Revolutionizing the IoT with Bluetooth 5

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Bluetooth 5 is finally here!

- Timeline
  - Core Version 4.0 – 30.6.2010
  - Core Version 4.2 – 2.12.2014
  - *Core Version 5.0 – 6.12.2016*

- 20+ companies, 45+ people
- 2822 pages of specification
- 6 UnPlugFest events
- 12+ formal/informal IoP events

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- Great expectations
  - › **13.9 billion wireless products by 2020. 1/3 of those will be Bluetooth!**

Bluetooth 5 in brief

- What's so cool about it?

  - *"Setting the stage for the future"*
  - *"Is fast. Is expansive. Is connected."*
  - *"A global wireless standard for simple connectivity"*

  - *"2X Speed"*
  - *"4X Range"*
  - *"8X Broadcasting capacity"*
  - *"Improved inter-operability / coexistence"*

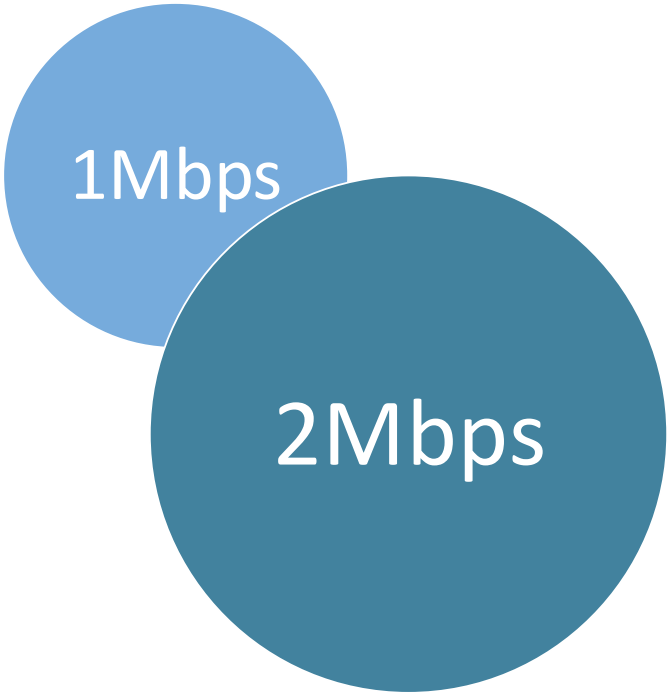
Exaggerating about the IoT revolution?

Today's talk

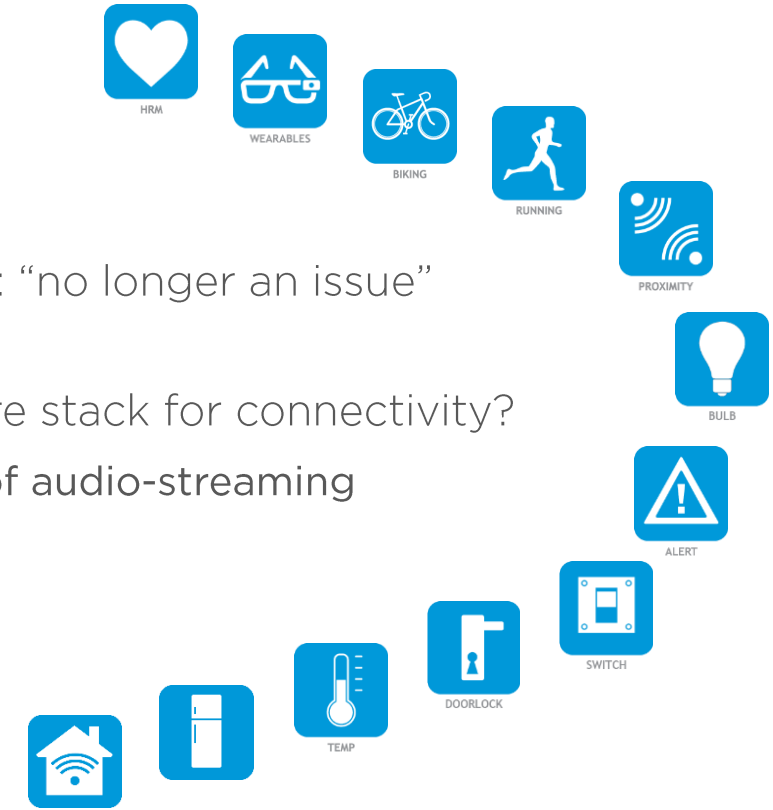
- A walk-through Bluetooth 5 enhancements

- Rethinking the IoT?

