



RichWave Technology Corp. Outlooks for 2017Q4 & 2018

Dec. 26, 2017

Product Portfolio

RF Front-end Components	FEM	SW	LNA	PA	PFEM
WiFi – Networking: Router/Gateway/STB/ GPON&EPON	V (3-in-1 & 2-in-1)	V	V	V	V (Diplexer+SW)
WiFi- Mobile phone	V (2-in-1 & 3-in-1)	V	V		
WiFi- Consumer: Speaker/OTT/Game/..	V	V	V	V	
LTE					
Diversity Antenna		V	V		
Main Antenna		V		V (F.Cell)	

SOC

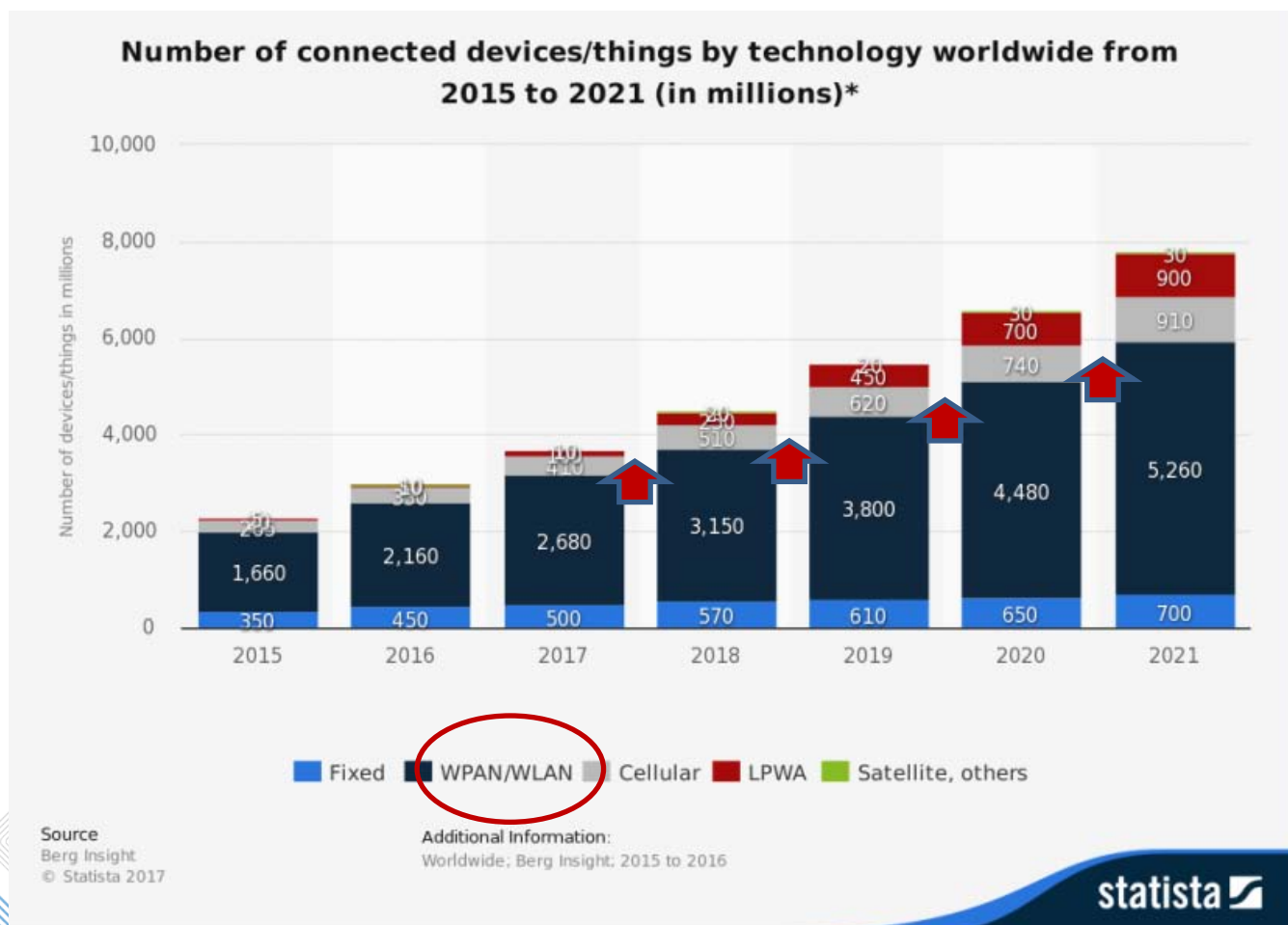
FM Tuner

AMFM Tuner

DAV/AAV Transceivers

Global Wireless Connected Devices Increase- WiFi Device Continuing Growth

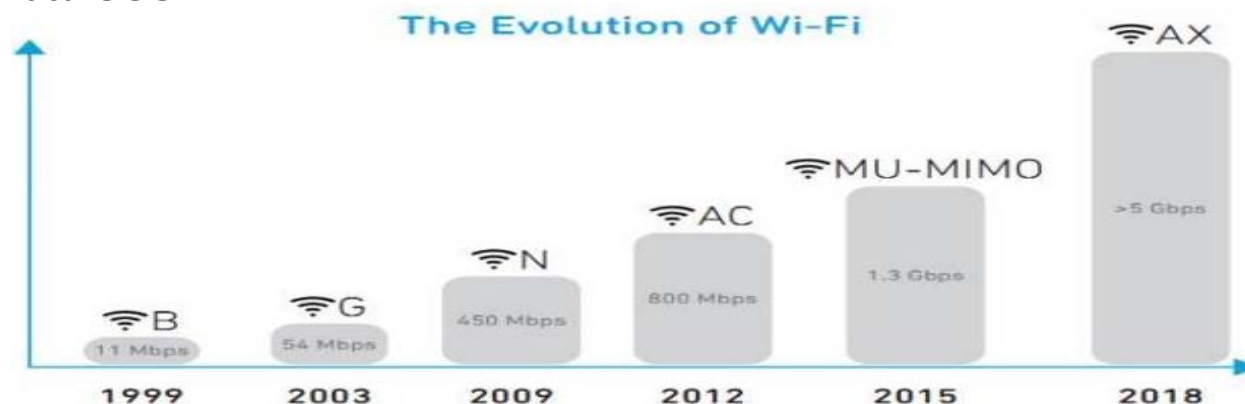
- WiFi Device continuing grow with ~6Yee/Yr to 8Yee/Yr new points/devices from 2018 to 2021
- WiFi RF-Front-End numbers further multiply by MIMO-number



