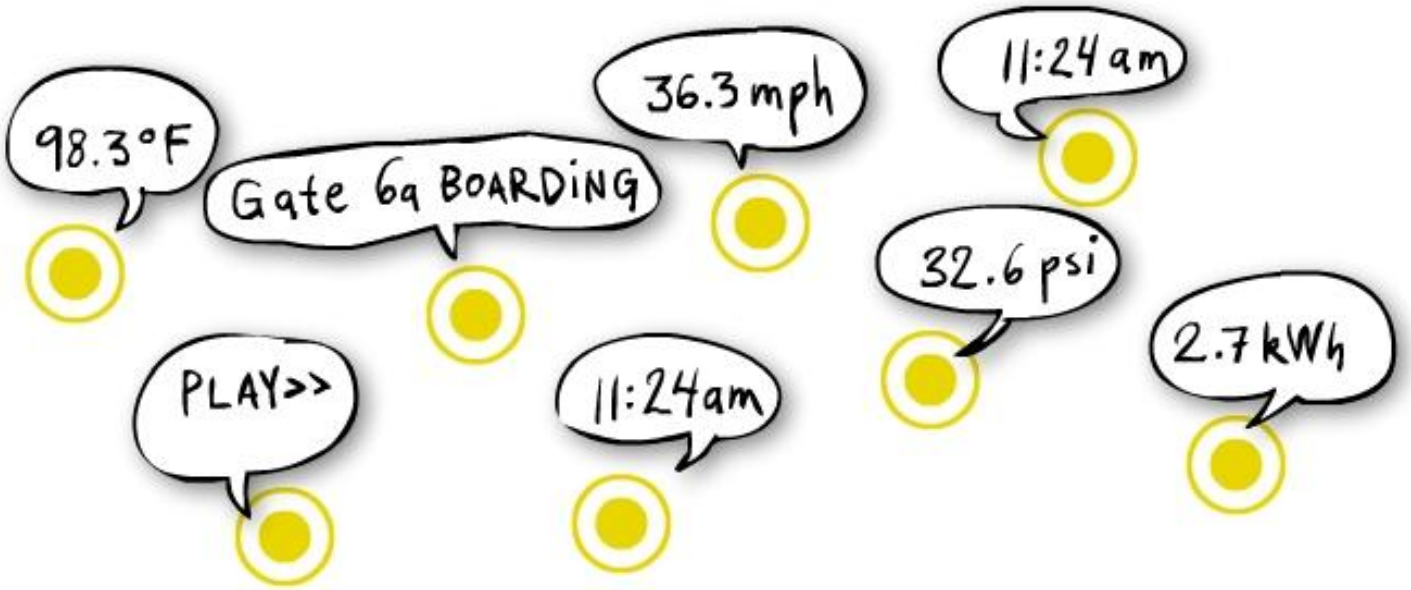
BLUETOOTH LOW ENERGY TECHNOLOGY

HOW IT WORKS

BLUETOOTH LOW ENERGY TECHNOLOGY

- Is good at small, discrete data transfers
- No connection needed before transmitting
- The best alternative for applications that are ‘always-off’



A DEVICE CAN…

- Provide regularly updated data
  - e.g. sports and health devices, M2M
- Request updated information
  - e.g. personal navigators, remote controls
- Control other devices based on connection data
  - e.g. smart meters, pill dispensers
- Load applications
  - Inform App stores of relevant applications for devices
- Register itself
  - Provide first use and maintenance data

KEY TECHNOLOGY DIFFERENTIATORS

- Simple star topology
  - significantly reduced implementation complexity
- Very small footprint
  - low cost
- Very robust
  - frequency hopping
- Very secure
  - optional 128 bit AES encryption
- Very low power
  - ‘always off’

ACHIEVING LOW ENERGY

- Keep the radio off, except when needed
  - Shorter standby time (lower duty cycle)
  - Faster connection (sends data quicker)
  - Lower peak power (can use coin cell battery)

Example:

Transmission time: 1 ms

Transmission interval: 5 s

Load: 0.01%

SHORTER STANDBY TIME

- Uses only 3 advertising channels
  - Uses 16 to 32 channels
  - RF is on for only 0.6 to 1.2 ms
- Idle current is dominated by deep sleep current
  - Sensor applications send data less often (0.5s to 4s intervals)
  - RF current is negligible due to low duty cycles
  - Protocols are optimized for this communication model