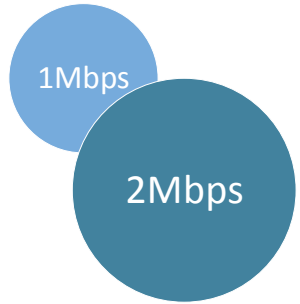
Into the numbers – Speed



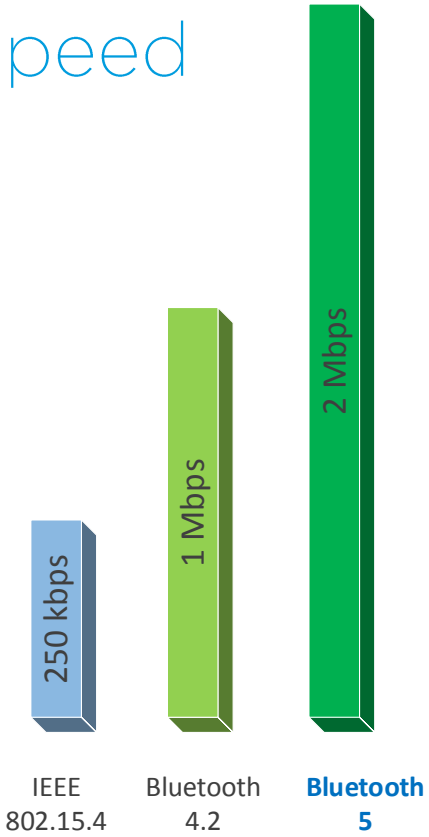
- Data Rate in IoT: “no longer an issue”
- A single software stack for connectivity?
  - The example of audio-streaming



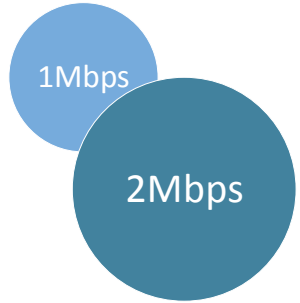
Into the numbers – Speed



- Positioning against IEEE 802.15.4:
  - A success story continues



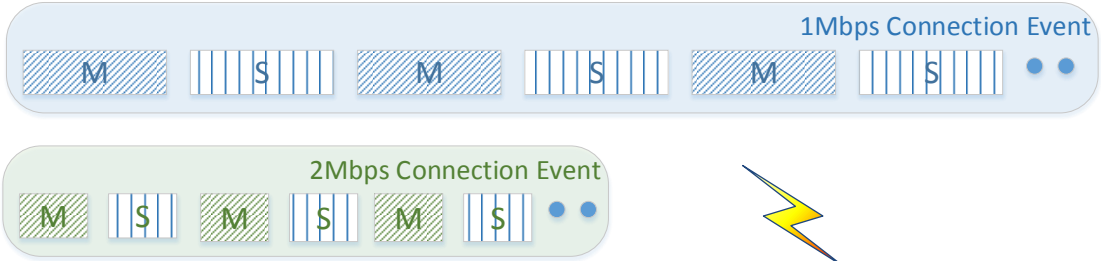
Into the numbers- Speed

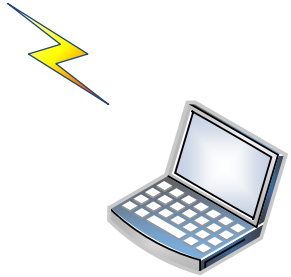


- Adaptive to:
  - Application traffic generation (e.g. traffic bursts)
  - Wireless environment
  - Seamless to the application

