



Wi-Fi in wearable / IoT

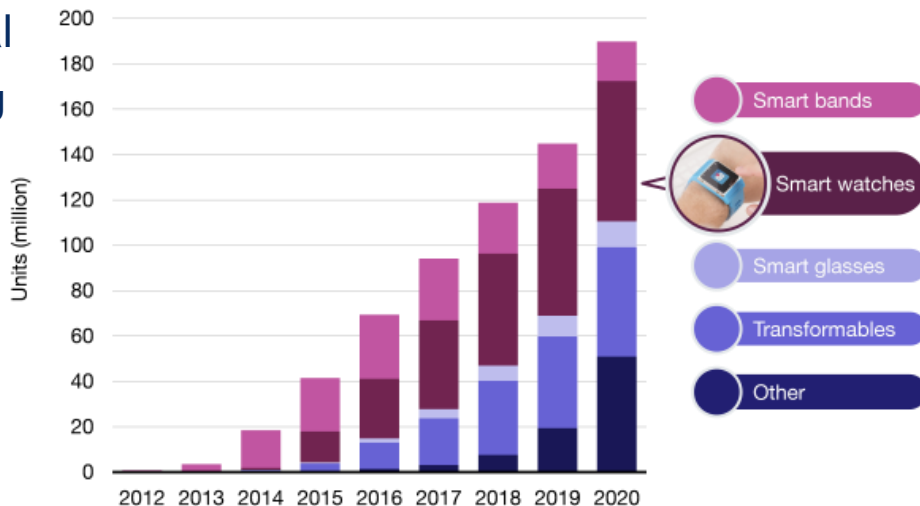
Franz Dugand

Linley IoT Conference, June 11, 2015

www.ceva-dsp.com

IoT & Wearable Markets – Key Trends

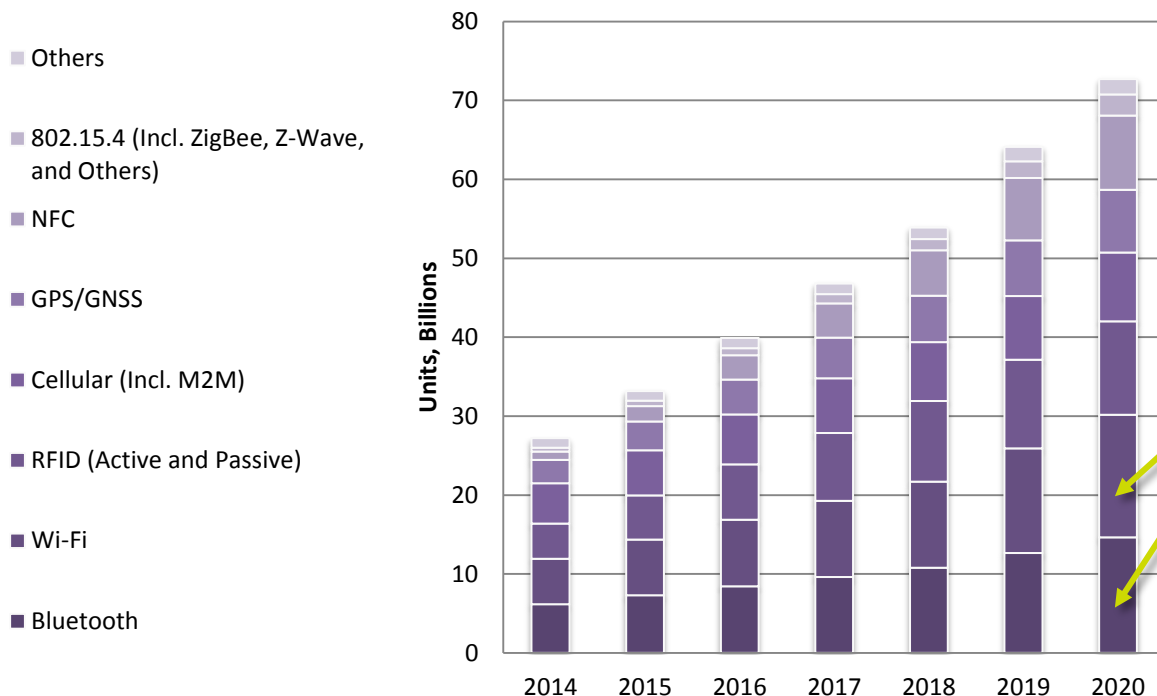
- ▶ The Internet Of Things becomes personal
 - ▶ More and more wearable devices are getting connected to the Internet (IPv6/6LoWPAN)
- ▶ Wearable devices to become fastest ramping consumer technology device to date
 - ▶ Faster than even smartphones and tablets
 - ▶ CAGR of 50% between 2014 and 2020
- ▶ Mass adoption highly depends on price
 - ▶ Cost-down cycle requires further system integration