Wi-Fi 802.11ac /11ax Speed & Capacity

Keep Multiples Growth

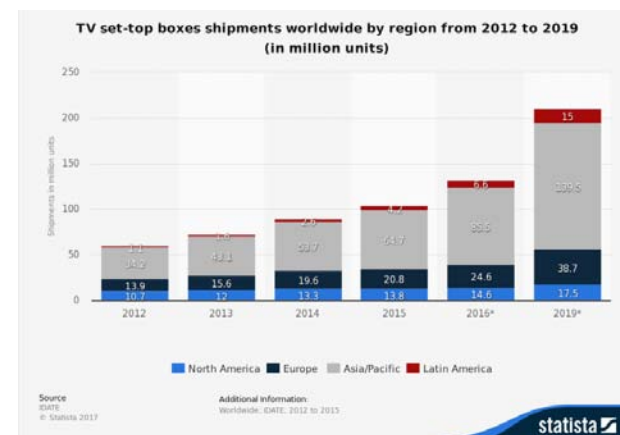
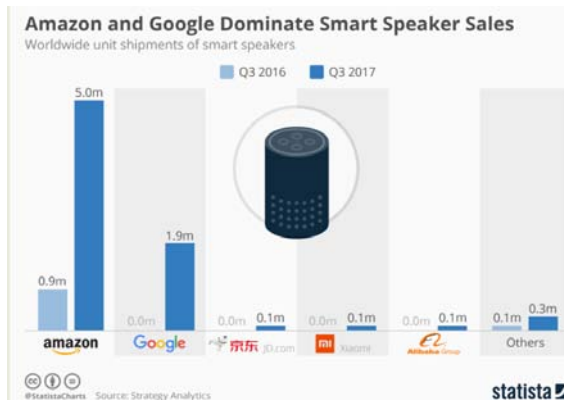
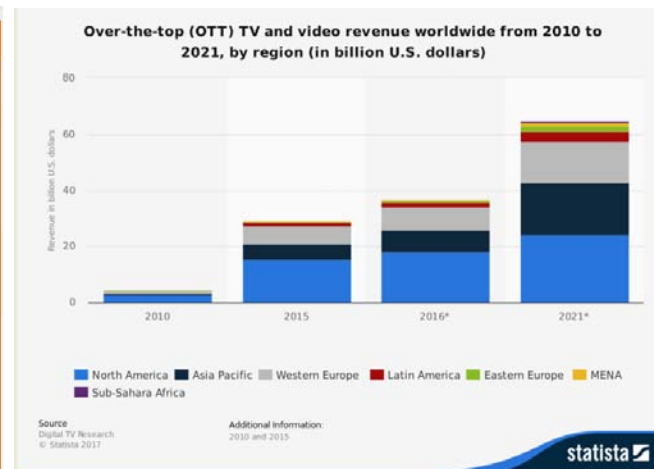
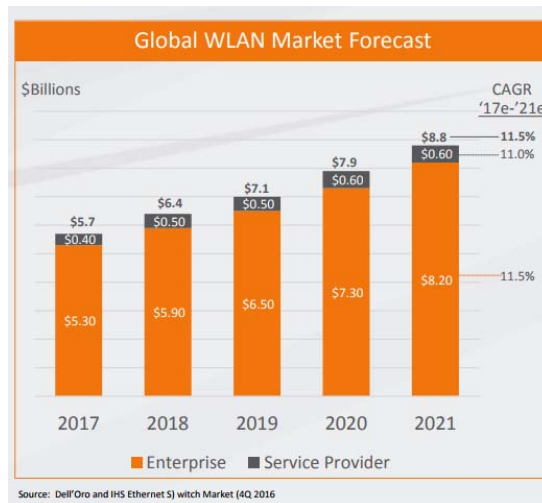
- Fastest data transmission among all standards.
- Last-mile, free-of—mmWave allow robust, complementary with LTE and future 5G.



	802.11g	802.11n	802.11ac	802.11ax
使用頻段	2.4GHz	2.4GHz和5GHz	5GHz	2.4/5 GHz
使用頻寬	20MHz	20MHz 40MHz	20MHz 80MHz 40MHz 160MHz	20MHZ 80MHZ 40MHZ 160MHZ
最高天線數	1x1 SISO	4x4 MIMO	8x8 MIMO(MU-MIMO)	12x12 MIMO
現有標準速度 (理論值)	54Mbps	150Mbps 300Mbps 450Mbps (頻寬40MHz)	433 Mbps 867 Mbps 1300 Mbps (頻寬80MHz)	600.4 Mbps 9607.8 Mbps
最高速率(理論值)	54Mbps	600Mbps	6.93Gbps	9.6 Gbps

Top 10 Applications for WiFi, TAM Growth Across All Segments

Segment	應用領域
AP Router-Retail	路由器- 零售
Gateway - Carrier	閘道- 電信商
IP Cam	監視器
STB/ OTT	機上盒
Gaming	遊戲機
Smart Speaker	智慧音箱
Smart TV	智慧電視
Smart Phone	智慧手機
Automotive	汽車
IoT	物聯網
AI/ Robotics	人工智慧



WiFi RF Front-end Growth Driver & Trend

- Our growth come from:
 - Segment TAM growth
 - WiFi attachment increase
 - MIMO increase
 - 11ac and Dual-band increase
 - RichWave market share increase

Growth Factors	Dual band (2GHz+5GHz)	MIMO	WiFi Attach-rate	Key Driver
AP Router/ Gateway	All 11ac in DB	2x2 => 3x3=> 4x4=> 8x8&higher	All	MIMO-Increase & WW share
PON	<50% DB	2x2 3x3-at TBD	Partial	WiFi Attach & MIMO
STB/OTT	High-end DB Others SB	2x2 => 3x3	Partial	WiFi attach& MIMO
Smart Speaker	DB	1x1 and 2x2	All	Architecture -embedded RF & MIMO