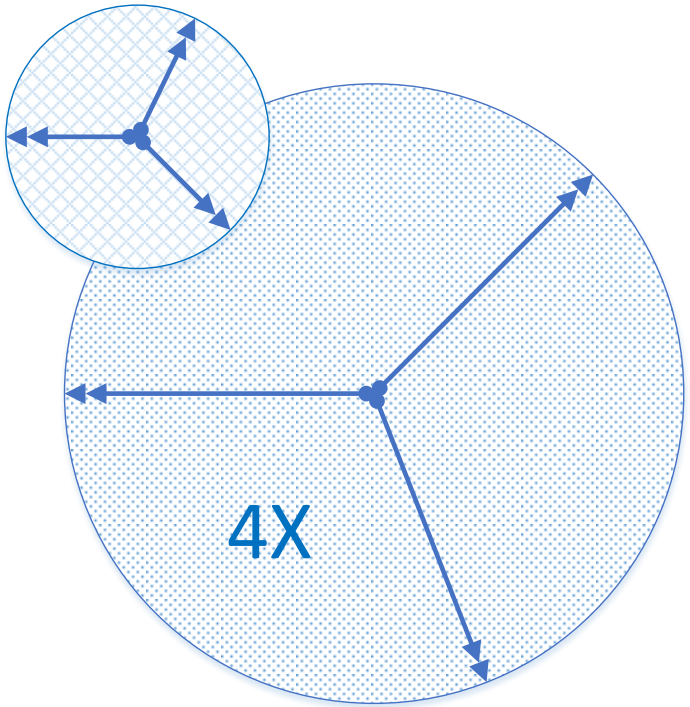
- Performance improvements
  - Energy consumption
  - Coexistence