Smart wearable unit sales by device category, developed markets, 2012–2020 [Source: Analysys Mason, 2014]

Wireless Technologies in IoT Devices

Installed Base of Wireless Connected Devices by Technology



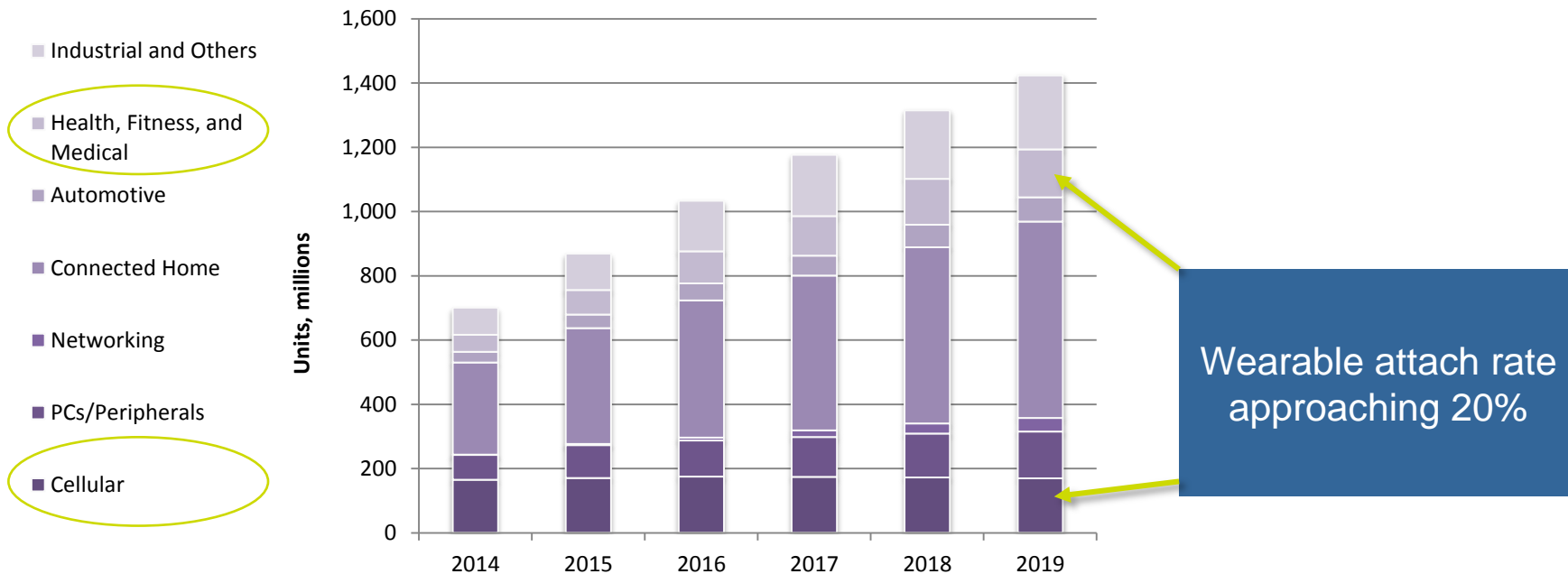
IoT devices are all getting connected wirelessly

