

SENSOR NETWORKS

Java

EMBEDDED

The following is intended to outline our general product direction. It is intended for information purposes only, and may not be incorporated into any contract. It is not a commitment to deliver any material, code, or functionality, and should not be relied upon in making purchasing decisions. The development, release, and timing of any features or functionality described for Oracle's products remains at the sole discretion of Oracle.

# ABOUT ME.

ORACLE®



Gerrit Grunwald | Java Technology Evangelist

Founder of JUG Münster  
JavaFX & IoT community Co-Lead  
Java Champion



JAVA ONE

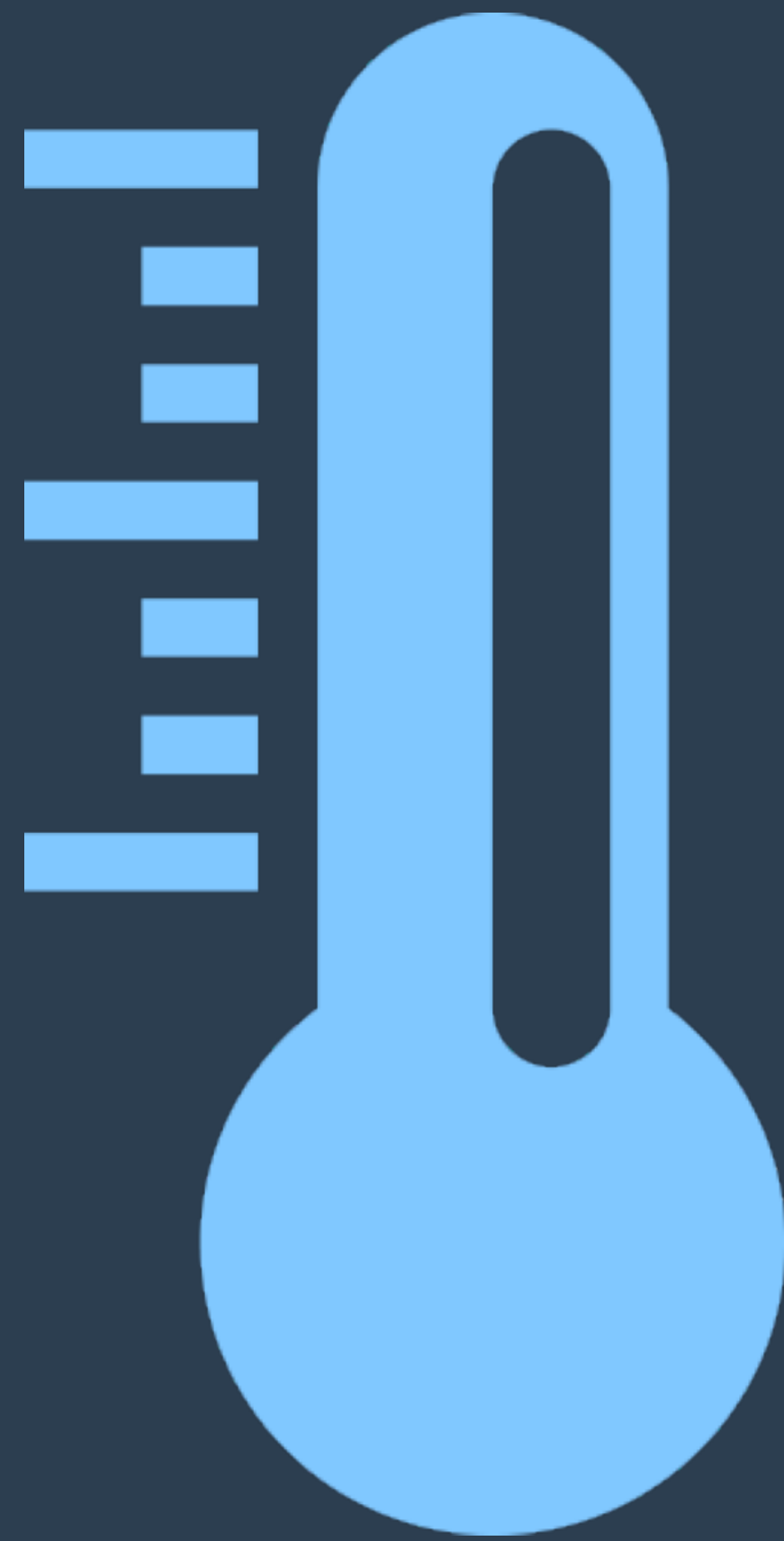
2013











# MONITORING

# QUESTIONS



HOWWTO

MONITOR?

WHERE TO

STORE ?

HOWWTO

VISUALIZE ?

EMBEDDED

ONLY?

JAWA

ONLY?



1

MONITOR 9 ROOMS

2

STORE DATA

3

VISUALIZE ON RASPBERRY PI

4

OTHER CLIENTS

MONITOR

9 ROOMS

HOW TO ?

SENSOR

NETWORK

# SENSOR NETWORK

- Built of sensor nodes
- Different network topologies
- Small and wide range networks possible
- Data is passed to a coordinator node
- Sensor nodes running on batteries