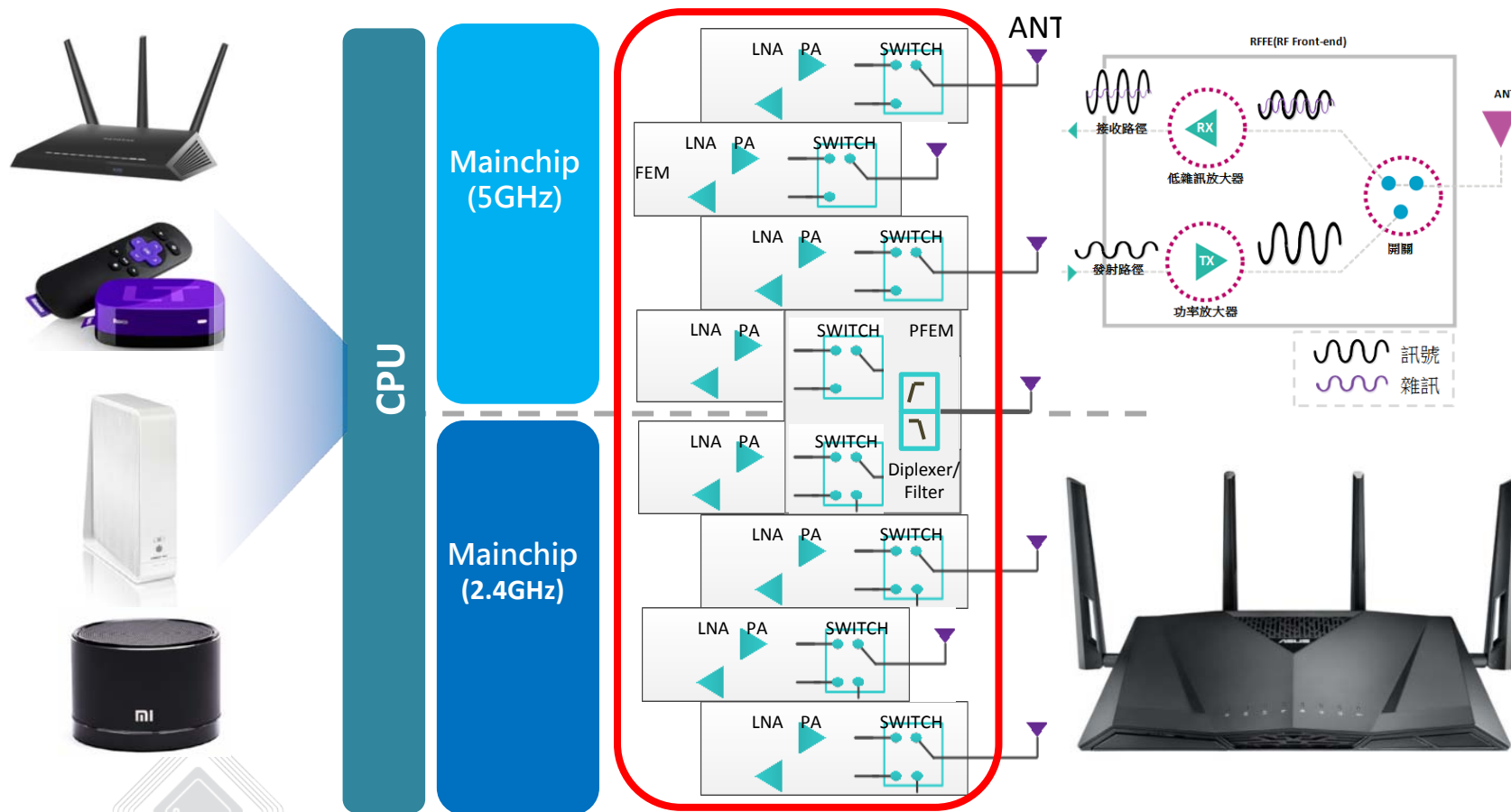
TAM of Segments	2017 (f)	2020 (f)	Growth (%)	Remarks
AP Router (DSL, Cable)	350	400	14%	M units
STB/OTT	380	460	21%	M units, 2020
Smart Phone	1,517	1,697	11.91%	M units
Game Consoles	135.2	184	36%	M units
Smart Speaker	8.3	94	1075%	M units, 2016
IoT	20,000	30,000	50%	M units
Automotive	1,062	7,914	645%	US\$M, 2016

Source: IDC, IHS, Accelerating Biz analysis, frost & Sullivan, Ovum, Statista, IDATE, Gartner, Voicebot.ai, Edison Research, Digital Market Outlook, ABI Research

WiFi MIMO Multiplies Data-Throughput and Multiplies RF Front-End Numbers

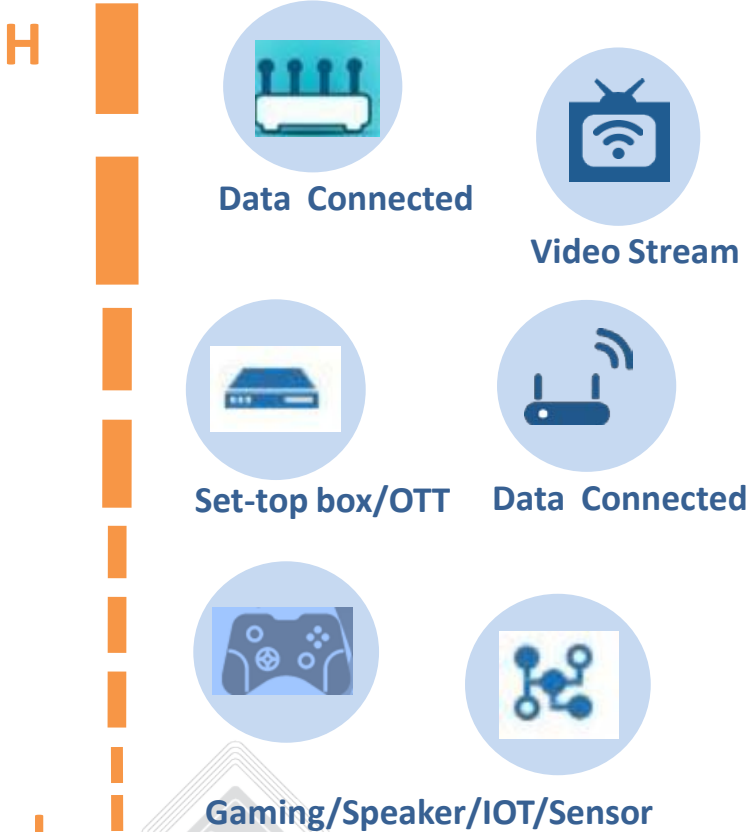
- The Front-End enhances coverage-range (PA/LNA) and receiving sensitivity (LNA) – FE performance is Key.