FASTER CONNECTION

- A device that is advertising, automatically connects to a scanning device

- Devices can connect in 3 ms, much faster than competing technologies

LOWER PEAK POWER

- The technology uses relaxed RF parameters
  - GFSK modulation index increased
  - Allows better range / robustness
- Packet length is restricted
  - Together with GFSK, the lowest-complexity transmitter / receiver
  - Lower peak power
- Coin cell operation with very long lifespan

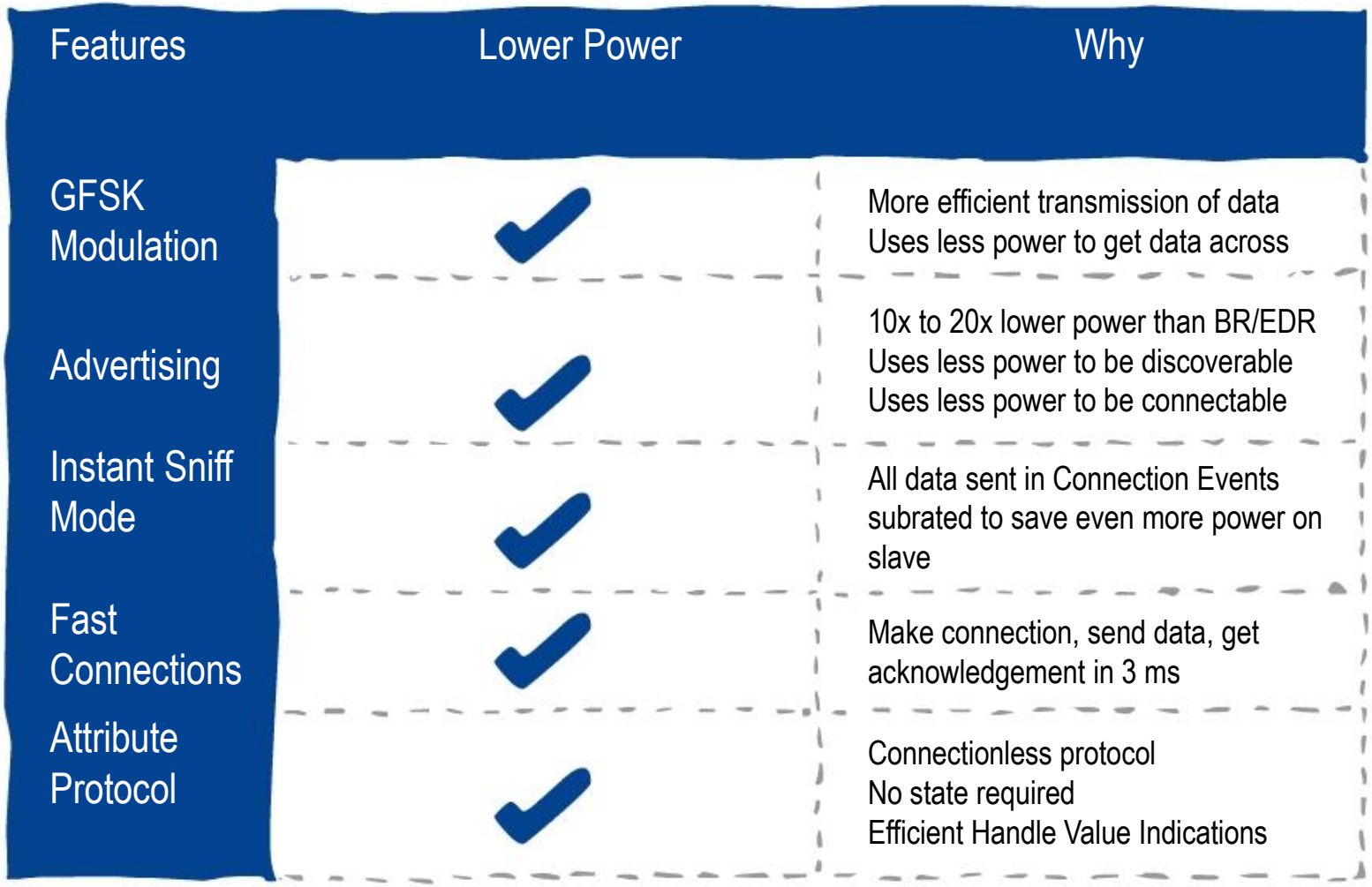
BATTERY MONITORING

- Battery monitoring on all devices
  - Remote controls
  - Sensors
  - Key fobs
- Automatic alerts if battery needs to be
  - recharged
  - replaced

EVERYTHING IS SIMPLER!