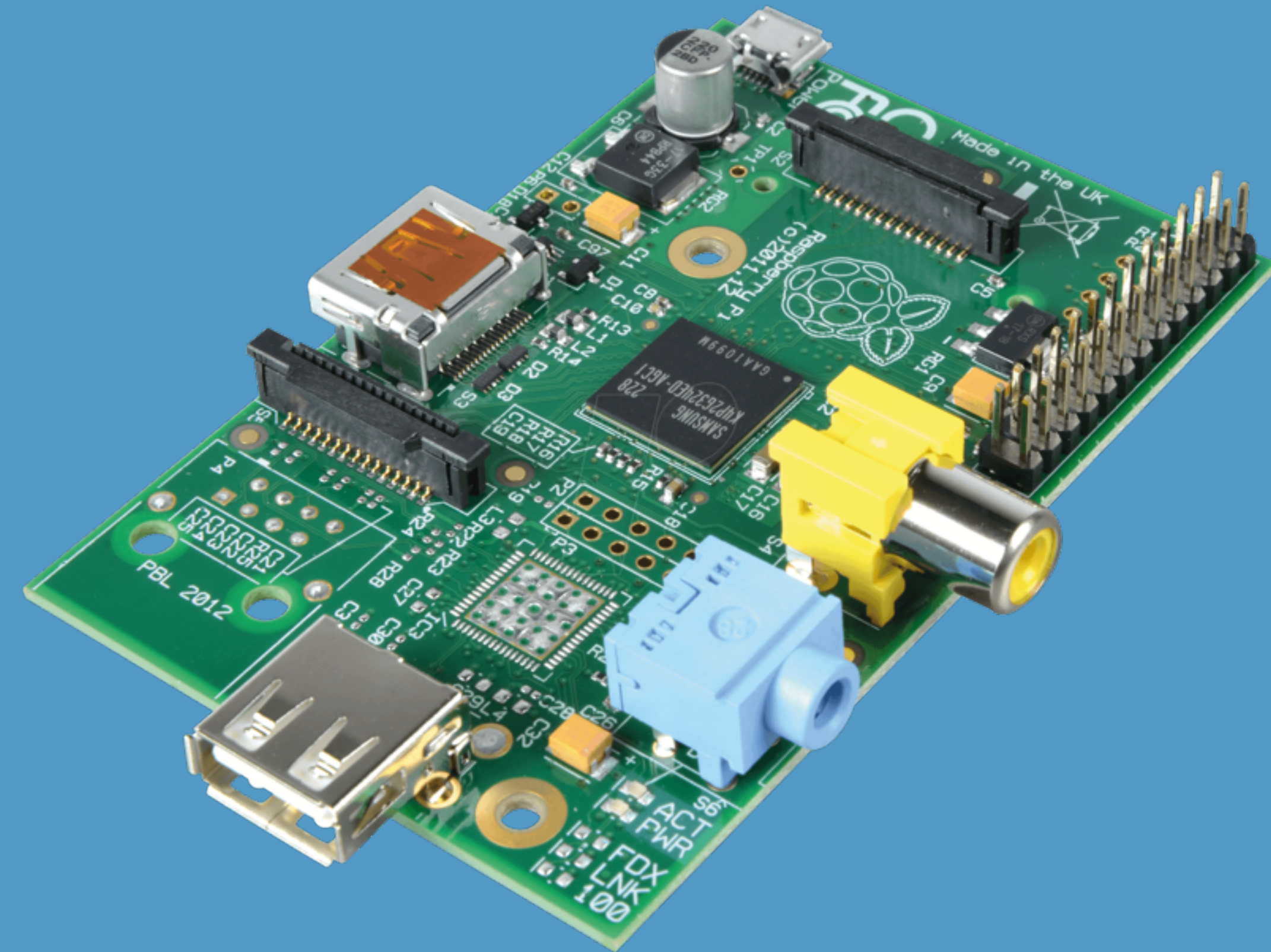


POSSIBLE

SENSOR NODES

# RASPBERRY PI

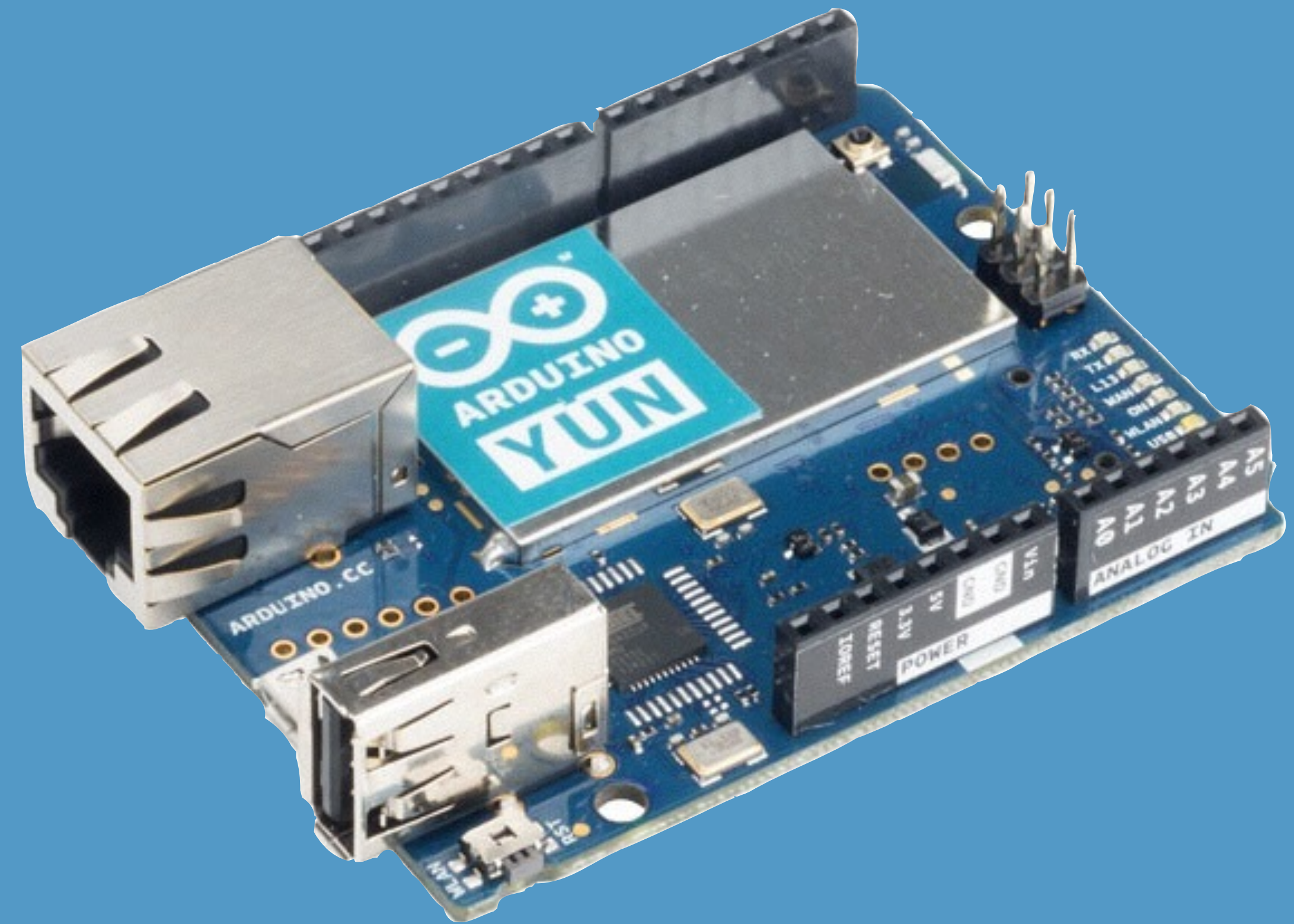
- Needs Power Supply
- 300 - 600 mA
- Form Factor
- Limited I/O
- Overkill





