.11ah draft 8.0
- Fully integrated on-chip 11ah Digital Baseband PHY & MAC, RF transceiver, Processors, and Memory
- Support 1/2/4 MHz Bandwidth
- Low power mode operation
  - Legacy, WMM-PS, TWT
- AES-CCMP Security
- WPA3 key generation HW
- Dedicated SPI & UART I/F for Host
- Various peripheral I/Fs for sensor devices
- Manufacturing tools for Configuration & Test
- Diagnostic & DUT test tools for indoor & outdoor test

NRC7394 – Module & EVK

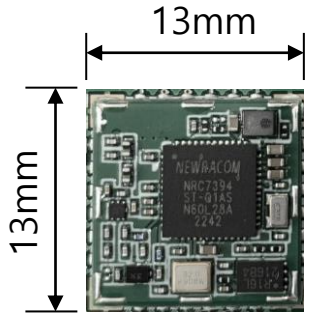
NRC7394 Module

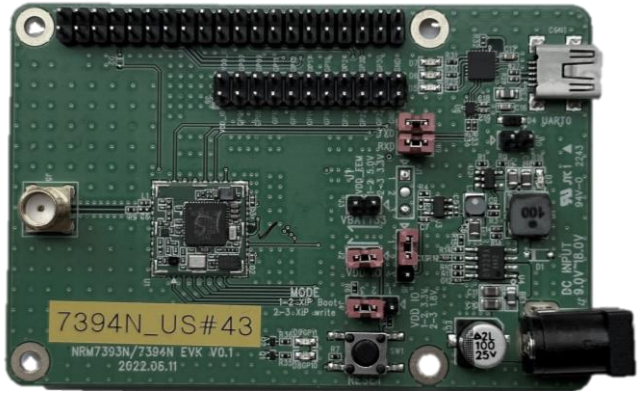
NRM7394A (External PA)