Feature	*Bluetooth* Classic	*Bluetooth* low energy technology
Packet Types	5 mandatory 13 BR packet types 10 EDR packet types	1 packet structure 2 packet formats (Adv / Data)
LM/LL Control Messages	75 LMP messages	8 LL control messages
Protocols	9 (RFCOMM, BNEP, AVCTP, AVDTP, HCRP, TCSBIN, MCAP, OBEX, HID, SDP)	1 (Attribute)

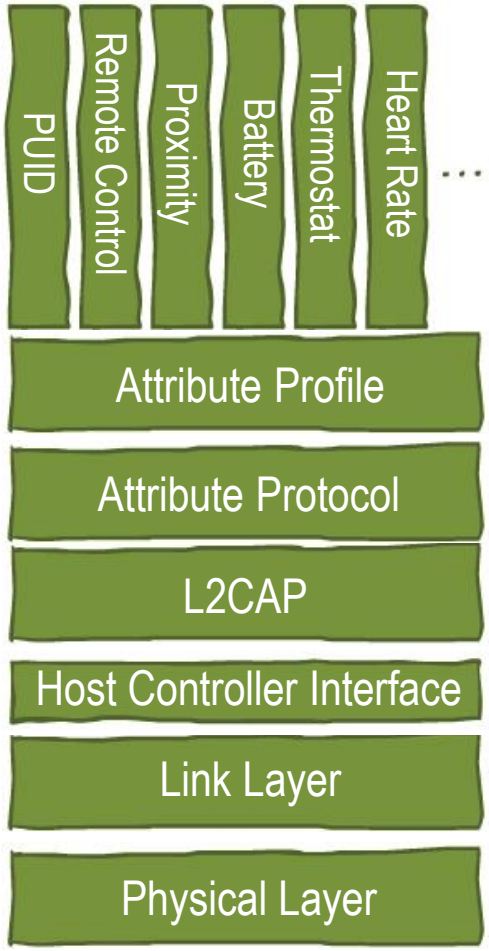
EVERYTHING IS DESIGNED FOR LOW POWER



BLUETOOTH LOW ENERGY TECHNOLOGY SYSTEM ARCHITECTURE

Layered Architecture:

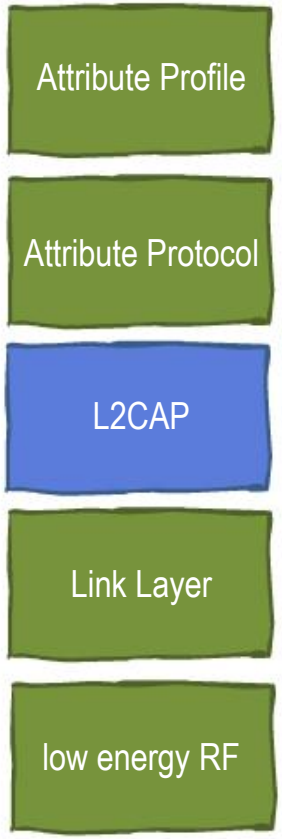
- Device Profiles – what can we do…
- Attribute Profile – how things are organized
- Attribute Protocol – protocol for accessing data
- L2CAP – multiplexor
- HCI – interface between Host and Controller
- Link Layer – packets and control
- Physical Layer – transmits/receives bits



BLUETOOTH SYSTEM ARCHITECTURE

Single Mode *Bluetooth* Classic

Single Mode *Bluetooth* low energy technology



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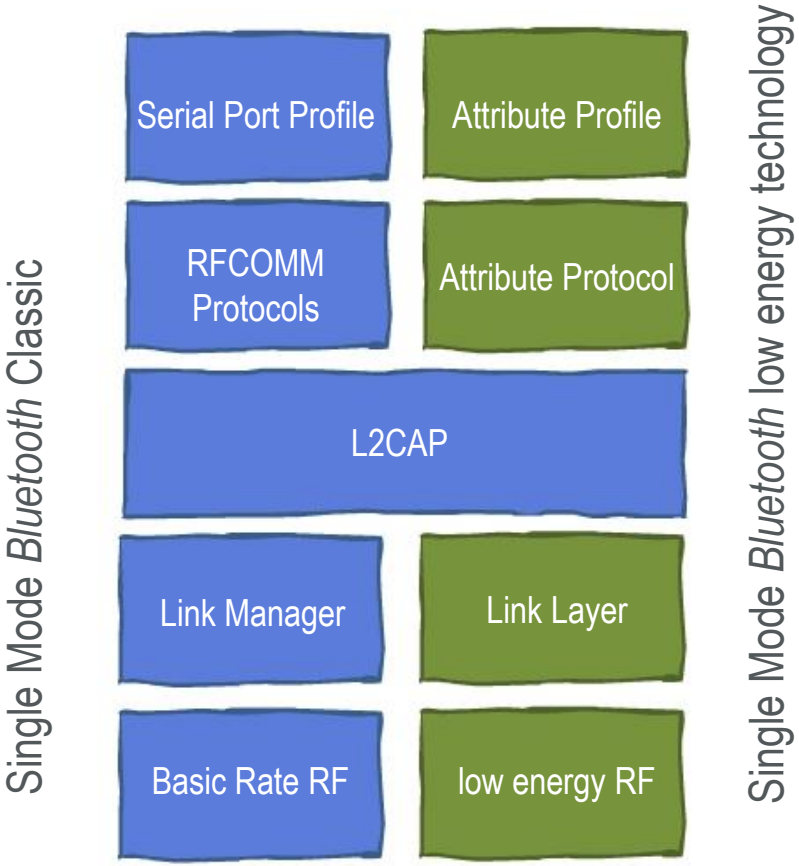