# ARDUINO YUN

- Needs Power Supply\*
- 250 - 300 mA
- Pricy
- A bit Overkill

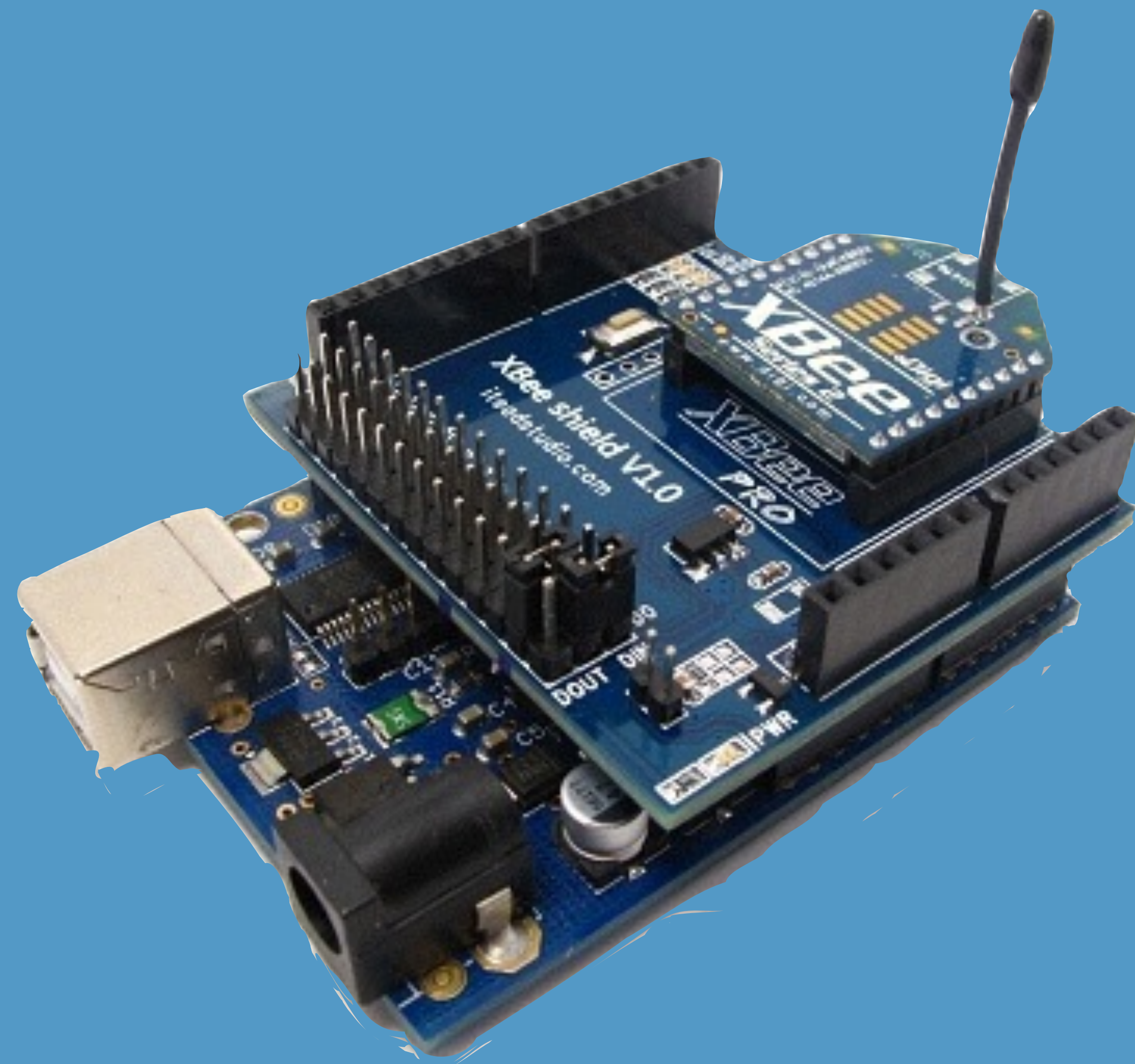


\* batteries only last for couple of days



# ARDUINO + XBEE

- Power Supply\*
- 75 - 140 mA
- Form Factor
- A bit Overkill

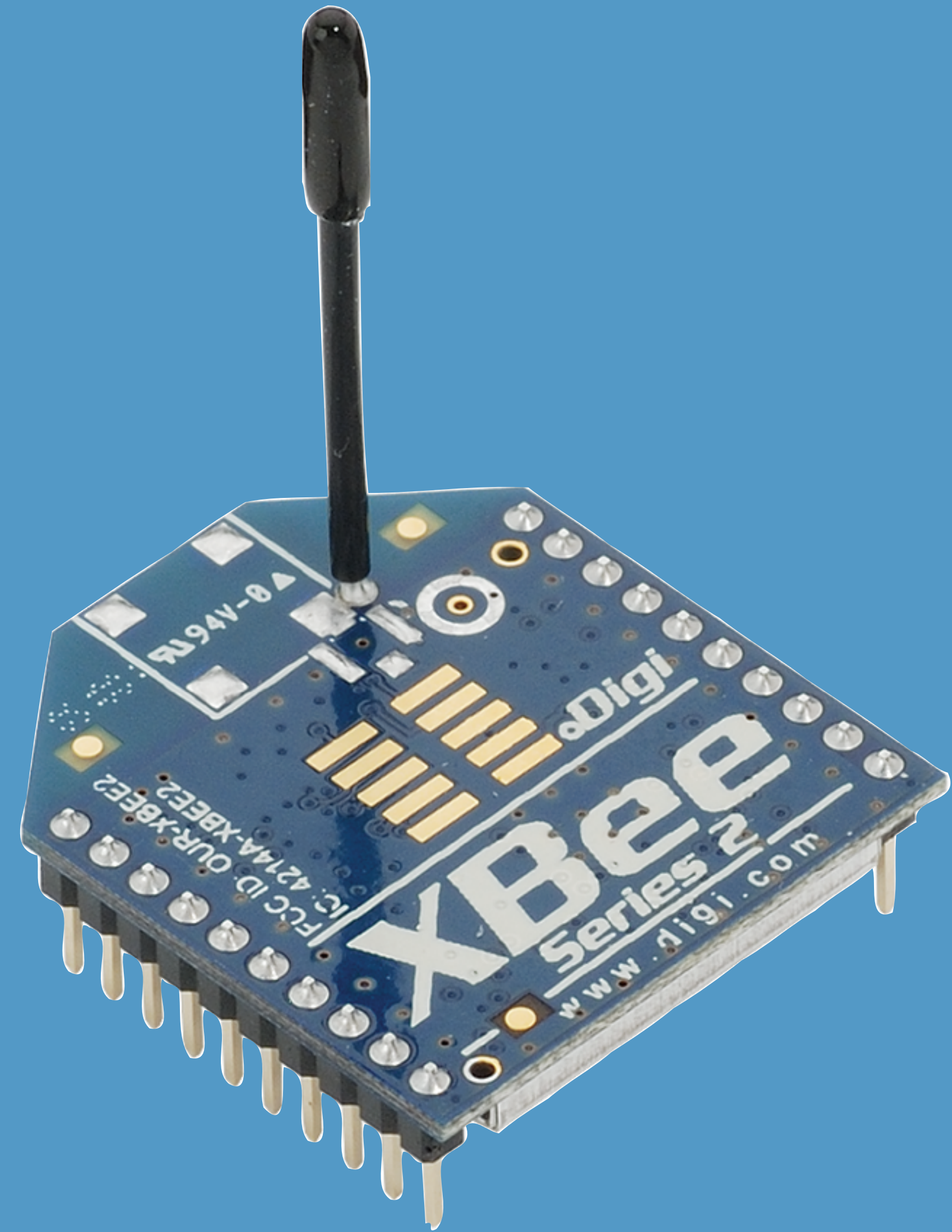


\* batteries only last for couple of days



# XBEE

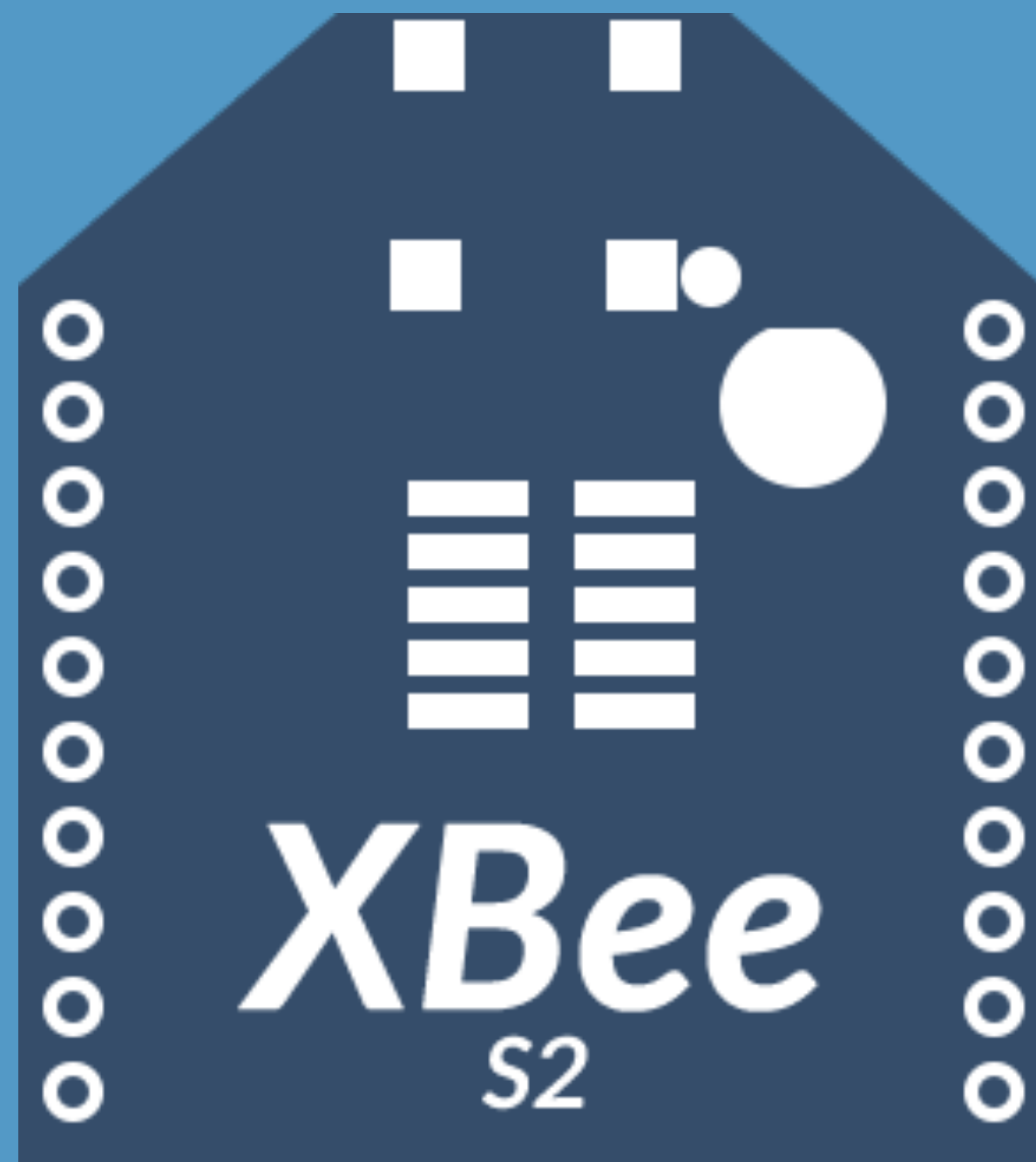
- Runs on batteries
- 45 - 90 mA
- Very small
- Cheap