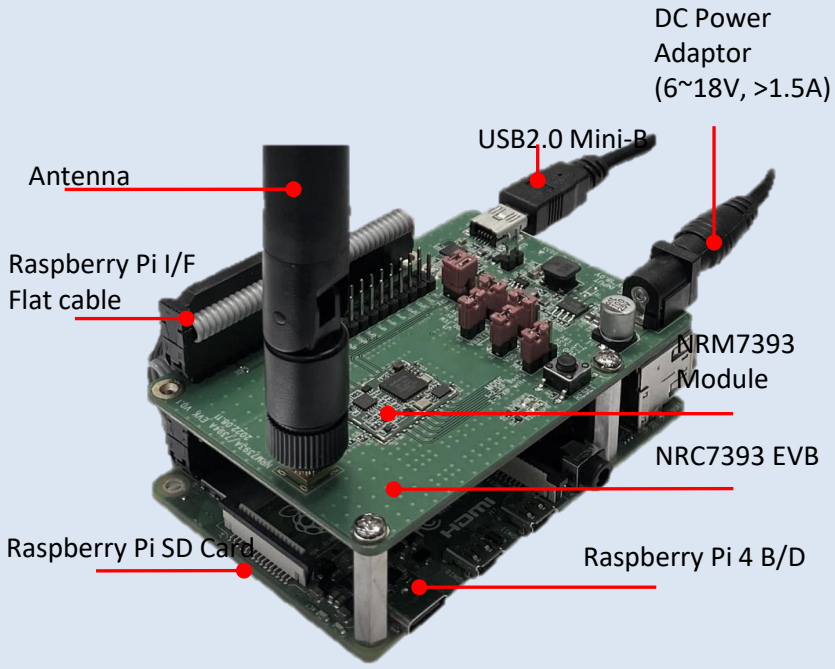


NRM7394N





NRC7394 EVK



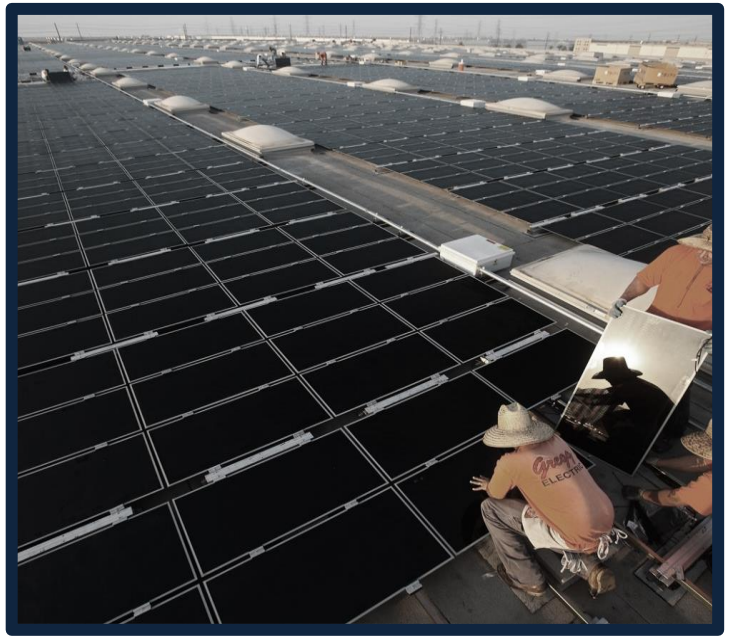
NRC7394 – Applications

Industrial Automation

Logistics / Transportation

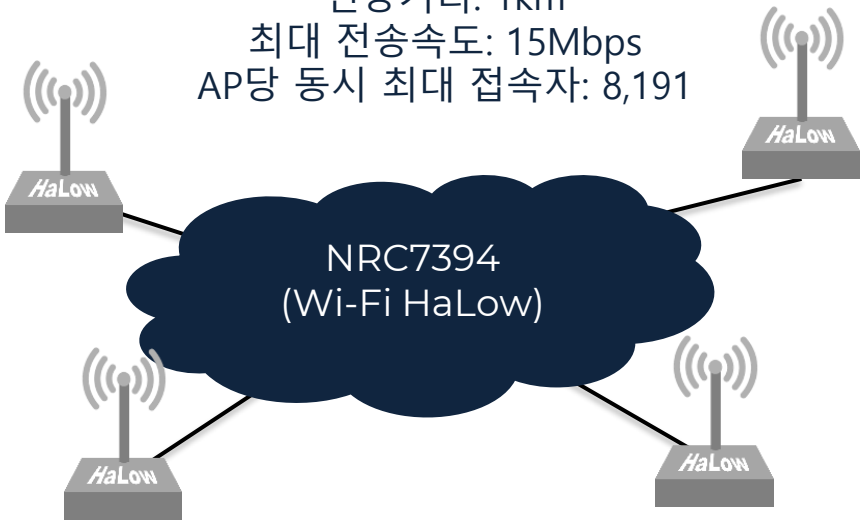
Surveillance Camera

Cattle Care



Solar Panel Monitoring

전송거리: 1km
최대 전송속도: 15Mbps
AP당 동시 최대 접속자: 8,191



Source: “Wi-Fi HaLow: Wi-Fi for IoT Applications” by Wi-Fi Alliance, May 2020.

Smart Metering