Wi-Fi and/or Bluetooth in more than 30 billion devices by 2020

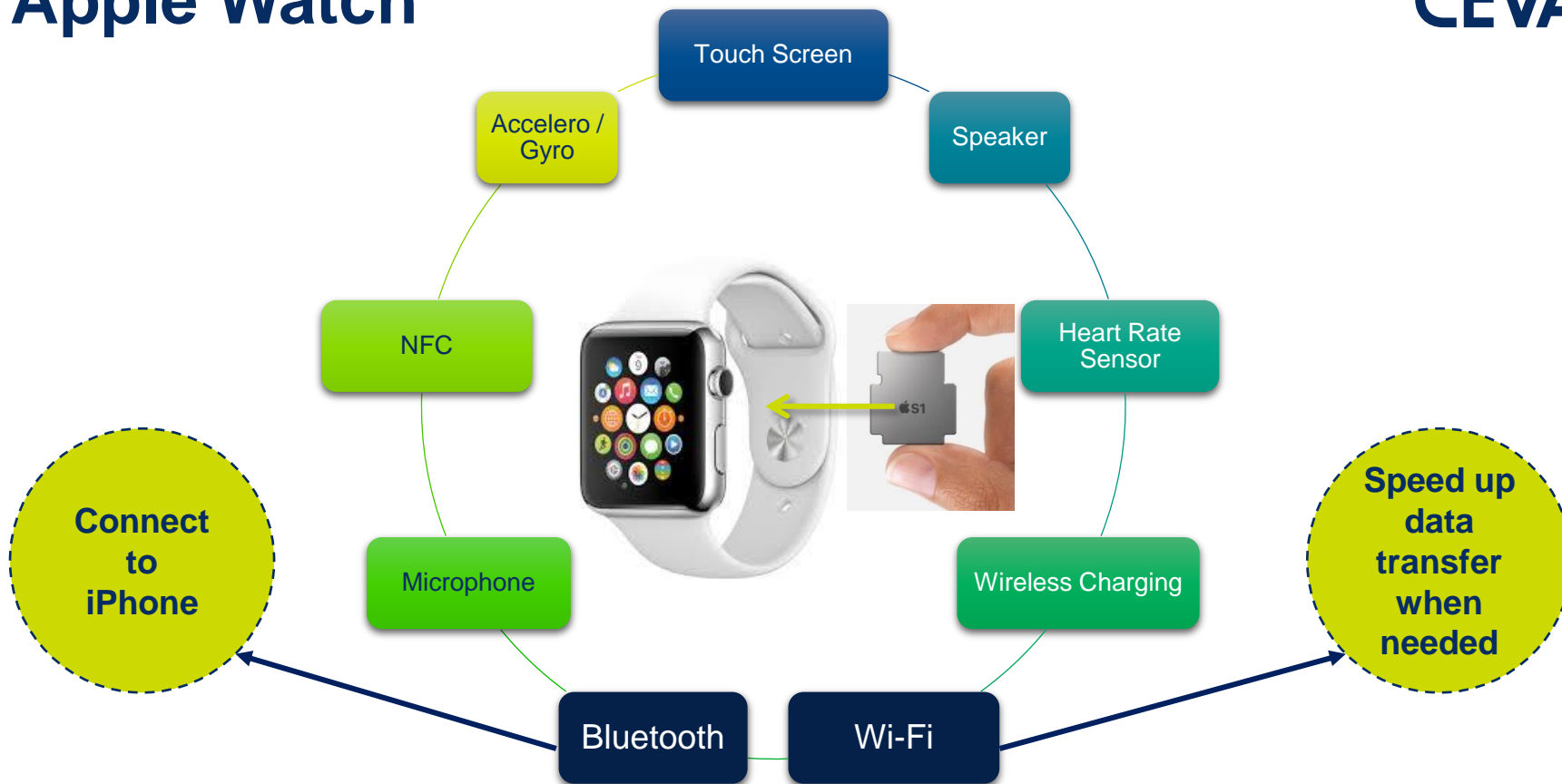
Wi-Fi connections forecast to overtake Bluetooth by 2020!