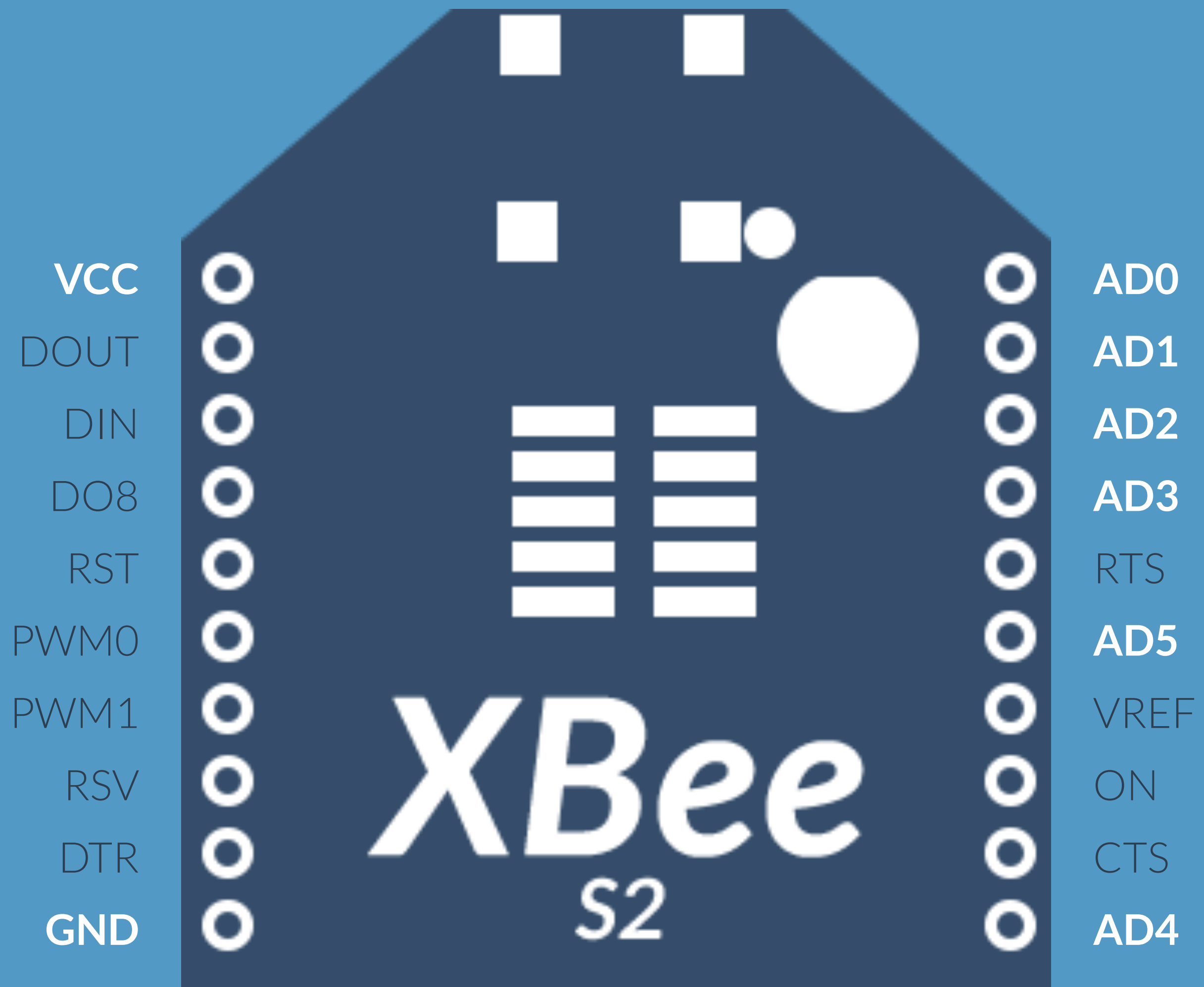
XBEE E

# XBEE

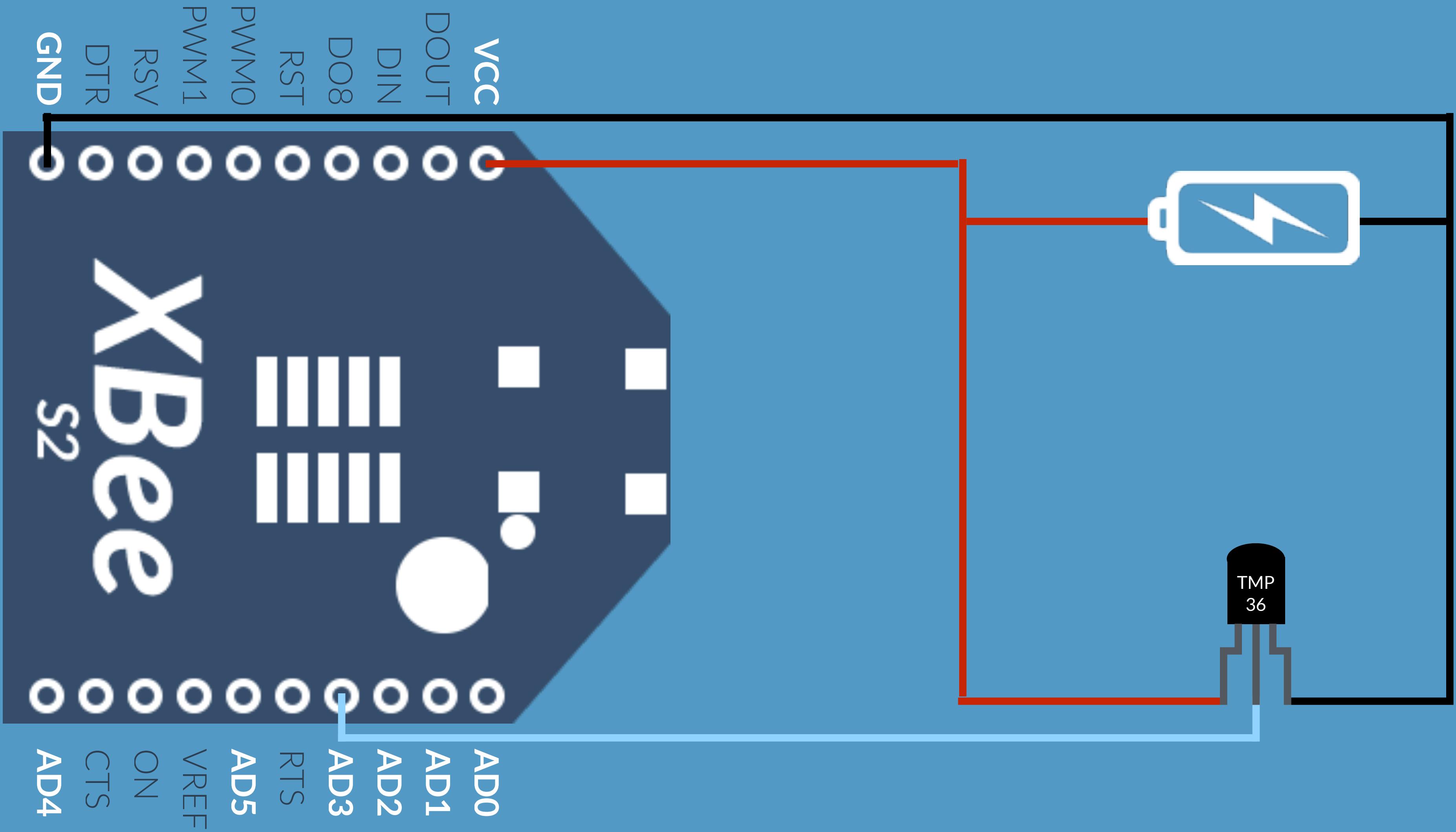


- 2.4 GHz at 2mW
- Indoor range up to 40m
- Outdoor range up to 120m
- 2.8 - 3.6 Volt
- -40 - 85°C operation temperature
- Tree, Star and Mesh support
- Programmable via AT cmd