NRC7394 – Performance

필드테스트 시험 결과
(NRC7292 사용)

창고 내부 시험

- 데이터 수집 지점: 1,294 곳
- 통신 단절 지점: 제로 (없음)
- **평균 TCP Thruput: 804.8 Kbps**

창고 외부 및 주변 시험

- 데이터 수집 지점: 2,087 곳
- 통신 단절 지점: 제로 (없음)
- **평균 TCP Thruput: 665.6 Kbps**

NRC7394 – Performance

필드테스트 – 서울 테헤란로/시화호 (NRC7292 사용)

1.79 Mbps Average Throughput @ 500m (1,640ft)

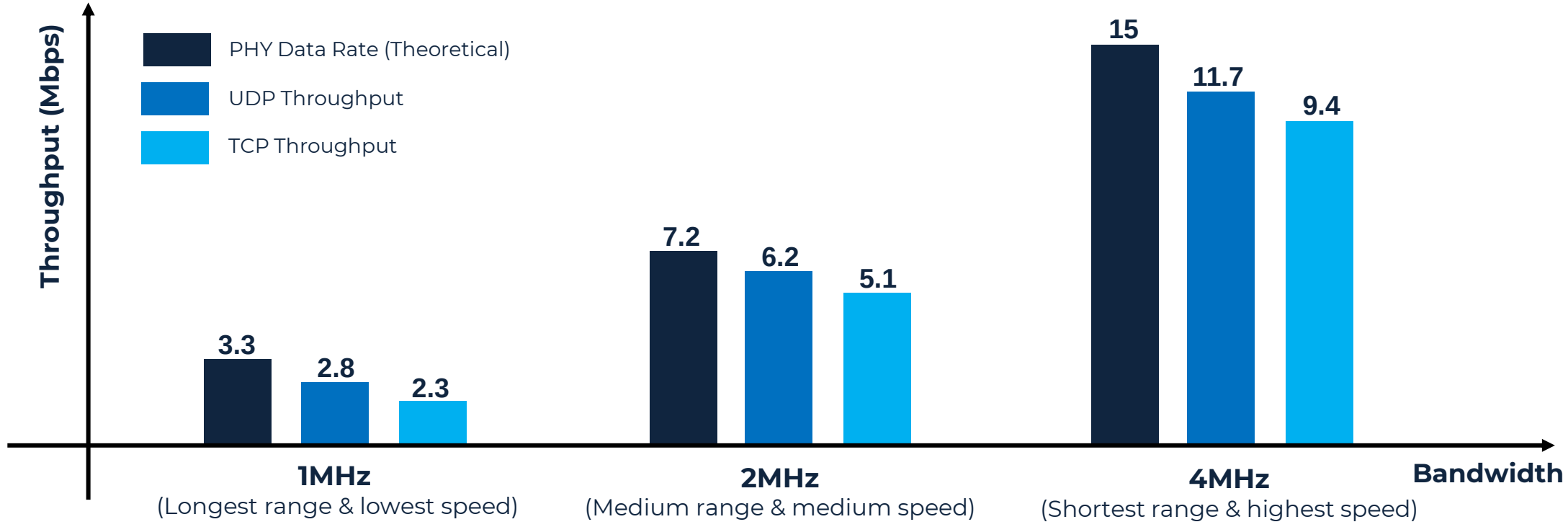
- 2MHz Channel Bandwidth
- 922.5MHz Center Frequency
- 17dBm Transmit Power