WiFi 802.11AC 4X4 MIMO



WiFi Devices/Equip.-Using RF Front-End Produce Performance Differentiated. WiFi RFFE Need Complete Products & Technical-Performance

Output Power



PA	3-in-1 FEM	2-in-1 FEM	SW	LNA
V	V	V		V
V	V	V	V	
		V	V	V

WiFi LTE-WiFi RF-FE Products- Complete Mix

- Wide Power@EVM range (mid.~high)
- Full-FEM (3-in-1) and Rx-FEM (2-in-1)
- PA/LNA/SW provide flexibility in system-design
- Winning performance for Full-FEM and Rx-FEM

High Power PA		
Parameter		Richwave
Frequency Band	DEVM	Power Level
5GHz	1.8%	23dBm
2GHz	3%	27dBm

Networking: Router/Gateway/STB/OTT

Full FEM					RX FEM			
Parameter				Richwave	Parameter			Richwave
Frequency Band	Power Sagment	Size	DEVM	Power Level	Frequency Band	Power Sagment	Transmisson/ Receive	Power Level
5GHz	H	5x3mm ²	1.8%	22~22.5dBm	5GHz RX FEM	H	TX IP1dB	37dBm
		3x3mm ²	1.8%				RX Gain/NF	14dB/2.6dB
		2.5x2.5mm ²	1.8%			M	TX IP1dB	32dBm
	3x3mm ²	1.8%	20dBm	RX Gain/NF			13.5dB/2.2dB	
	M	2.5x2.5mm ²	1.8%	2GHz RX FEM	H	TX IP1dB	36dBm	
		2x2mm ²	1.8%			20dBm	RX Gain/NF	16dB/1.7dB
2GHz		Pout @ 3% DEVM			27dBm	M	TX IP1dB	32dBm
							RX Gain/NF	15dB/1.6dB



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Mobile Phone: WiFi in LTE-phone

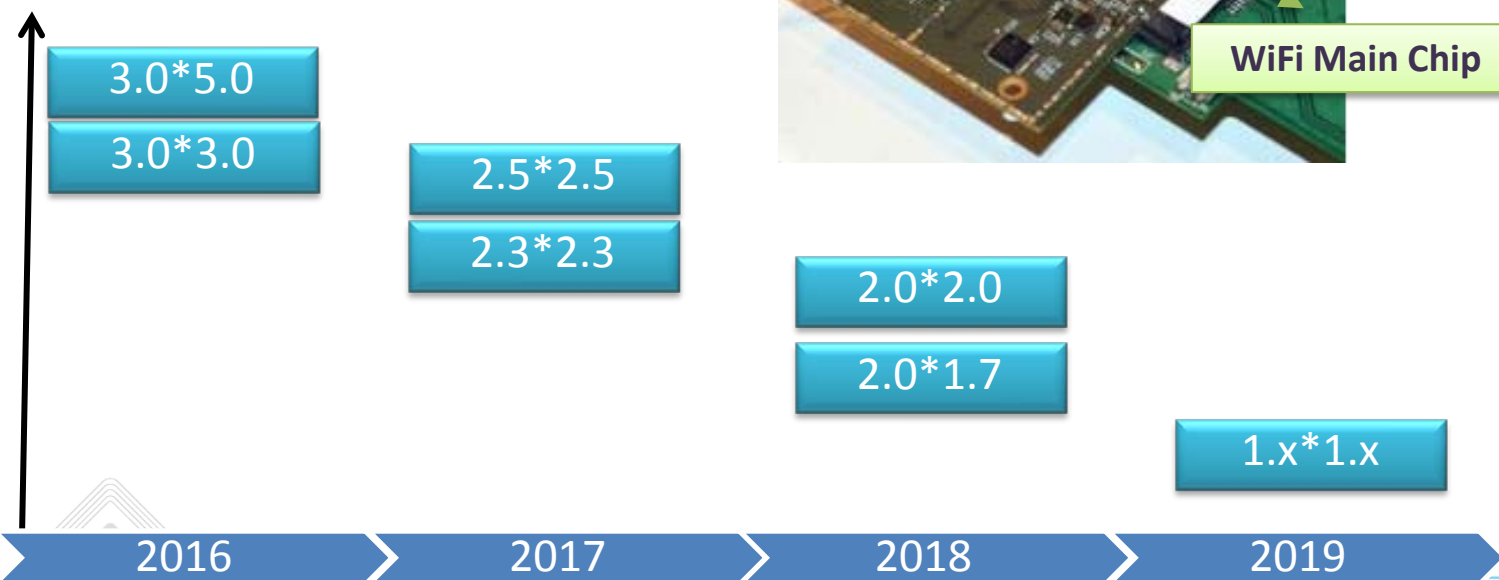
	Parameter		RichWave
5GHz FEM	3 in 1	TX EVM@1.8%	17dBm
		RX Gain/NF	16.5dB/2.0dB
	2 in 1	RX Gain/NF	13.5dB/2.2dB
2GHz RX FEM	3 in 1	TX EVM@1.8%	18.2dBm
		RX Gain/NF	16.5dB/1.5dB
	2 in 1	RX Gain/NF	15dB/1.6dB