- Wake-up time ~30ms
- ZigBee standard (IEEE 802.15.4)

# XBEE



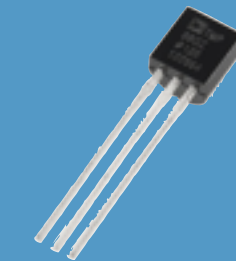
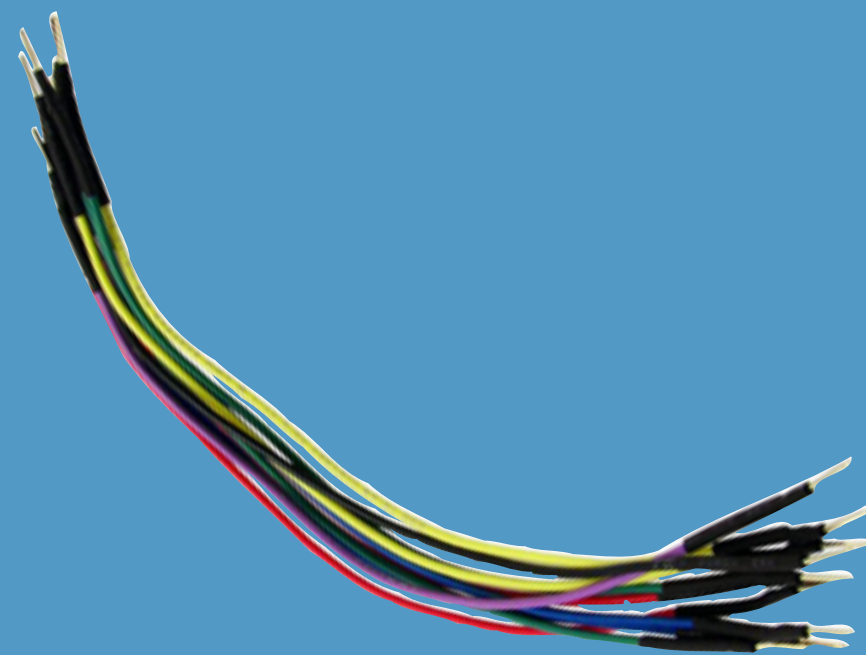
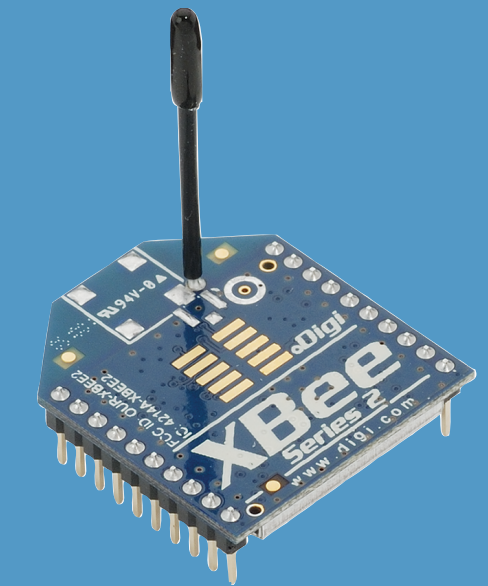
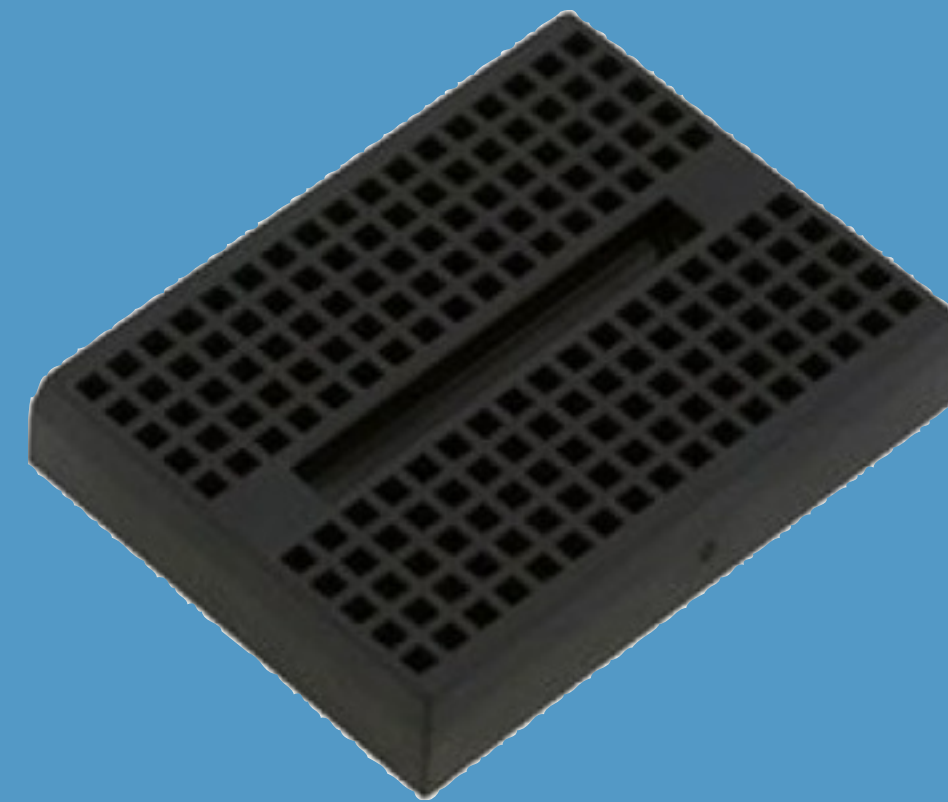
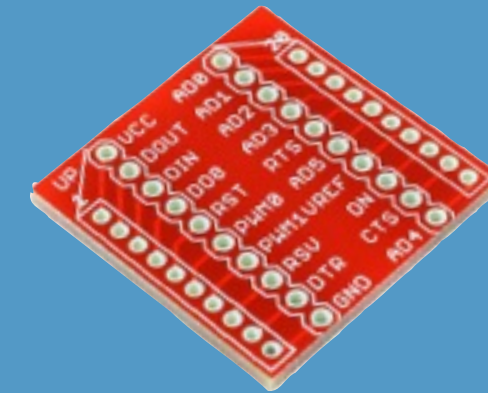
# XBEE SETUP