2.58 Mbps Average Throughput @ 3km (9,840ft)

- 2MHz Channel Bandwidth
- 924.5MHz Center Frequency
- 17dBm Transmit Power

HaLow Throughput and Channel Bandwidth (NRC7292)

HaLow throughput and range can be tuned by selecting the appropriate channel bandwidth for the application.



NRC5293 – Chip Product

Ultra Low Power / Low Price

CPU

- ARM Cortex-M3 for Wi-Fi & Applications
- High performance XIP with internal cache memory

Communication Peripherals

- GPIO X 19
- SPI X 2
- UART X 2
- I2C X 2
- 4 channel 10-bit ADC X 1

RF Transceiver

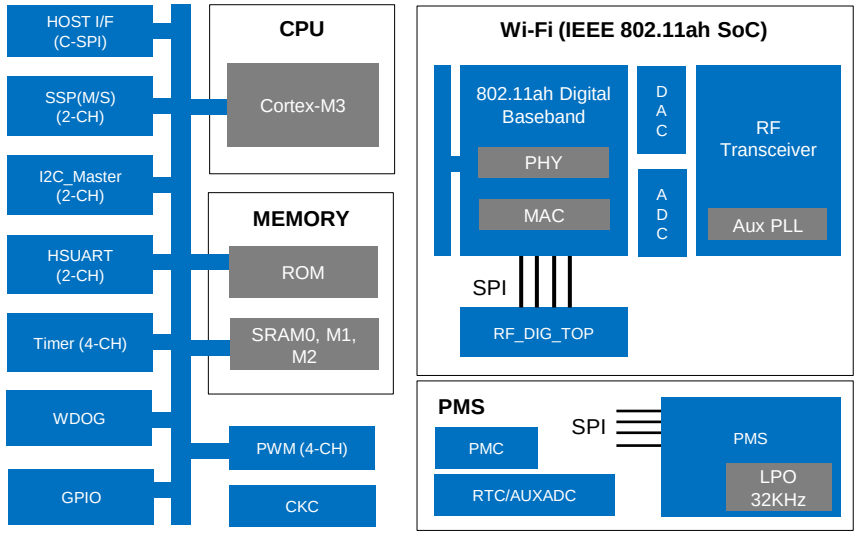
- Single-ended RF ports
- Frequency band: 840 ~ 950MHz
- Linear Tx output power: 3dBm
- Tx gain range: 30dB
- Rx noise figure: <6dB
- Max. input level: -10dBm
- 10bits ADC & DAC
- SBR sensitivity: -100dBm

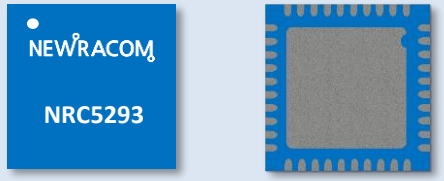
Memory

- 32-KB Boot ROM
- 200KB System SRAM
- XIP with cache (2 ways, 16KB)
- SRAM retention

Chip Security

- Secure Boot
- Flash Encryption





NRC5293 KEY FEATURES

Low Power

- **1.4 mA RX current**
- **10 mA TX current @ 3 dBm output power**
- **1.0 µA Deep Sleep current (16 kB RAM Retention and RTC running from LFXO)**

Key Features

- Compliance with IEEE 802.11ah draft 8.0
- Fully integrated on-chip 11ah Digital Baseband PHY & MAC, RF transceiver, Processors, and Memory
- Support 1/2/4 MHz Bandwidth
- Up to 12Mbps Data Rate
- Low power mode operation
  - Legacy, WMM-PS, TWT
- AES-CCMP Security
- WPA3 key generation HW
- Various peripheral I/Fs for sensor devices
- Manufacturing tools for Configuration & Test
- Diagnostic & DUT test tools for indoor/outdoor test