WiFi FEM Key Feature & Trend

- EVM ↓
- NF ↓
- Gain ↑
- Package Size ↓

QFN Size



2.4GHz 802.11b/g/n FEM

5GHz 802.11ac FEM



WiFi Main Chip

Source: from Web

Achievements

- WiFi 802.11AC FEM has reached ~8% worldwide share at 2017/E, from ~2% at 2016/E
- Penetrated into leading Global Brands with 802.11AC 3-in-1 FEM, such as Netgear (US), TPLink (China), Technicolor (Europe); and Telecom Operators such as DT, BT (Europe), China Mobile and China Telecom (China), and LGU+ and SKT(Korea)
- Continue winning all Amazon TV-dongle and Smart speaker new models, and penetrated into MII's smart speaker
- Winning LTE LNA on Huawei mobile phone and Nokia phone models
- Winning NB-IOT models with Switch for China Mobile on Smart meters
- Winning FMAM Tuner in Clock Radio and High-end Radio
- FM Tuner continue win on new Mobile models and High-end Boom boxes.



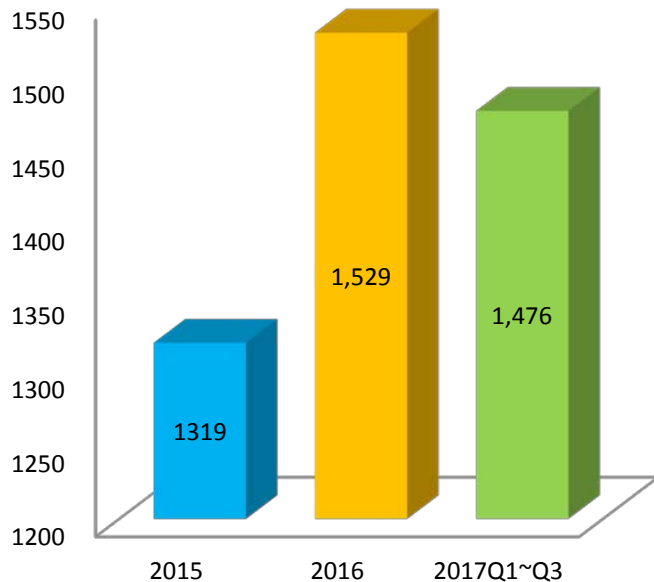
Over 100 reference designs with Mainchip Partners



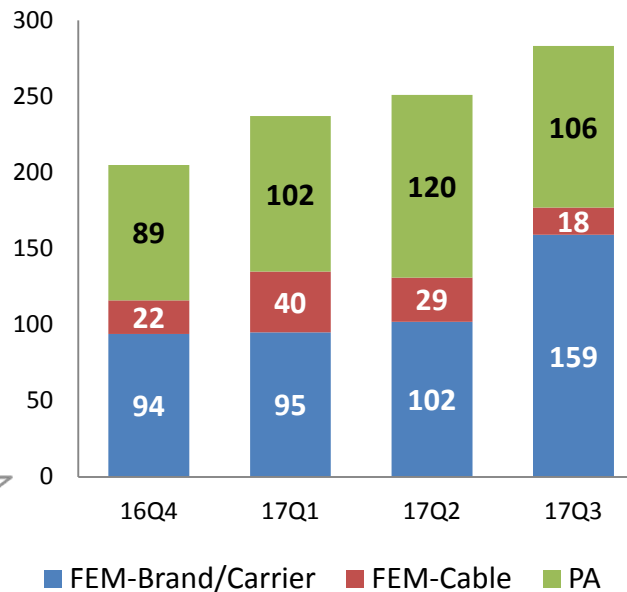
Annually Solid Growth over 30% in WiFi

- 2017Q3 FEM with QoQ growth is over 55% by 802.11ac Brand/Carriers.
- 2017Q3 WiFi Overall QoQ growth is 14%, YoY growth is over 30%.
- Driven by 11ac worldwide share, MIMO 2x2 and 3x3, and increasing Range-coverage.

Unit: NT\$ Million



Unit: NT\$ Million



中国移动通信
CHINA MOBILE



中国电信
CHINA TELECOM



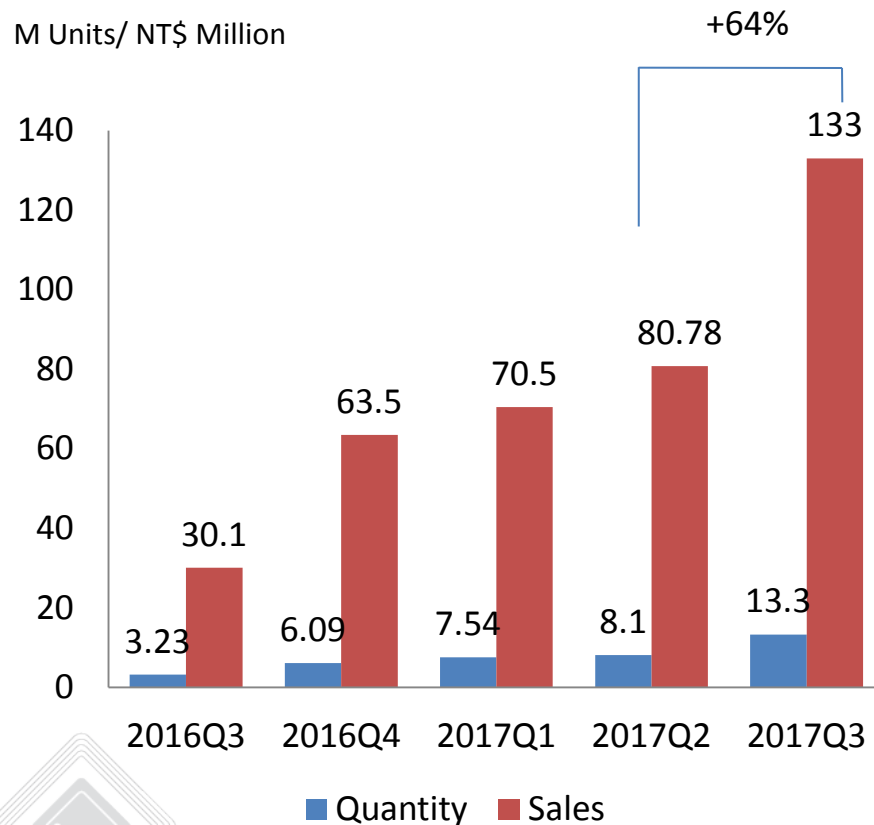
Deutsche
Telekom



LIBERTY GLOBAL

FEM engaged in Router & STB/OTT with Big Brands worldwide

- Our quality and performance are armed with the world level.
- Q4 revenue will increase over Q3 QoQ both in China & Europe.