Wi-Fi in IoT devices

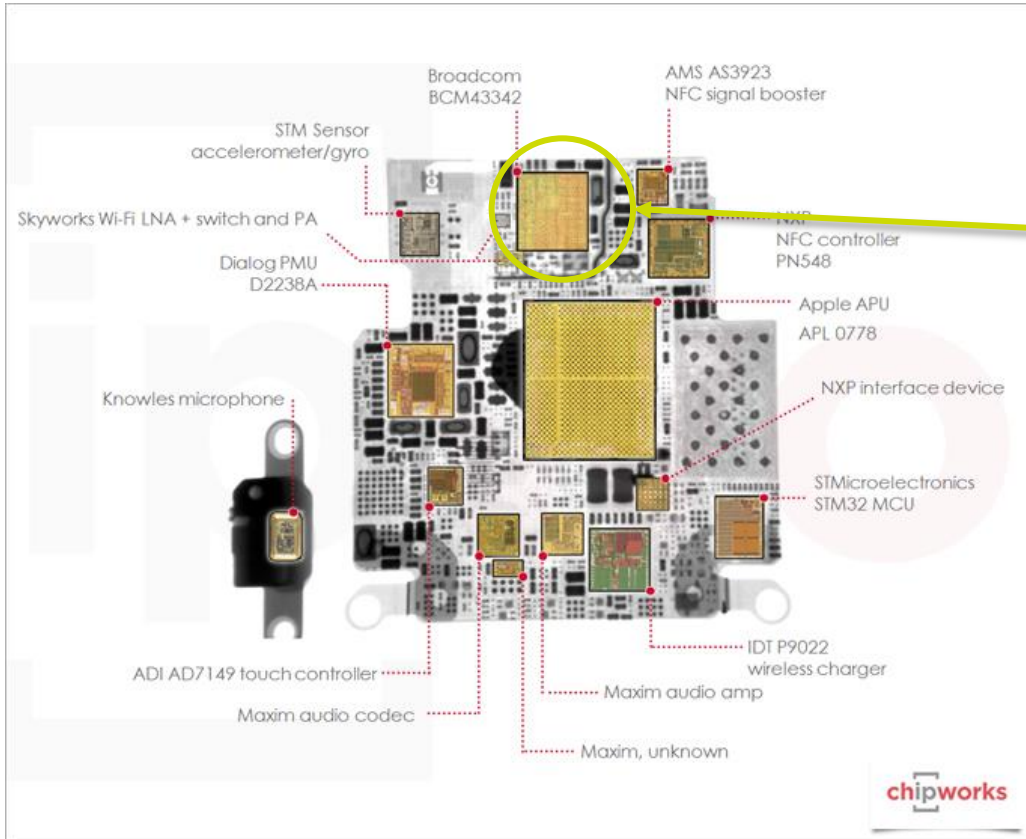
Wi-Fi Enabled Device Shipments



Apple Watch



Apple S1 SiP Teardown



► SiP with 30 components!