배터리 수명 (BLE & Zigbee 제품 대비 3배 이상 수명)

❖ Simulation Assumptions

- Battery capacity: 950mAh (CR2477), 75% of capacity useable (≈712mAh)
- Device wakes up every 1(또는 3) sec for 10ms to see if there is any data or command from gateway
- Device updates data 3 times a day, with each updates taking 3 sec

Part No.	Manufacturer	Specification	Deep sleep Current	RX Current	TX Current	Battery Lifetime (Years) (Wake-up time이 매 1초(3초) 인 경우)
NRC5293	**Newracom**	**802.11ah**	**1.0uA**	**1.4mA**	**10mA (3dBm)**	**5.06 (12.11)**
nRF52811	Nordic	BLE 5.2	1.1uA	4.6mA	4.6mA (0dBm)	1.71 (4.80)
CC1310	TI	802.15.4g	0.7uA	5.5mA	13.4mA (13dBm)	1.42 (3.98)
EFR32BBG22	Silicon Labs	BLE 5.2	1.4uA	3.6mA	4.1mA (0dBm)	2.15 (5.87)

NRC5293 – Applications

ESL

Sensors for Health Care

Sensors for Smart Home

Coin Cell Battery (와이파이 최초)
전송거리: 0.5km
최대 전송속도: 12Mbps
BLE/Zigbee 대비 배터리 수명 3배

Sensors for Factory / Building Automation

Application Demo

HaLow Demo – Access Point

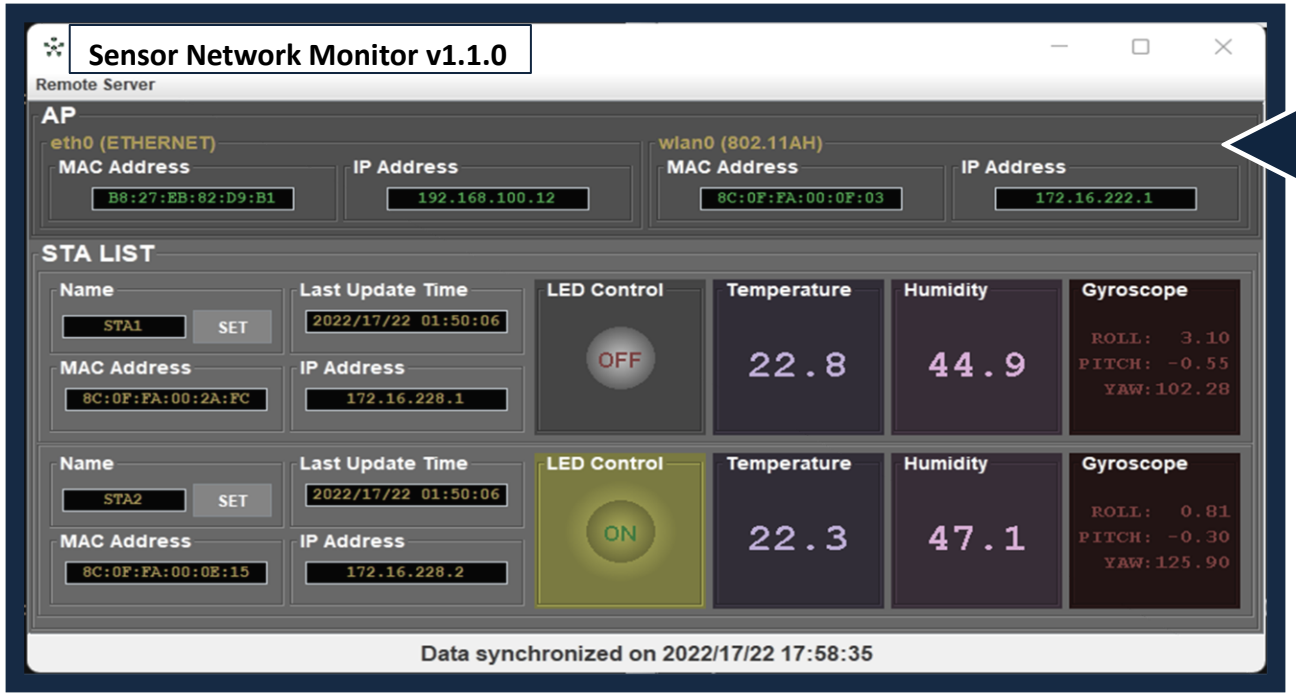
- Wi-Fi HaLow Access Point
- Ethernet interface
- Support 1, 2, 4MHz Channels
- WPA3 & Enterprise Security
- NRC7292+Host Processor
- OpenWRT Support