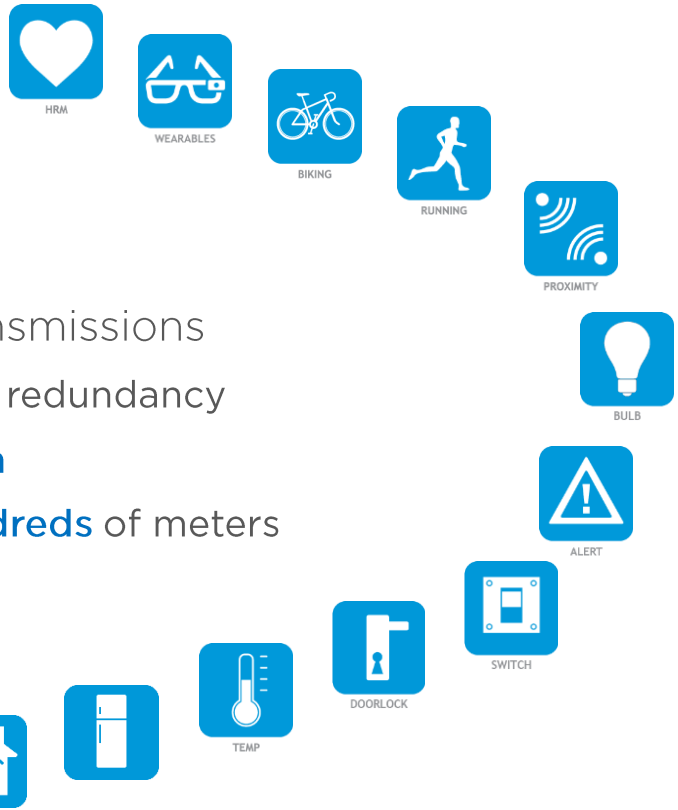
- Range compromise





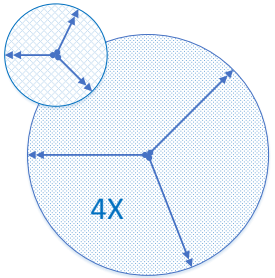
Into the numbers- Range

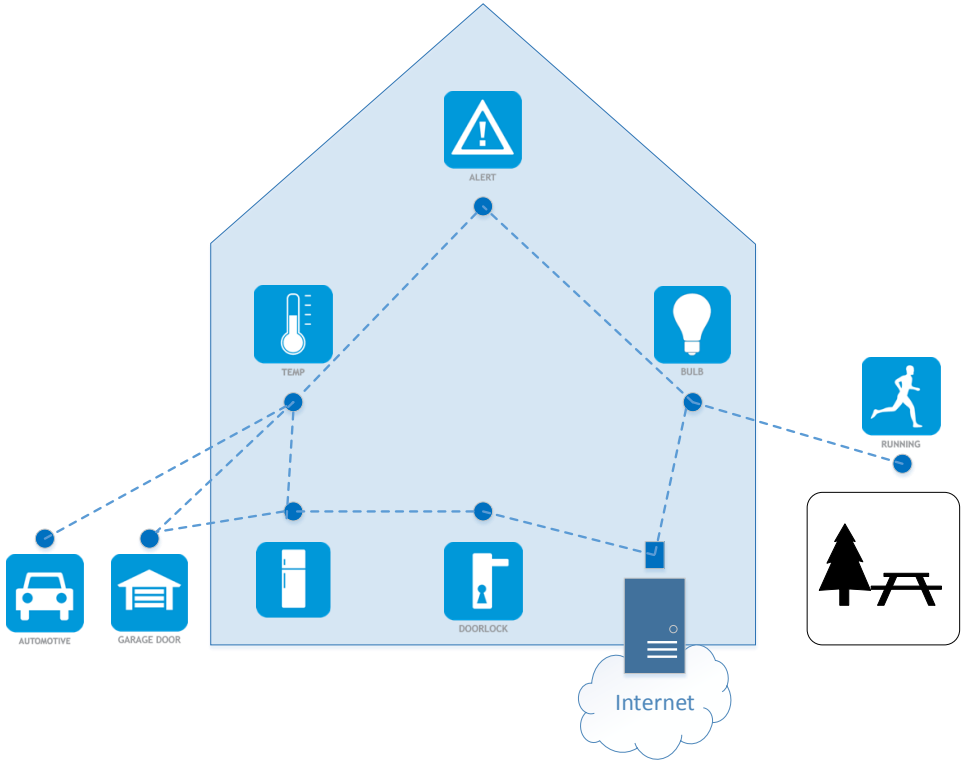




- Coded PHY transmissions
  - 2X and 8X FEC redundancy
  - Indoors: >100m
  - Outdoors: **hundreds** of meters

The use-case of Smart Home





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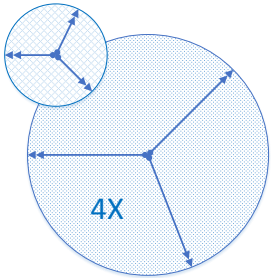
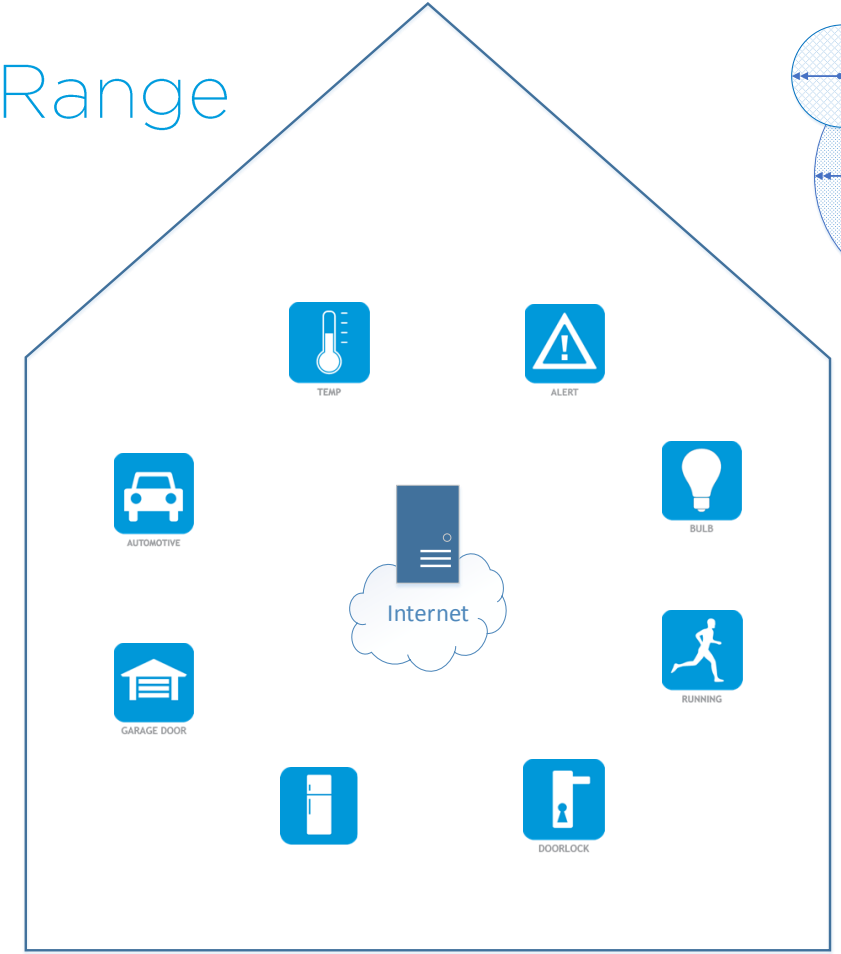