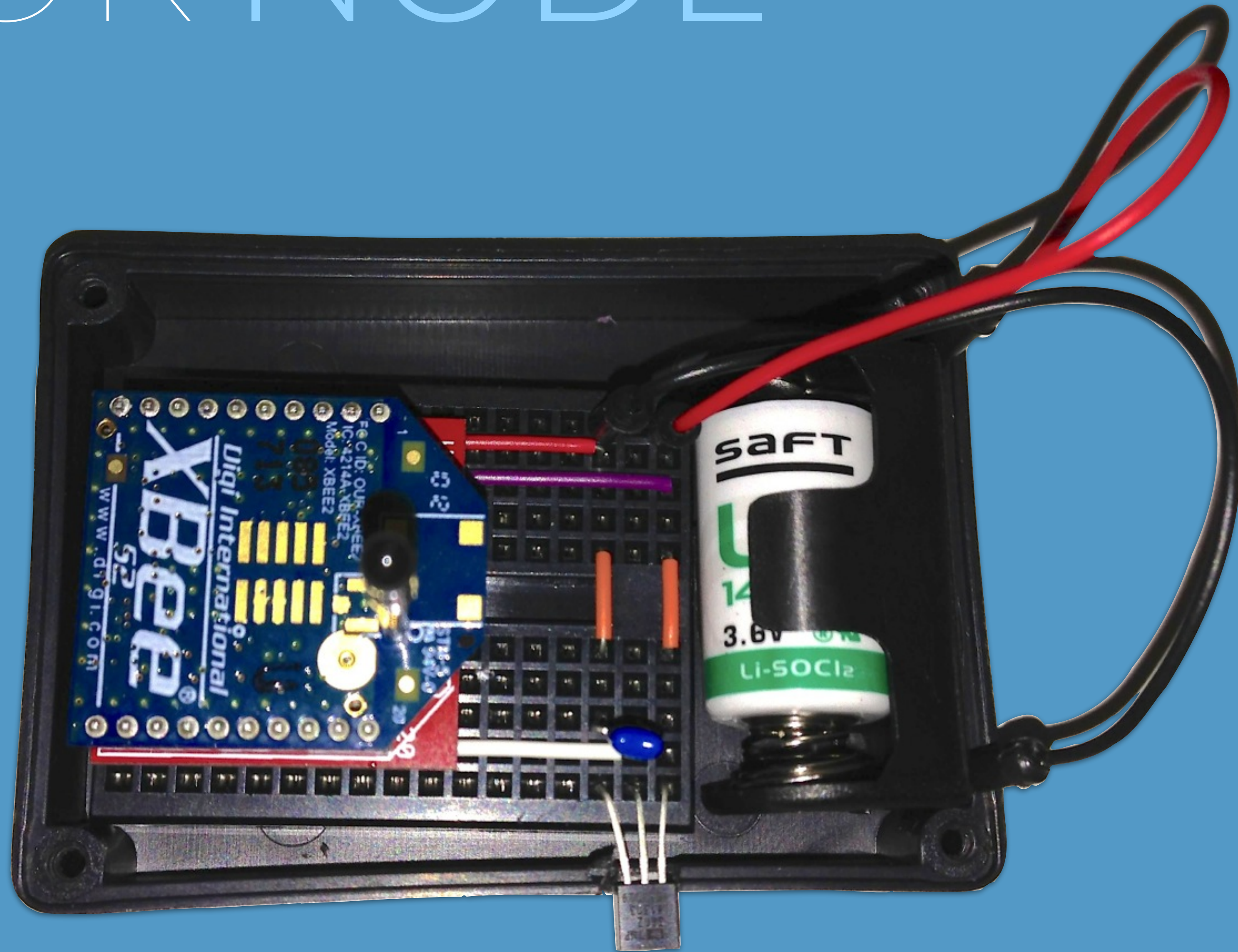
# SENSOR NODE





# SENSOR NODE

5 cm



SENSOR NODE

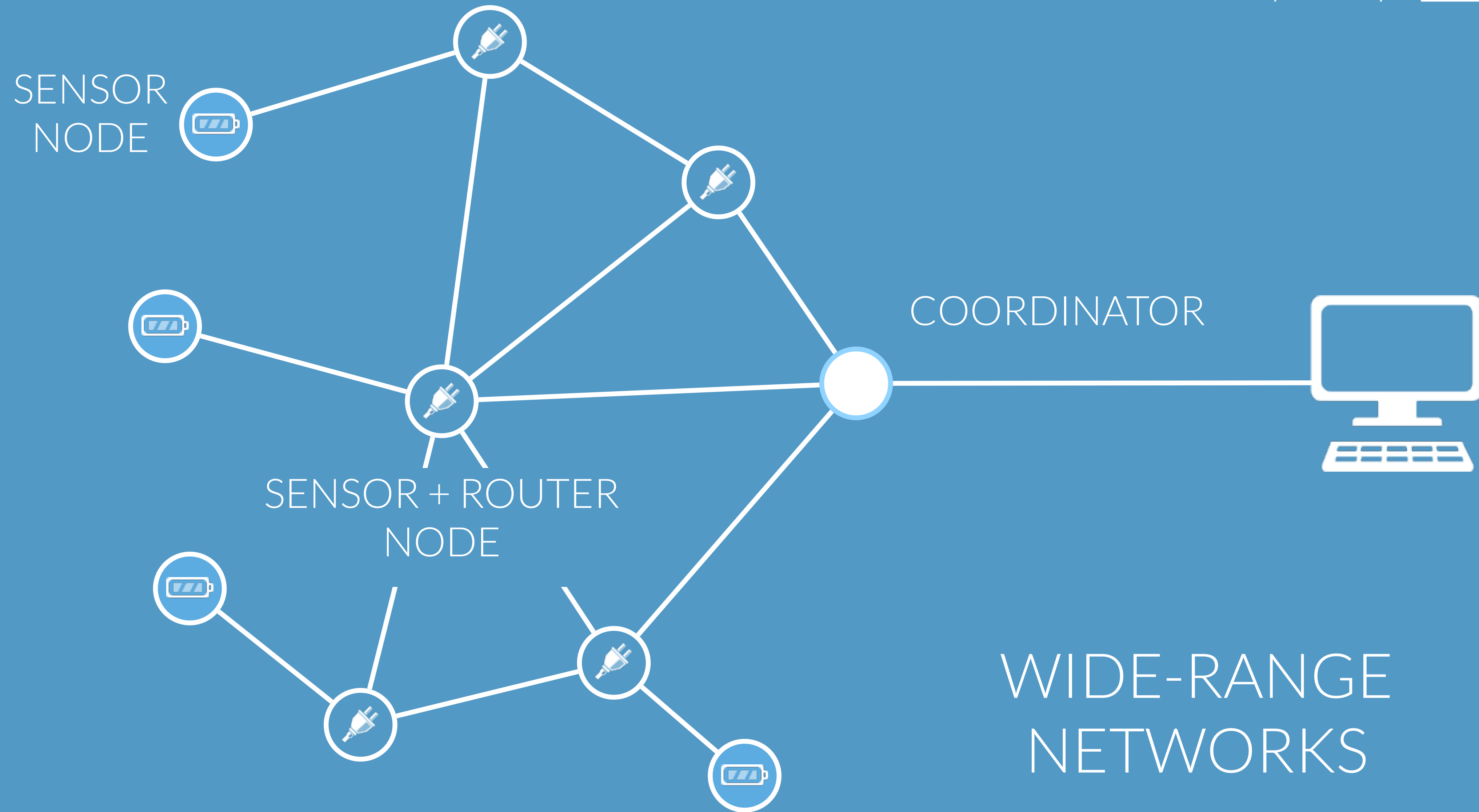
35 €

POSSIBLE NETWORK

# TOPOLOGIES



# MESH





# MESH