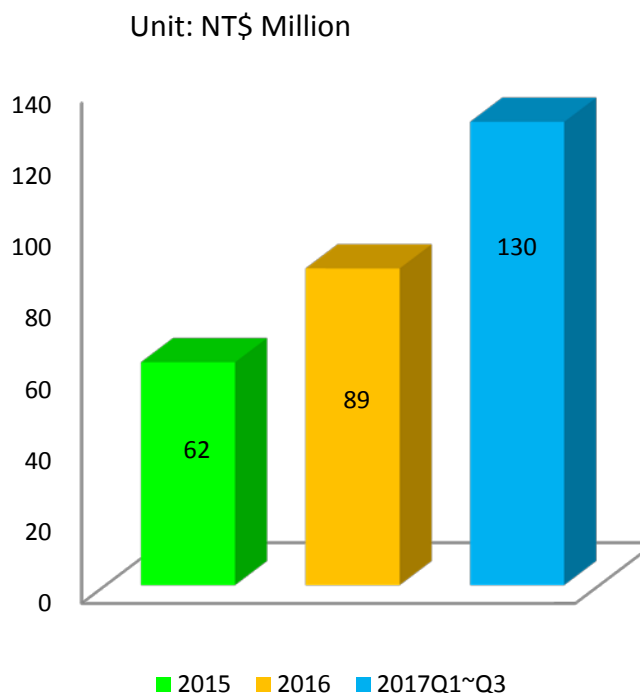
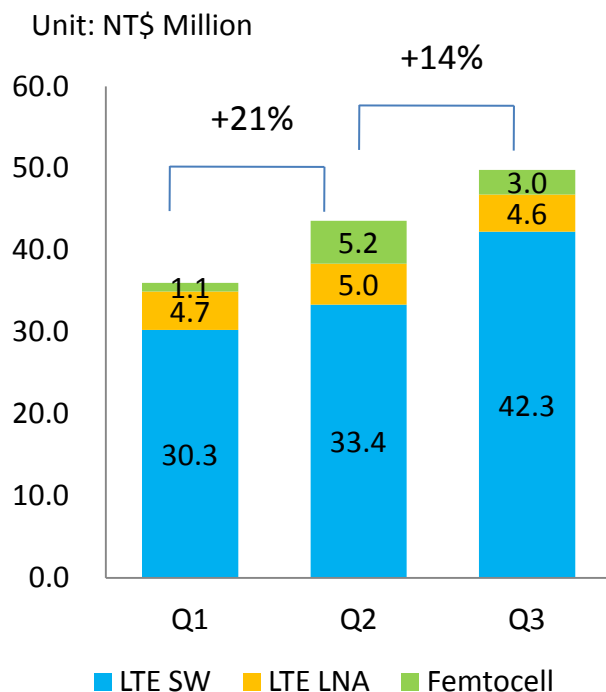