HaLow Demo – ESL (Electronic Shelf Label)

- Electronic Display/ESL
- High Client density
- Star or Mesh Topology
- Low Power and Long Battery Life
- Demo on NRC7292 in Standalone Mode
- Target Chip is NRC5292

HaLow Demo - Sensor Networks

- Sensor Demo
- Temp/Humidity/Gyro/LED
- Low Latency and Long Range
- Demonstration of Standalone capabilities of NRC7292/7394



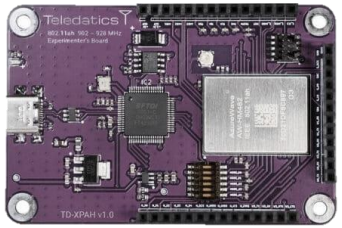
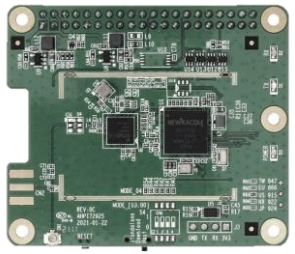
HaLow Demo - HD IP Camera

- HaLow enabled Still Camera Network
- Standalone operation of NRC7292
- Programmable picture interval
- 1000's of Cameras can be supported per AP

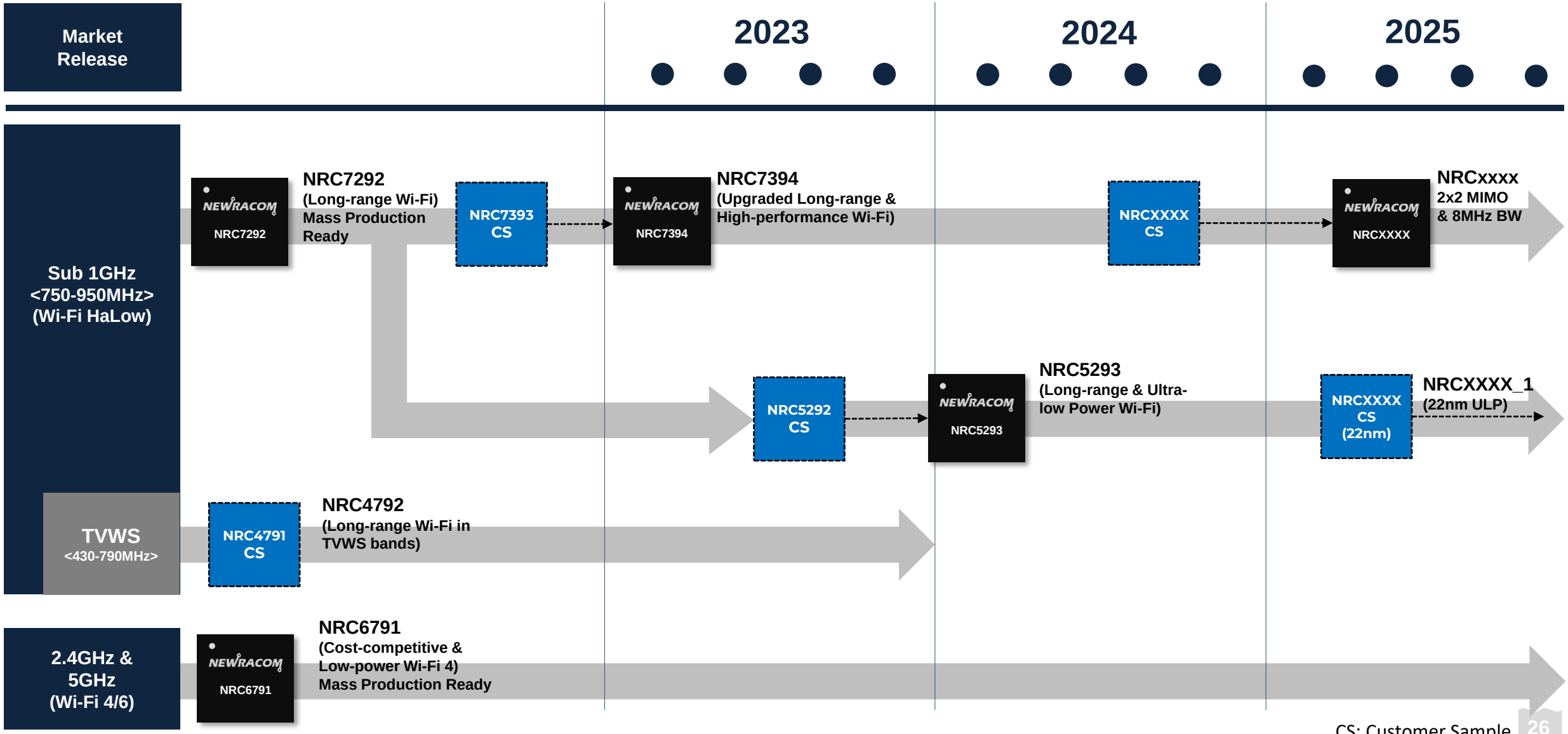
Additional Information

Module Partners

Module & Solution Ecosystem Partners

				
WSG300NRC (Wi-Fi HaLow Module)	AW-HM482 (Wi-Fi HaLow Module)	GW16146 802.11ah (Wi-Fi HaLow Mini-PCIe)	World's First Wi-Fi HaLow™ Raspberry Pi™ HAT (Wi-Fi HaLow Module)	IEEE 802.11ah M.2/NGFF for Linux (Wi-Fi HaLow Module)
LiteOn	**AzureWave**	**Gateworks**	**ALFA Networks**	
				
SX-NEWAH (Wi-Fi HaLow Module)	SX-NEWAH-EVK-US (Wi-Fi HaLow EVK)	HA92 Class (Wi-Fi HaLow Module)	RYW729x (Wi-Fi HaLow Module)	xTAG HaLow Sensor (Sensor Solution)
Silex Technology		**AIRETOS**	**REYAX**	**Deviceworx**