- Long Range Bluetooth simplifies:
  - IoT topologies
  - Deployment & maintenance
  - Data forwarding
- Technology at our hands



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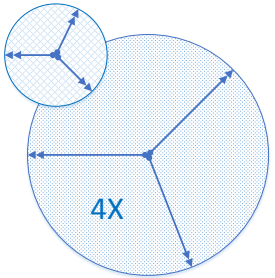
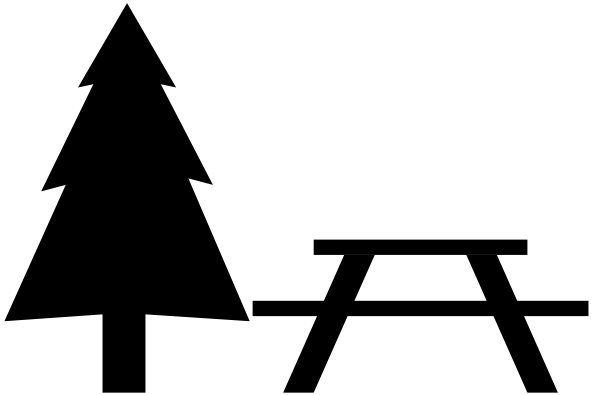


- Open air networking
- Mobility scenarios



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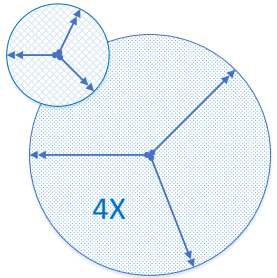
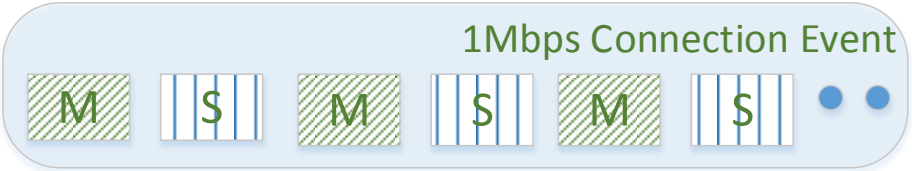
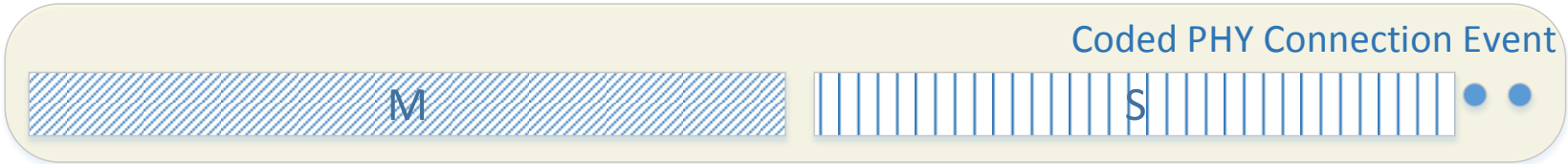


- Challenges are inevitable:
  - Interoperability
  - Coexistence
- Good for *not so much* traffic…





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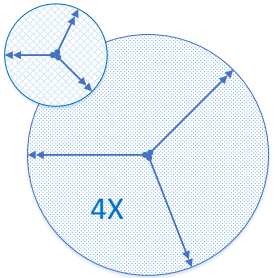
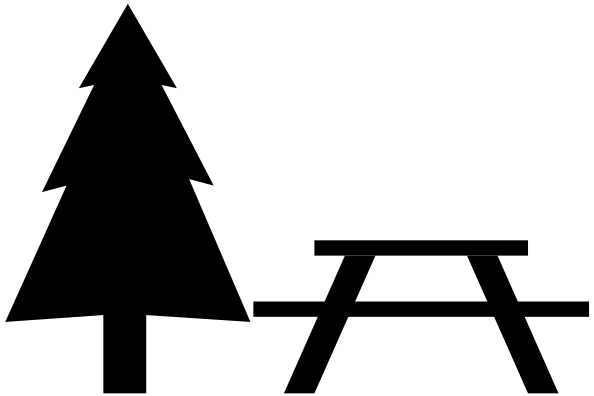
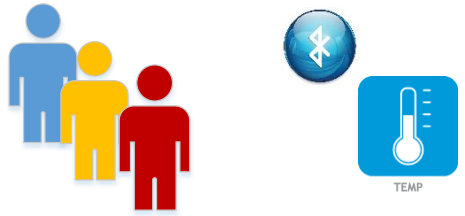