► BCM43342 die size is ~18.5 sqmm

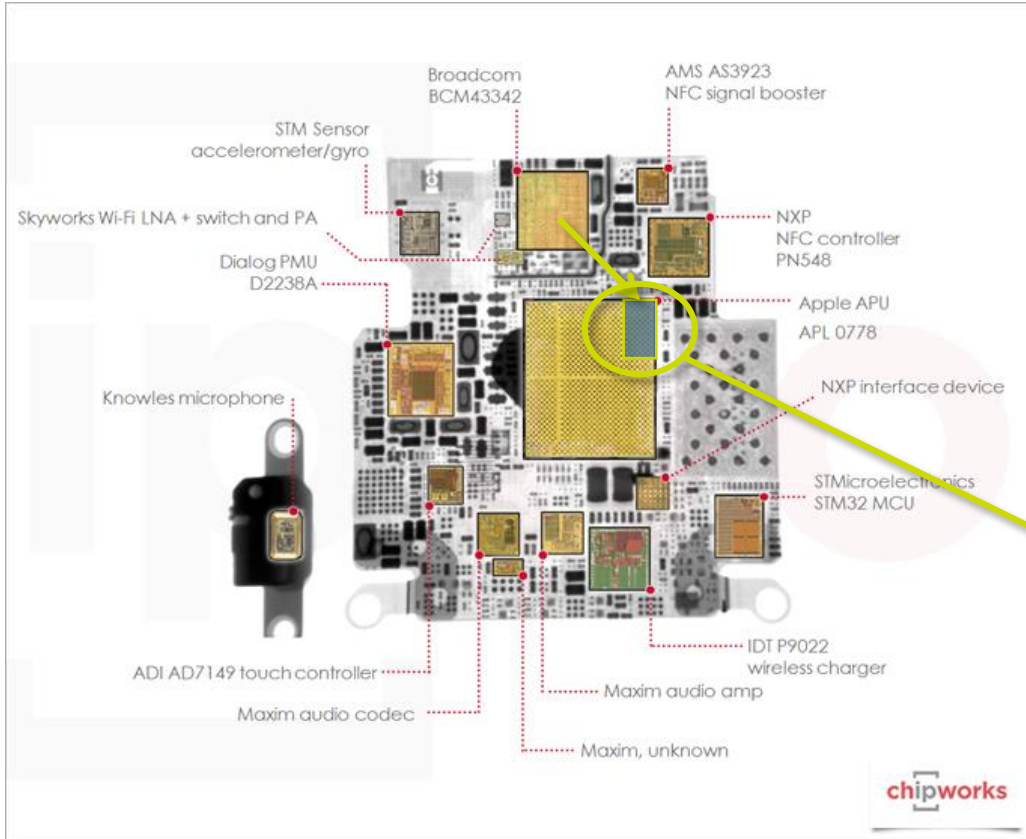
► Wi-Fi 802.11a/b/g/n

► Bluetooth 4.0

► FM

► 40nm process node

What Happens When Integrating Wi-Fi?



- ▶ Reduce size by ~70%
- ▶ APU is smaller geometry ($\leq 28\text{nm}$)
- ▶ Reduce cost
- ▶ Smaller size and lower BOM
- ▶ Reduce power consumption
- ▶ Lower geometry
- ▶ No I/Os, pads, etc

6sqmm if integrated into S1

- Wi-Fi 11ac
- Bluetooth 4.0
- Complete with MAC, modem, AFE, RF, MCU, memories

Integration options of Wi-Fi into APU/MCU



	External Wi-Fi IC		External Radio IC		Fully Integrated	
Size	Extra component	✗	Smaller node of APU/MCU, Less pads, less interface	✓	Smaller node of APU/MCU, Less pads, less interface	✓ ✓
Power consumption	Bigger node	✗	Smaller node of APU/MCU	✓	Smaller node of APU/MCU	✓ ✓
Manufacturing cost	Highest BOM	✗	Lower BOM, smaller RF package	✓	Lowest BOM, no extra IC	✓ ✓
Design cost		✓ ✓	Digital integration	✓	Digital and RF integration, RF porting when going to smaller node	✗

RivieraWaves Wi-Fi



Ideal for SoC Integration

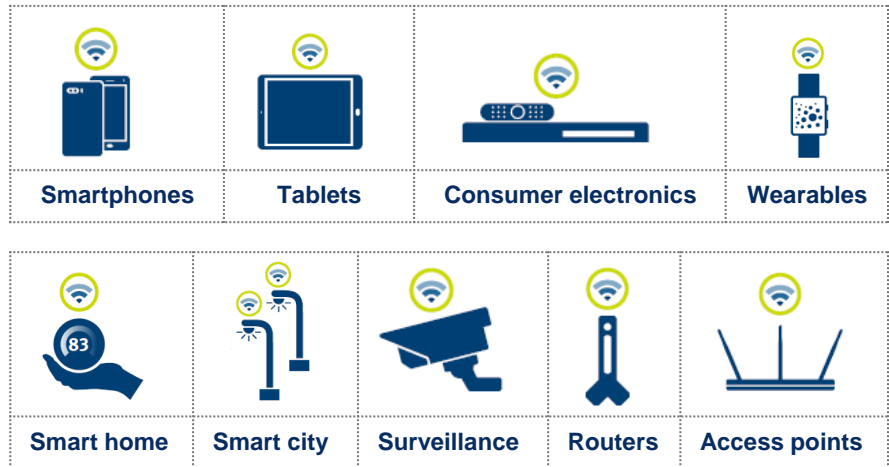
- ▶ Long legacy in Wi-Fi:
 - ▶ Licensing since 2002
 - ▶ Widely adopted IPs: more than 50 customers in Asia, Europe and U.S.
- ▶ Range of options, from 802.11n 1x1 up to 802.11ac 4x4
- ▶ IP solution consists of
 - ▶ MAC:
 - ▶ Hardware accelerator
 - ▶ Software stack: LMAC & UMAC
 - ▶ Processor agnostic
 - ▶ Modem, 2 options:
 - ▶ Hardwired – smallest size, cost
 - ▶ Software-defined modem – enhanced flexibility