Newratek Chip Roadmap



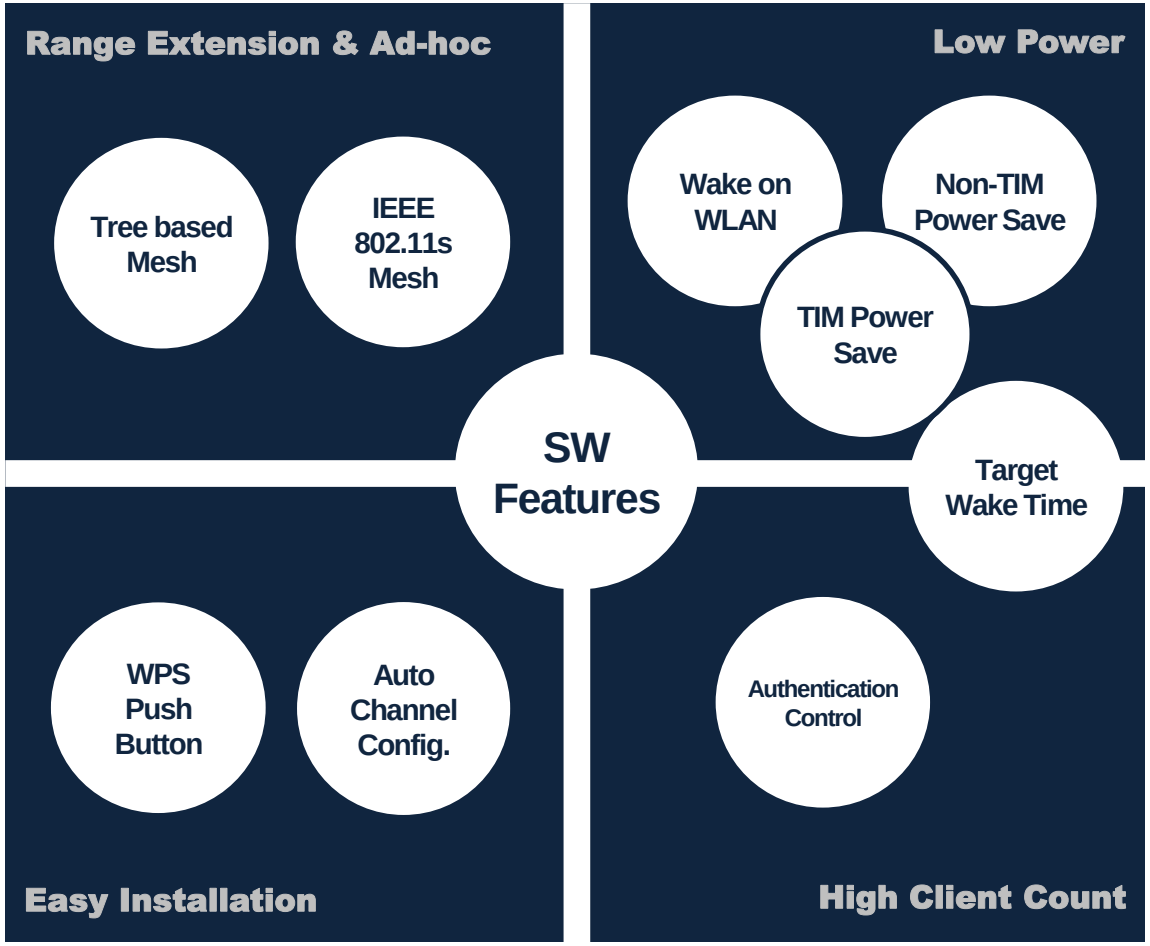
CS: Customer Sample

Software

❖ Support for Variety of Platforms

- Linux
- FreeRTOS
- Windows and Non-OS w/ AT-command over SPI or UART

❖ 다양한 어플리케션을 지원할 풍부한 기능들



Software

뉴라텍 칩셋의 소프트웨어는 다음과 같은 내용들을 지원

Standalone

Application runs on embedded Cortex M3

- Single chips solution for sensors applications, electronics shelf labels, and other battery powered IoT devices

Hostless

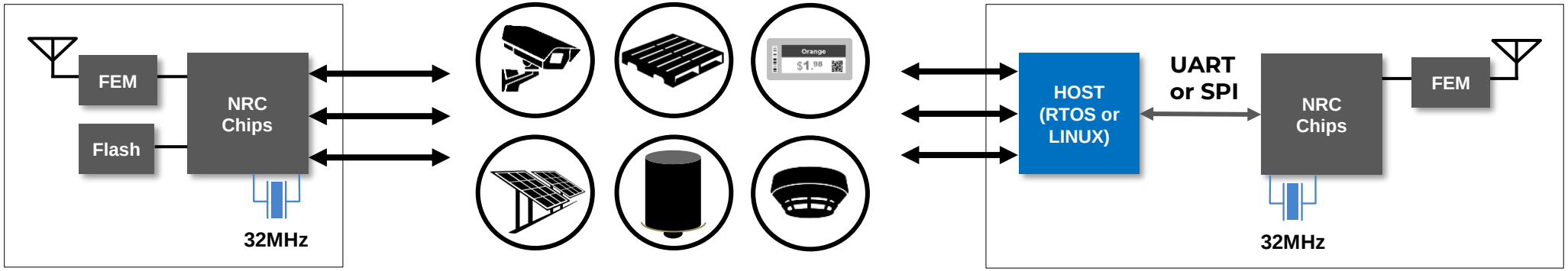
Communication to NRC Chips via “AT style” commands

- Easy implementation with variety of host devices

Hosted

Communication with NRC Chips via SPI Interface

- Driver runs on Host Processor and communicates via SPI interface offering performance and flexibility