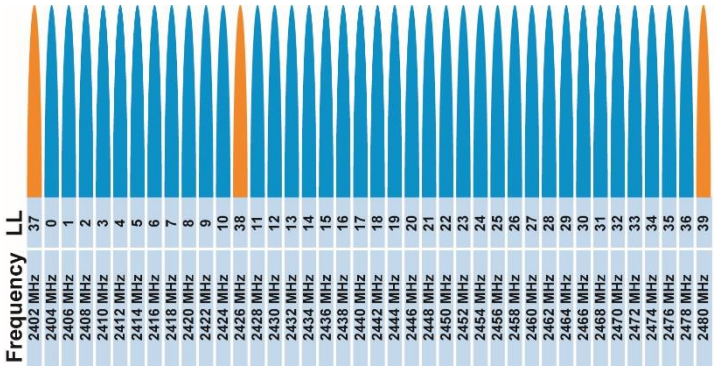
- But there **are** use-cases out there!



Into the numbers- Broadcasting

- Minimal connection-less broadcasting capabilities
  - Primarily a connection-based protocol
  - Power optimization was the ultimate priority
  - Minimal ”wasted” capacity for Device Discovery
  - Noise for Device Discovery needed to be kept low
    - 31 byte-long max advertising packet payload



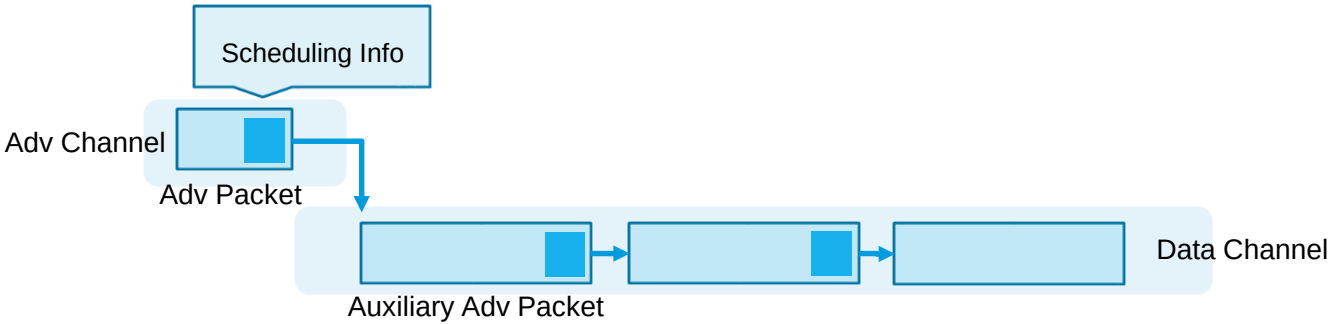


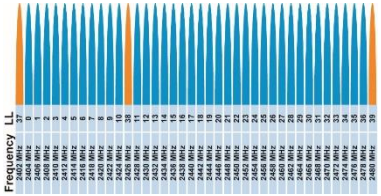
Enhanced broadcasting with Bluetooth 5

- Connection-less communication: now as important as connections
  - Broadcasters with higher amounts of data
  - Multi-cast communication is an essential part of IoT

- ”Advertising Extensions”
  - Long advertising packets (27 → 255 bytes)
  - Support for scheduling ”chained” (back-to-back) broadcast packets
  - Support for periodic advertising streams
  - Highly configurable broadcasting

Scaling-up broadcasting: challenge accepted!