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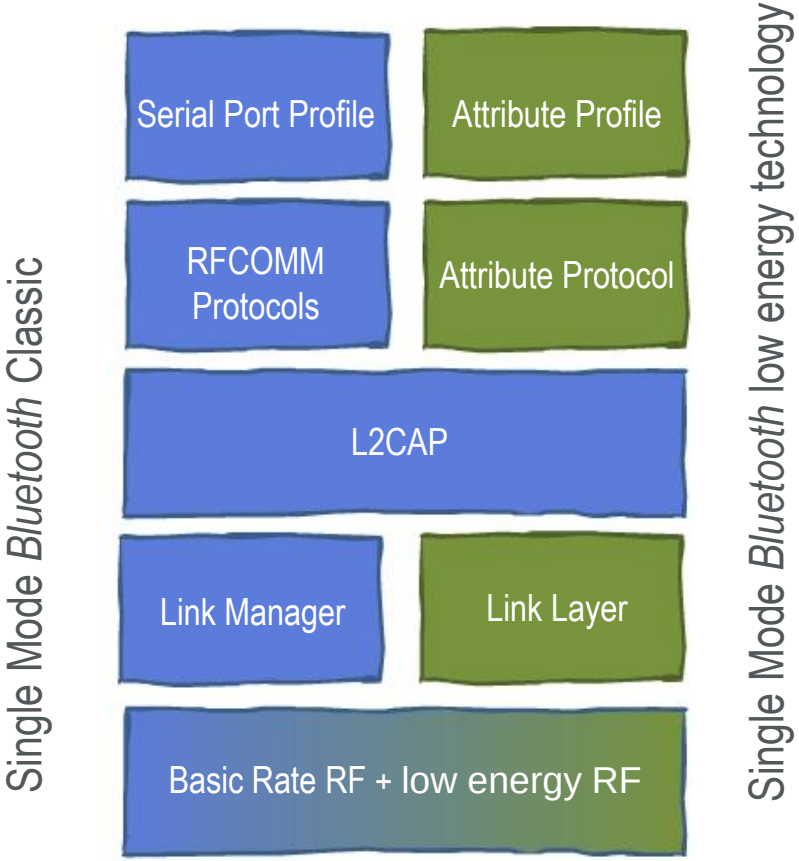