TOPOLOGY

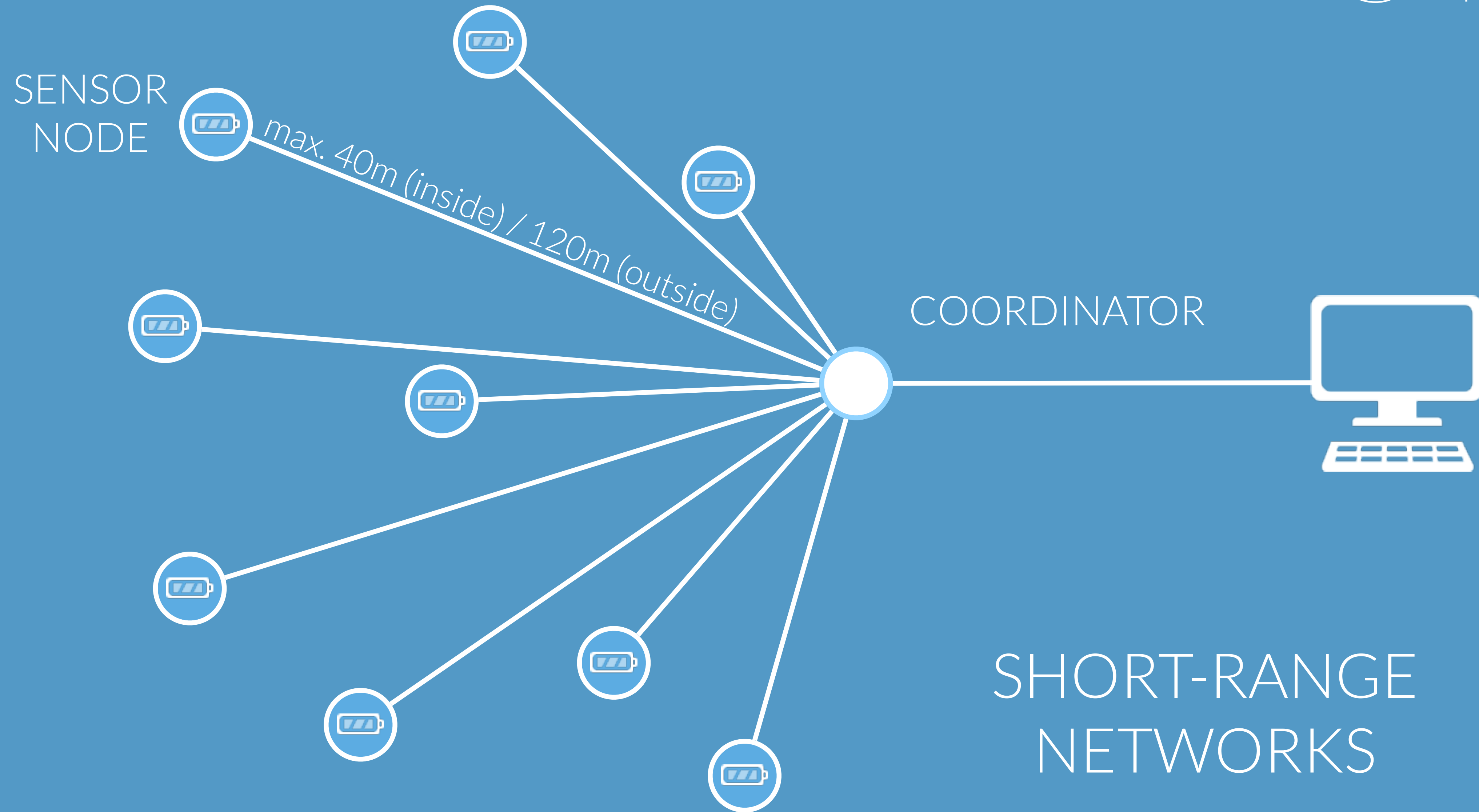


- Self healing
- Wide range
- Alternative routes



- Broadcast
- Complex setup
- Higher power consumption

# STAR



SHORT-RANGE NETWORKS