- Offloading broadcast data – reducing noise – improving interoperability
- Expand broadcasting capacity
- Address the coexistence problem

Summary

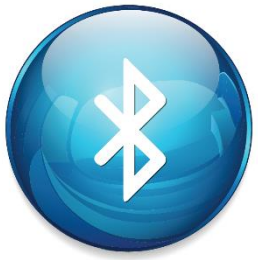
- Strong against competing technologies
- Flexibility & optimization (power consumption, throughput, topology)
- Efficient broadcasting made possible

Rethinking the IoT?

Joining the Bluetooth 5 train?

- Strong in Consumer Electronics
- Now ”powerfull enough” for bigger things

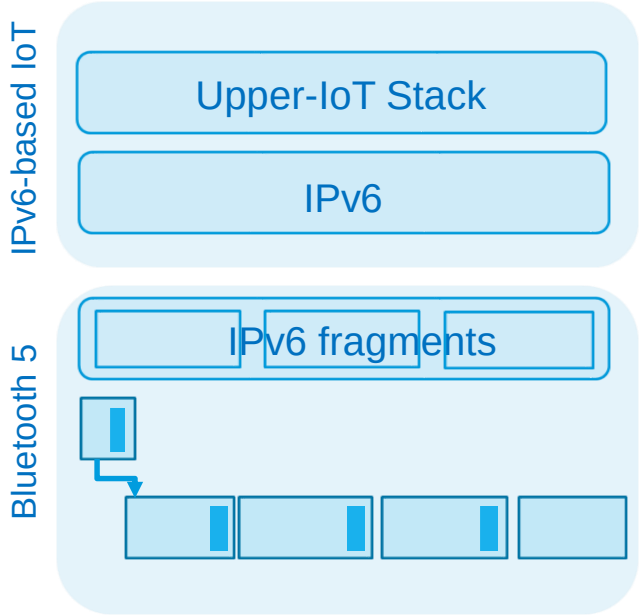
- Do we need other RF technologies in IoT?
- Competitors’ response?
- Other IoT ecosystems?



IEEE 802.15.4

Rethinking the IPv6-based IoT stack

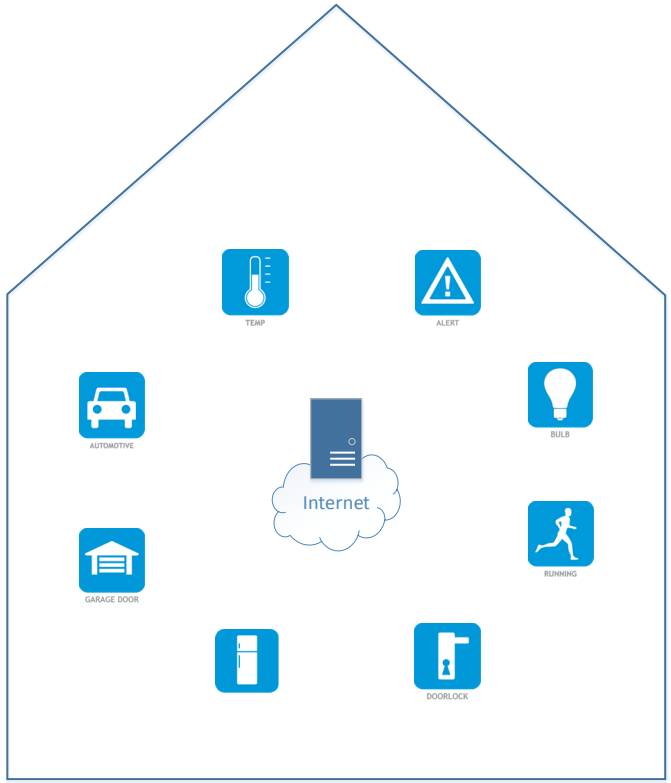
- IPv6 over IEEE 802.15.4: 6LoWPAN networks
  - Limited bandwidth and frame sizes
  - IPv6 datagram size reduction
  - Fragmentation
- IPv6 over Bluetooth 5: a "transparent" option?
  - 2Mbps, 255 byte-long frames, chained packets
  - Interference and coexistence mitigation
  - Native fragmentation support
  - A "farewell" to intra-mesh routing?



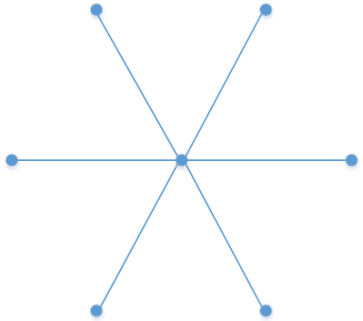
To mesh or not to mesh?