Wi-Fi Licensees Include:



Wi-Fi Everywhere:



RivieraWaves Wi-Fi Platforms



Industry's Smallest, Most Power-Efficient Wi-Fi IP Platforms
Complete solutions including PHY and MAC, up to 802.11ac 4x4



- ▶ **RivieraWaves Sense: 802.11b/g/n 1X1**
 - ▶ Lowest power, lowest cost
 - ▶ Available as hardwired or software-based modems
 - ▶ Upgradeable to support 802.11ah and LTE Cat0



- ▶ **RivieraWaves Surf: 802.11ac 1X1 and 2X2**
 - ▶ Low power design
 - ▶ Supports Wave 2 MU-MIMO



- ▶ **RivieraWaves Stream: Up to 802.11ac 4X4**
 - ▶ Flexible & future-proof SDM design for wireless infrastructure
 - ▶ High throughput up to 1.7Gbps MU-MIMO

Full MAC	HW MDM	SDM
✓	✓	✓
✓	✓	
✓		✓

RivieraWaves Wi-Fi: Target Apps

SURF

802.11ac 1x1, 2x2



SENSE

802.11n 1x1



RivieraWaves
Wi-Fi

STREAM

High-performance 802.11 ac 4x4

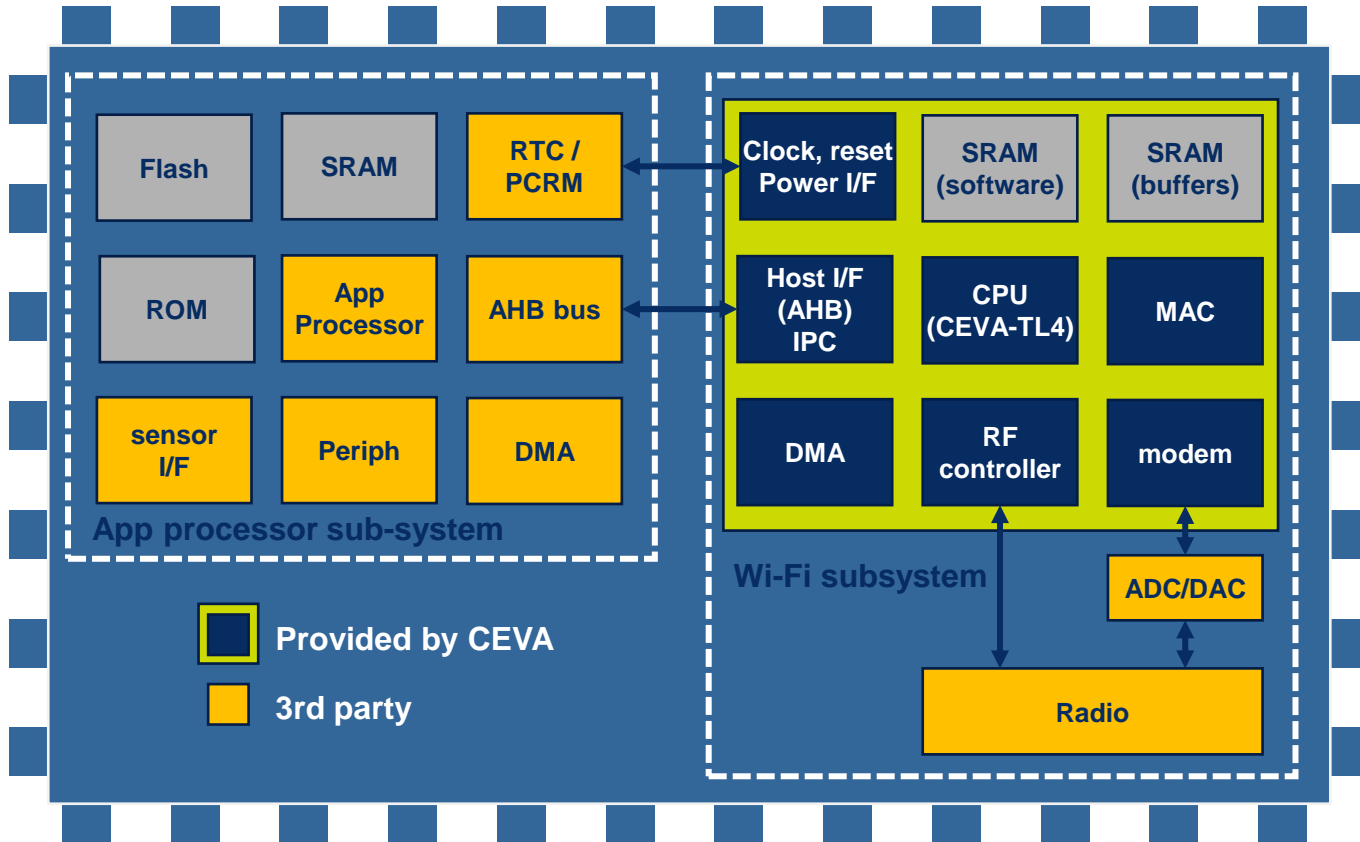


Main Wi-Fi Supported Features

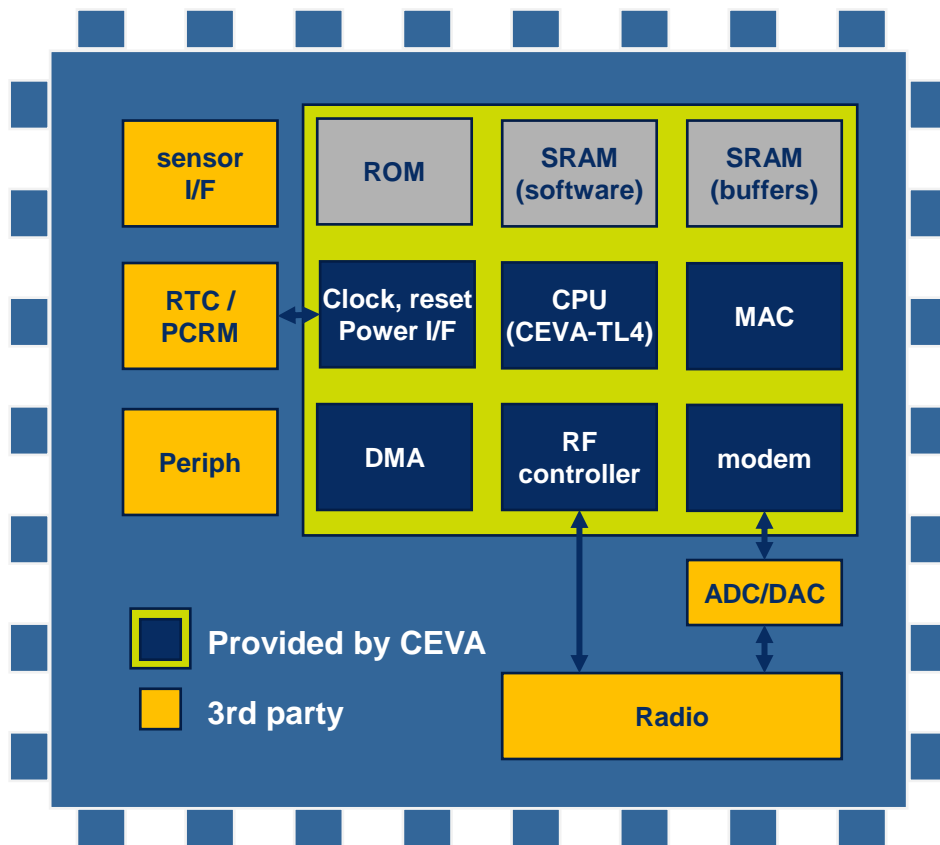


	Sense	Surf		Stream
Configuration	11n 1x1	11ac 1x1	11ac 2x2	11ac 2x2 – 4x4
Versions	802.11b/g/n	802.11a/b/g/n/ac		
Bands	2.4GHz	2.4/5GHz		
Bandwidths	20MHz or 20/40MHz	20/40/80MHz		
Max throughput	72Mbps (20MHz) 150Mbps (40MHz)	433Mbps	867Mbps	1.3Gbps (3SS) 1.7Gbps (4SS)
Options	WAPI, LDPC	WAPI, LDPC, MU-MIMO (Wave 2)	WAPI, LDPC, MU-MIMO (Wave 2)	