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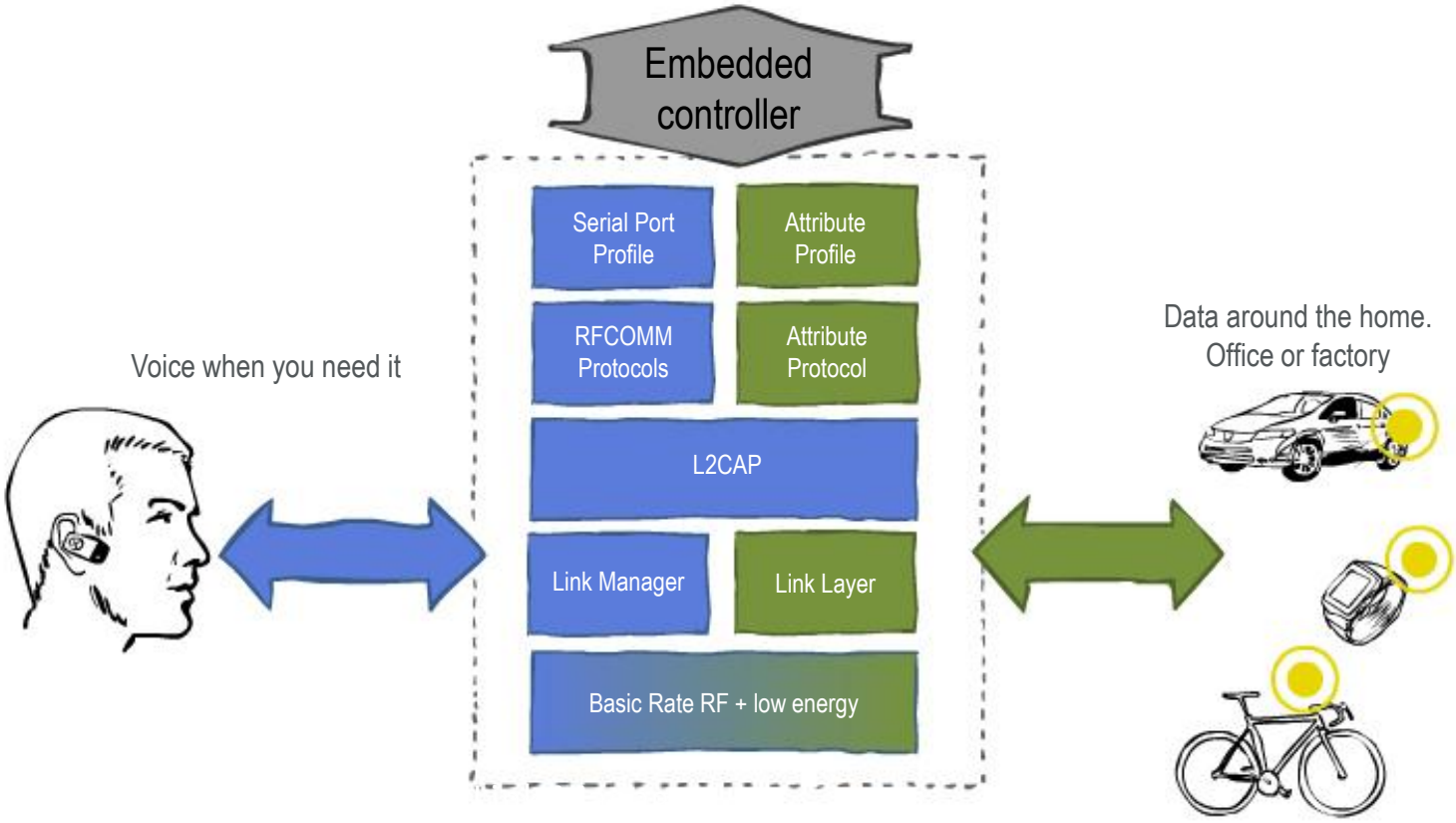

One dual-mode chip supports both applications

IN SUMMARY

- Low cost
- Lowest power
- Global *Bluetooth* standard
- Interoperable
- Robust

HOW WILL THEY WORK TOGETHER?

- *Bluetooth* low energy technology does not replace Classic *Bluetooth* technology, which offers a different range of functions

- However, effective 2010, most classic *Bluetooth* chips will be *dual mode*, securing a path for the rapid spread of low-energy applications

BLUETOOTH LOW ENERGY TECHNOLOGY ENABLES:

LOW ENERGY VS. CLASSIC *BLUETOOTH* TECHNOLOGY

Technical Specification	Classic *Bluetooth* technology	*Bluetooth* low energy technology
Radio frequency	2.4 GHz	2.4 GHz
Distance/Range	10 meters	50 meters
Over the air data rate	1 - 3 Mbps	1 Mbps
Application throughput	0.7 - 2.1 Mbps	0.2 Mbps
Nodes/Active slaves	7	Unlimited
Security	64b/128b and application layer user defined	128b AES and application layer user defined
Robustness	Adaptive fast frequency hopping, FEC, fast ACK	Adaptive fast frequency hopping
Latency (from a non connected state)		
Total time to send data (det. battery life)	100 ms	<3 ms
Government regulation	Worldwide	Worldwide
Certification body	Bluetooth SIG	Bluetooth SIG
Voice capable	Yes	No
Network topology	Scatternet	Star-bus
Power consumption	1 as the reference	0.01 to 0.5 (depending on use case)
Peak current consumption	<30 mA	<15 mA (max 15 mA to run on coin cell battery)
Service discovery	Yes	Yes
Profile concept	Yes	Yes
Primary use cases	Mobile phones, gaming, headsets, stereo audio streaming, automotive, PCs, etc.	Mobile phones, gaming, PCs, watches, sports & fitness, healthcare, automotive, Home electronics, automation, industrial, etc.