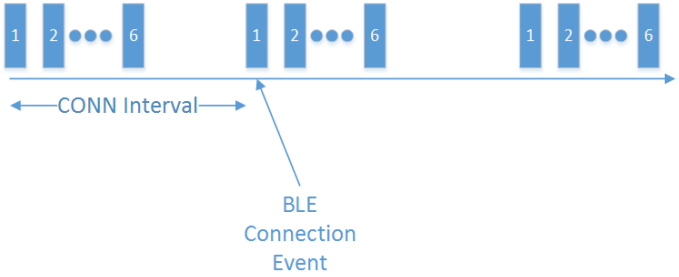
- IoT networks with wide physical network area, but
  - Low traffic generation
  - Low-end devices
  - Required to be ”always” connected
  - But also ”almost-always” sleepy
  - Can benefit from Long Range vs. multi-hop mesh

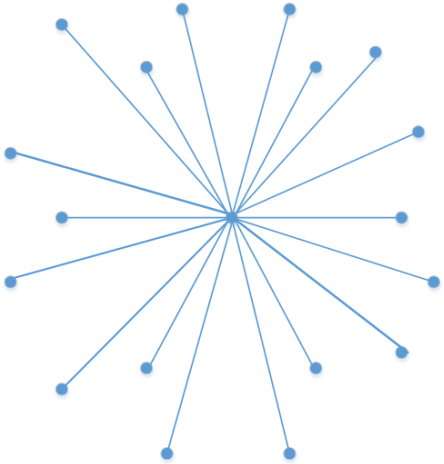
- Can these networks scale-up?



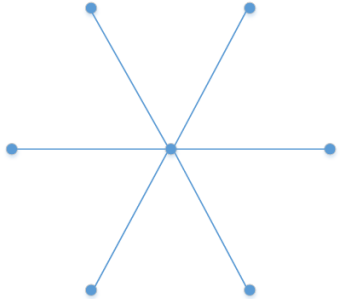
Scaling up Long Range Star IoT?



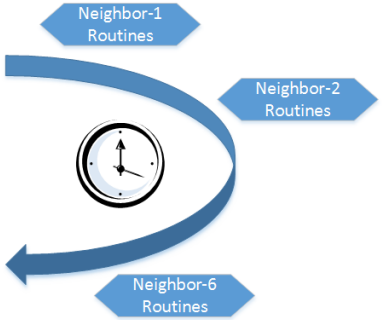


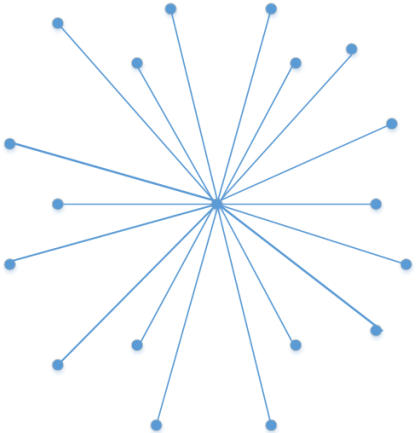


Scaling up Long Range Star IoT?

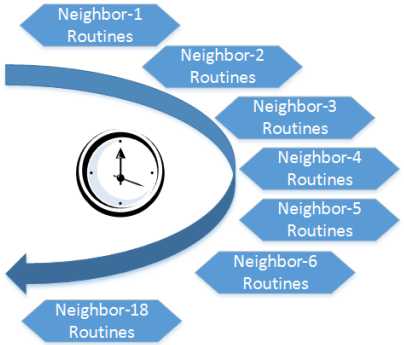


Neighbor 6
...
Neighbor 2
Neighbor 1





Neighbor 18
....
Neighbor 7
Neighbor 6
Neighbor 5
Neighbor 4
Neighbor 3
Neighbor 2
Neighbor 1



To mesh or not to mesh?

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Large-scale IoT networks with wide physical network area, and

- High traffic generation
- High node density
- Both low-end, and powerful devices
- Multiple gateway points
- Will not benefit from Long Range Bluetooth!

RPL-based Networks

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A Bluetooth Mesh Solution?

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