Other features	<ul style="list-style-type: none"> - STBC (improve link reliability minimizing the effects of scattering, reflection, refraction) - STA, AP and Wi-Fi Direct Modes supported concurrently - Security (WEP/WPA/WPA2/WPS), Quality of Service (WMM, WMM-PS) 			

Wi-Fi Integrated into APU or MCU



Low-Cost Standalone Wi-Fi Chip



- ▶ No need for extra Host application processor
- ▶ CPU (ex. CEVA-TeakLite-4) can execute:
 - ▶ Wi-Fi full MAC protocol stack
 - ▶ Simple TCP/UDP stack
 - ▶ Application
 - ▶ Always on Sensor
 - ▶ Audio processing
- ▶ Lowest cost solution

RivieraWaves Wi-Fi: Flexibility Where Needed



RF

- ▶ Multiple choices, including customer's own
 - ▶ Catena (available in TSMC 65nm and GF 28nm)
 - ▶ Maxscend (available in SMIC 55nm and UMC 55nm)
 - ▶ Customer's own radio, utilizing flexible AGC/CCA mechanism
 - ▶ Other alternatives coming soon..

CPU

- ▶ (MAC): Your choice, including fully integrated CEVA solution
 - ▶ ARM Cortex-M, Andes, Cortus APS, ARC EM, others
 - ▶ CEVA-TeakLite-4: Enabling a fully integrated, one-stop-shop solution

Modem

- ▶ 2 alternatives
 - ▶ Hardwired modem: Ultra-low cost and power efficient
 - ▶ Software-defined modem (SDM): Further flexibility to adapt to new requirements

Integration

- ▶ Multiple options