Standalone Type

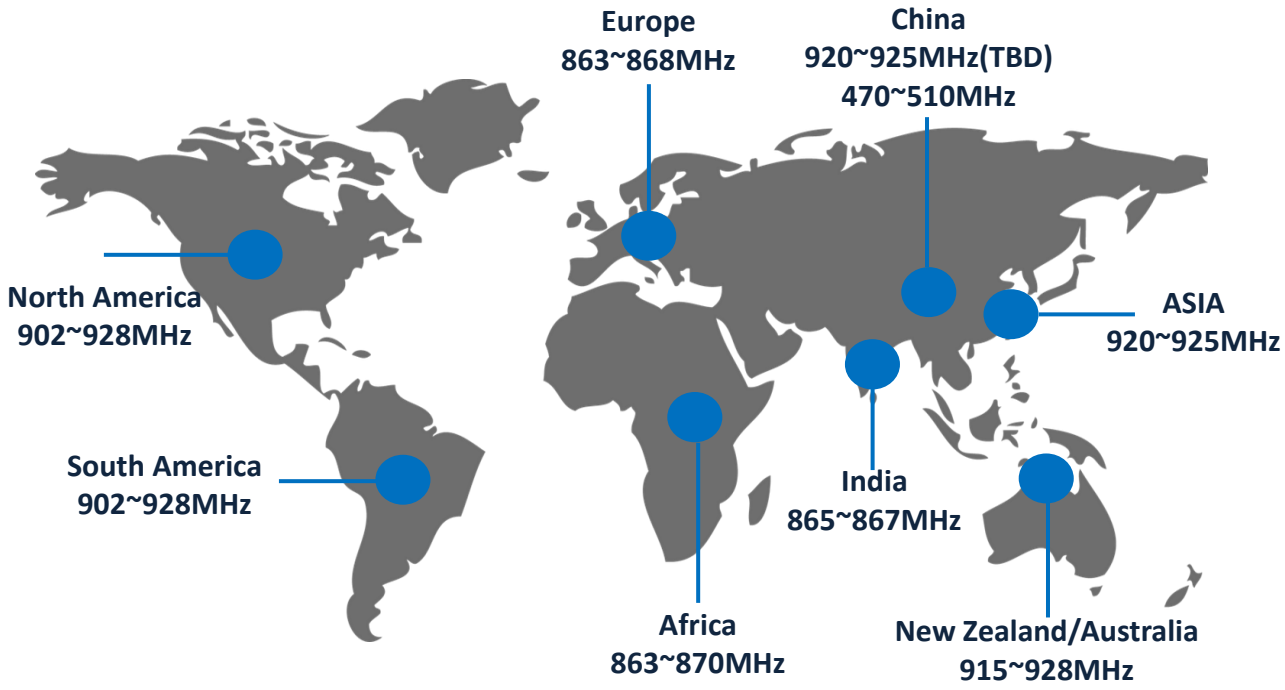
External Host Type

Regulatory

- Sub 1 Gig (S1G) spectrum is not harmonized globally. However, the regulatory landscape is changing quickly with increased adoption of S1G LPWAN devices such as Lora. Contact us for the current status in your target region.
- HaLow solutions can be deployed globally by considering local regulations for frequency, transmit power, bandwidth, and duty cycle.
- Regardless of local regulations, HaLow provides the best combination of range, throughput, and battery life among S1G technologies.

Frequency Band	Sub 1GHz (850 ~ 950MHz)
Channel Width	1/2/4/8/16 MHz
Range	Up to 1Km (outdoor)
End Node Transmit Power	Dependent on regional regulations (from 1 mW to 1 W)
Data Rate	150 Kbps ~ 346.666 Mbps
Devices per Access Point	8,191
Standard Body	IEEE 802.11 working group
Topology	Star, Relay, Mesh

NRC7292/7393 operates in Sub-1GHz (840-950 MHz)



Comparison with Other IoT Technologies

Attributes	Wi-Fi HaLow	Bluetooth Low Energy	Z-Wave	Zigbee	Wi-SUN	Sigfox	LoRaWAN	NB-IoT
Frequency	Sub- 1 GHz	2.4GHz	Sub- 1 GHz	2.4GHz / Sub-1 GHz	Sub-1 GHz	Sub-1 GHz	Sub-1 GHz	Licensed
Data Rate (bps)	**150k - 86.7M**	125k - 2M	9.6k – 100k	250k	6.25 – 800k (50k default)	100 or 600	330 – 27k	20k – 127k
Range (m)	> 1k	< 100	< 30	< 20	< 1k	< 40k	< 10k	< 10k
Modulation	OFDM over BPSK, QPSK, 16/64/256 QAM	GFSK	GFSK	BPSK / OQPSK	MR-FSK / MR-OFDM / MR-OQPSK	DBPSK / GFSK	CSS	QPSK
Battery Life	Years	Years	Years	Years	Years	Years	Years	Years
Security	**WPA3™**	128-bit AES in CCMode	Security 2 (S2)	128-bit AES in CCMode	IEEE 802.1X	Session- level security	128-bit AES in CCMode	3GPP Security
OTA firmware updates	**Supports**	Supports	-	-	-	-	-	-
Subscription required	No	No	No	No	No	Yes	Yes	Yes
TCP/IP (internet)	**Supports**	-	-	-	-	-	-	-
Network topology	**Star / Relays**	P2P* / Mesh	Mesh	Mesh	Mesh	Star	Star	Star
Open standard	**IEEE 802.11ah**	Bluetooth SIG	Proprietary	IEEE 802.15.4	IEEE 802.15.4g	Proprietary	Proprietary	3GPP LTE Cat-NB1/NB2

Other HaLow Resources

❖ Information

- Japan 11ah Counsel (AHPC) – (**LINK** & **LINK**) Great data in Japanese
- Wi-Fi Now – Long form HaLow presentation video (**LINK**)
- Wi-Fi Alliance – WFA HaLow Page (**LINK**)
- Electronic Design - HaLow Overview (**LINK**)
- IEEE HaLow & NRC7292 Technical – (**LINK**)
- IEEE Survey of HaLow for IoT – (**LINK**)
- EEWorld Halow 2-part article – (**LINK**)
- Rethink research – HaLow could spell Goodbye to Zigbee – (**LINK**)
- Comparison of HaLow and 802.15.4 – (**LINK**)
- 802.11ah: A technology to face the IoT Challenge – (**LINK**)
- DK Labs – Current overview of HaLow landscape – (**LINK**)
- IEEE802.11ah Network Simulation – (**LINK**)
- Gateworks Wiki – (**LINK**)

❖ 3rd Party Tools

- HaLow network simulator – (**LINK**)
- Free Radio Coverage Modeling (contact us for HaLow parameters) – (**LINK**)
- S1G native Linux (Droidifi) – (**LINK**)
- SX-NEWAK EVK Setup (Hacker.io) – (**LINK**)

감사합니다

대리점 : **SIT** Technology

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□□□ : **010-2962-5549**