Continue Win in Smart Speaker



LTE LNA and Switch – As Mobile Strategic Step

- Focus on Winning LTE LNA
- LTE switch focus on leading Brands

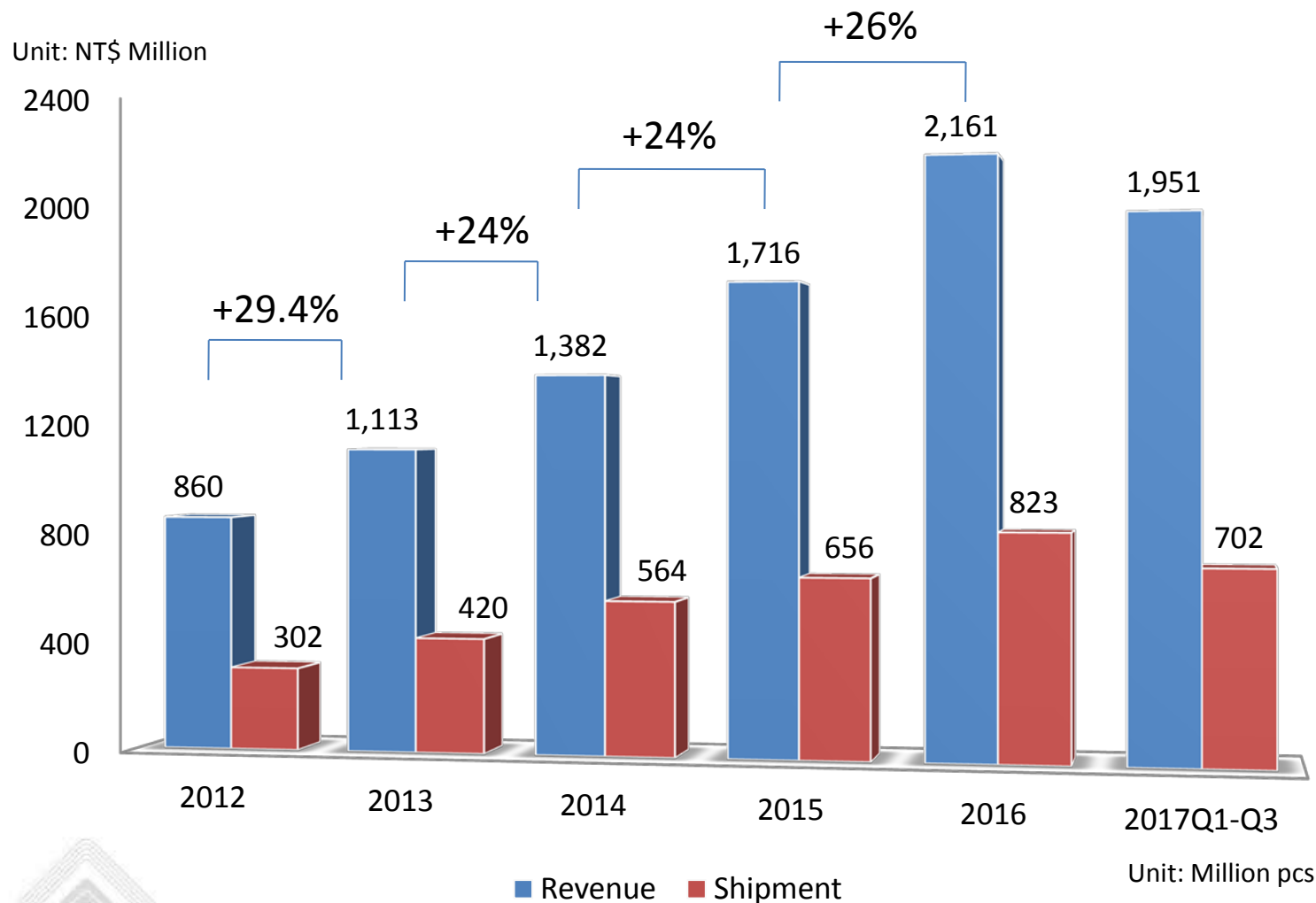


Continue Cook on FM, Consumer FM, & Achieve FMAM Win

- FM continues to win in Korea flagship phones.
- Wireless long-distance HD video increased the shipments to smart home, car backup, drone... with our proprietary transceiver.
- AM is penetrating into Clock Radio and Boom box