 - ▶ Standalone connectivity chip / Integration with APU / Integration with Baseband
 - ▶ Integrated with RF / Separate RF combo

▶ Smallest Wi-Fi IP

- ▶ {CEVA + Catena} {modem + RF + MAC} {802.11ac 1x1 + BT 4.2} < 6 sqmm in 28nm

▶ Lowest power consumption

- ▶ RivieraWaves Sense based SoC can operate for years on a single AA battery
 - ▶ Full SoC including RF/AFE
 - ▶ 40% lower power consumption than any other 11n chips commercially available
 - ▶ RivieraWaves Sense IP contribution is less than 50mW peak in 28nm!
- ▶ 802.11ac 4x4 Wi-Fi Stream based chip (including RF, PA) consumes less than 3.5W
 - ▶ Broadcom BCM43465 is 6W* for the same functionality

Conclusion



- ▶ Wi-Fi integration is a Smart choice for IoT, and for wearable in particular
 - ▶ Smaller, cheaper, lower power
 - ▶ Lower power than Bluetooth when higher data transfer required

- ▶ CEVA is the smart choice for Wi-Fi IP
 - ▶ Widely adopted in APAC, Europe and US
 - ▶ Only IP company to provide all flavors:
 - ▶ Low power 11n 1x1 → RivieraWaves Sense
 - ▶ Consumer Electronic up to 11ac 2x2 → RivieraWaves Surf
 - ▶ Gateway up to 11ac 4x4 → RivieraWaves Stream
 - ▶ Highest experience in licensing and supporting Wi-Fi since 2002!





Thank You

Contact: franz.dugand@ceva-dsp.com

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