Trend in Revenue >20% growth

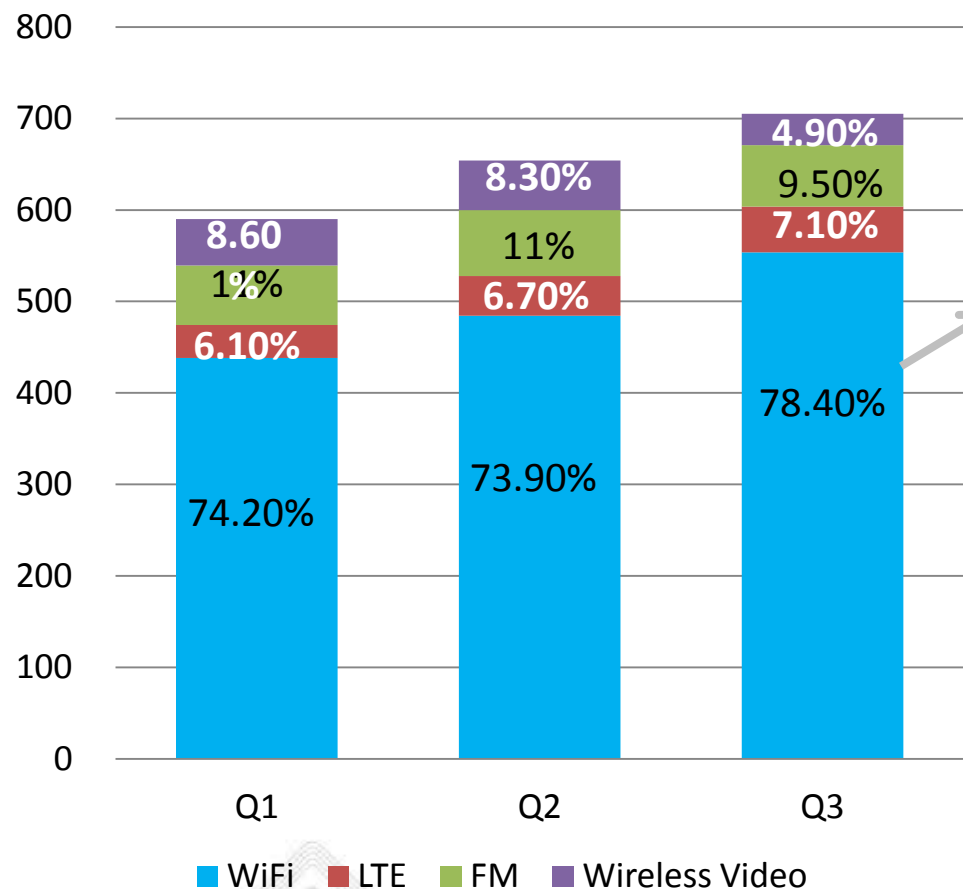


Product Portfolio WiFi FEM Growth Speed Up

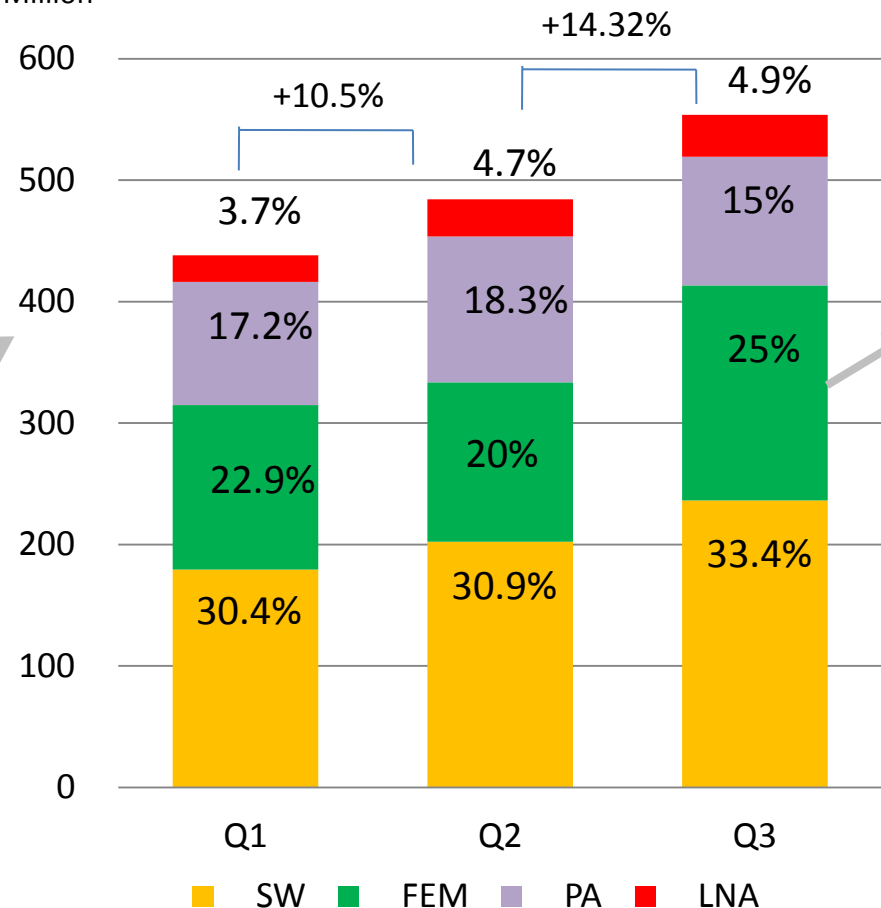
Unit: NT\$ Million

Product Portfolio

Unit: NT\$ Million

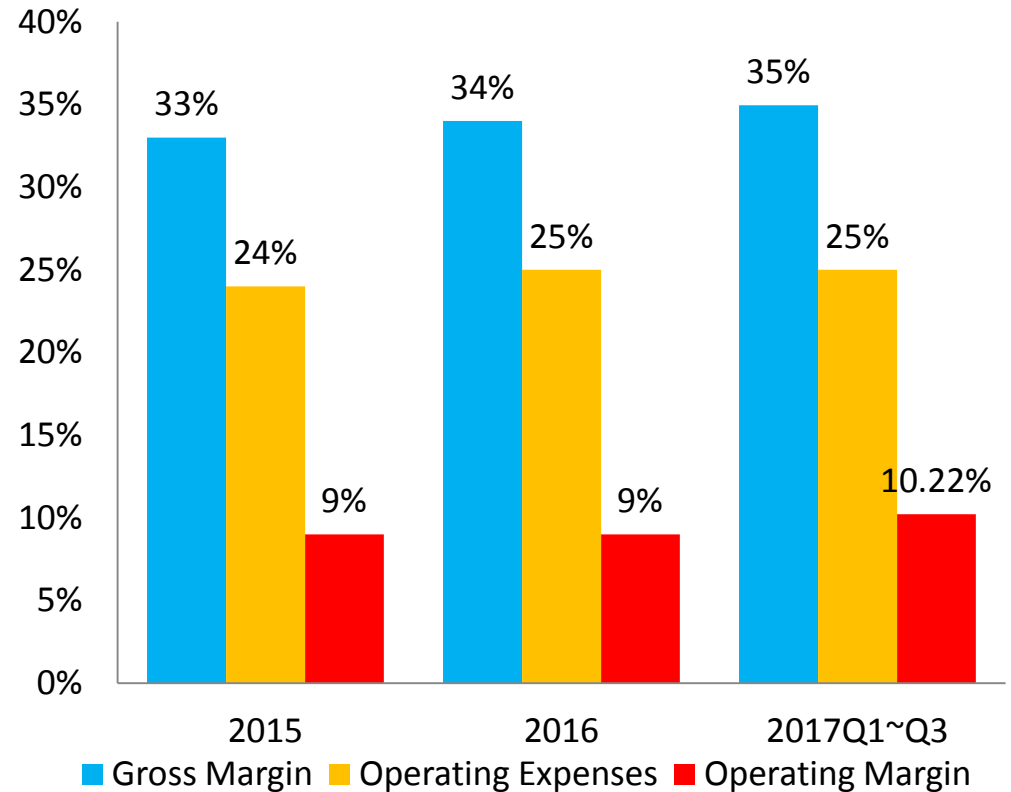
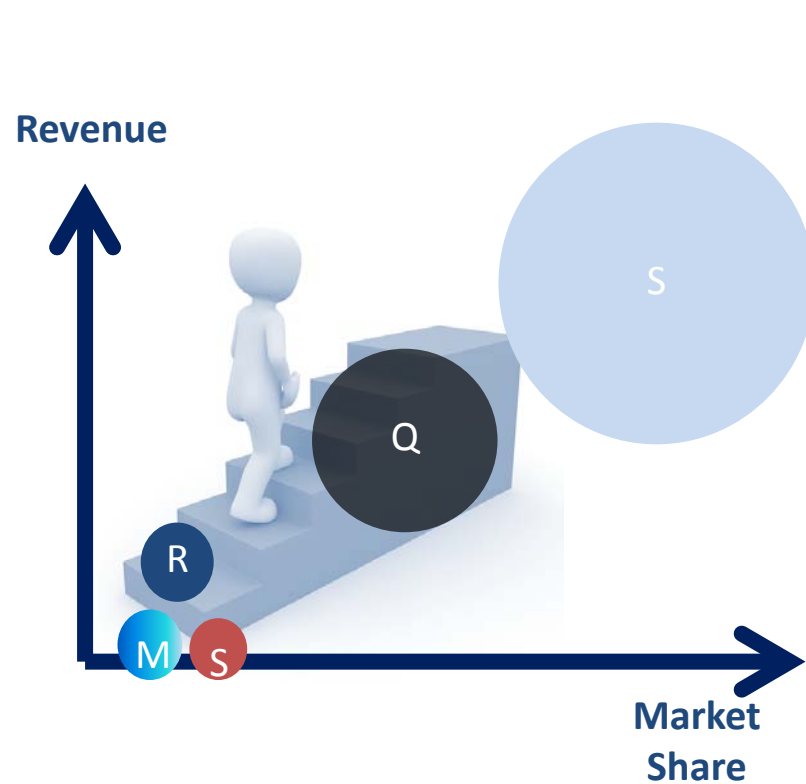


RFFE components Portfolio in Wi-Fi



Product Portfolio Migration toward High-GM PA and FEM

Accompanied with Market Share Gain, Operational Performance Moving Forward





RichWave