# STAR TOPOLOGY

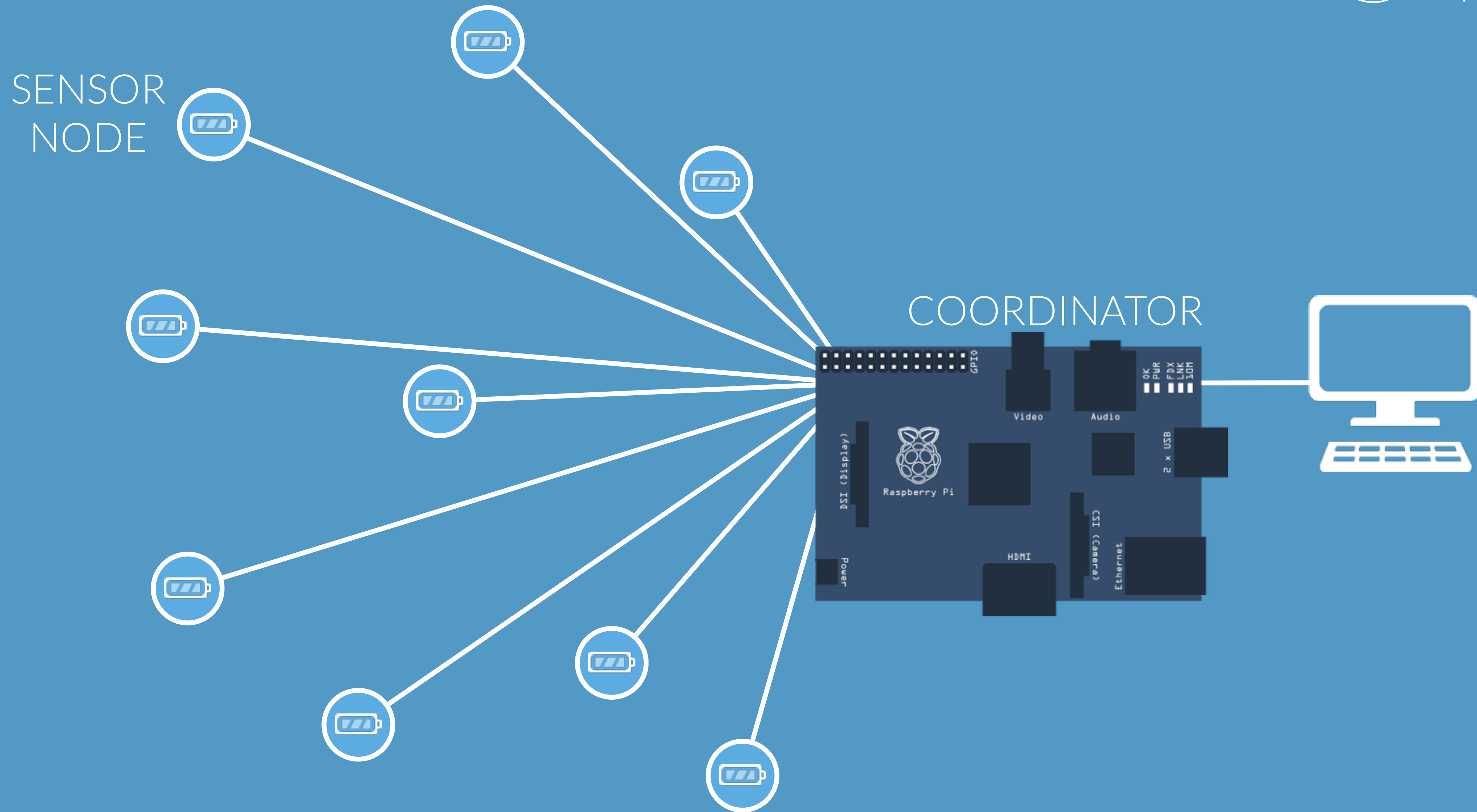


- Easy setup
- Low power consumption
- Easier to maintain

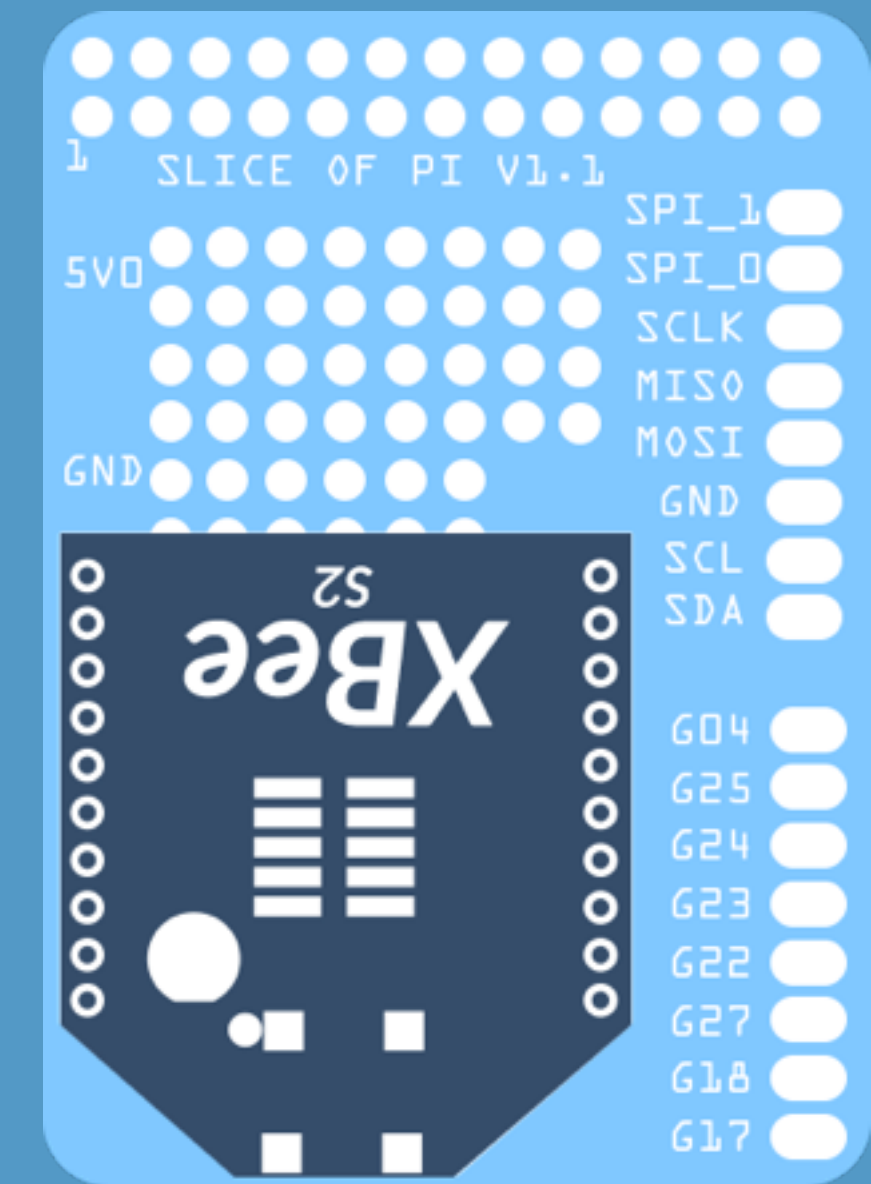
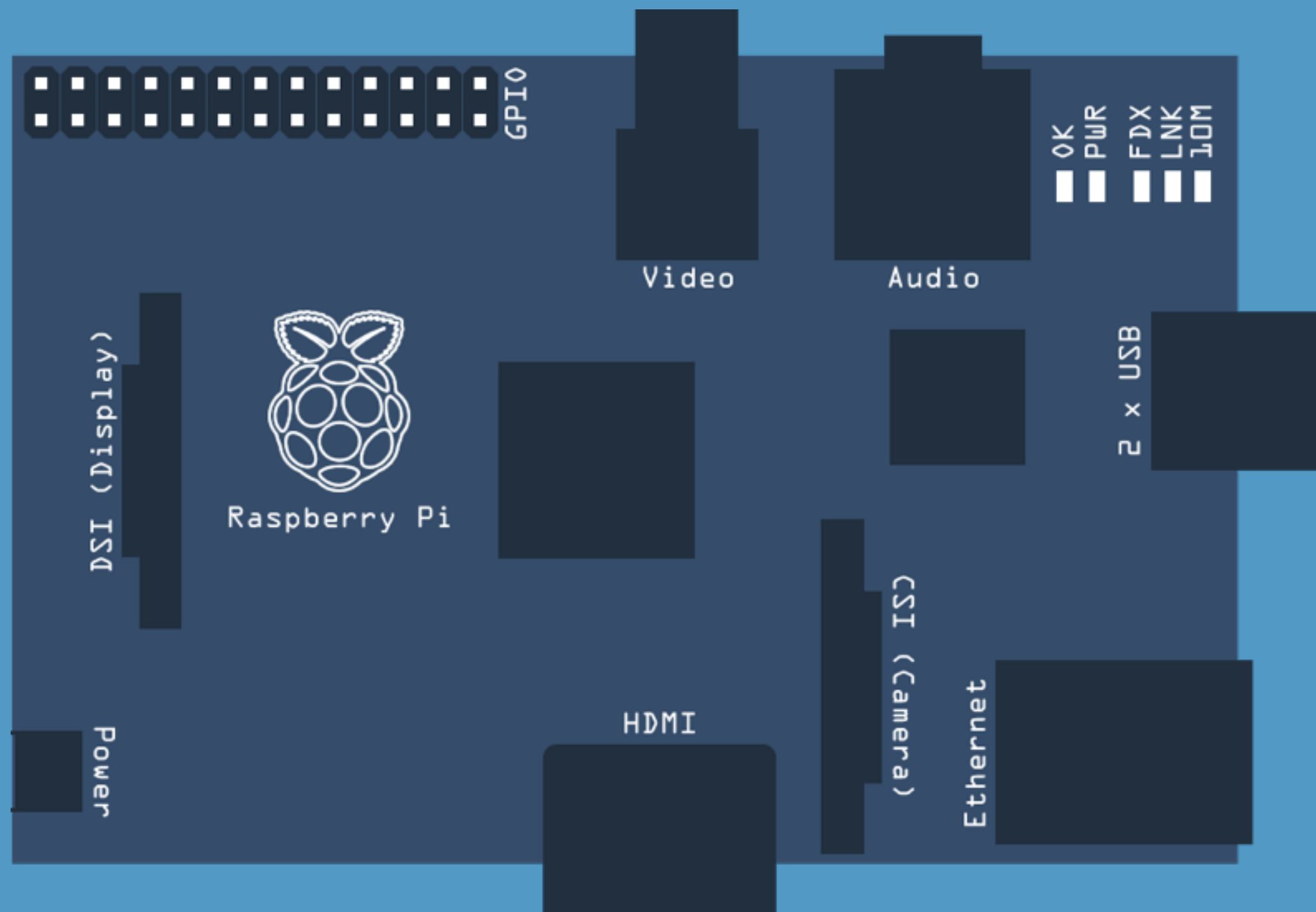


- Short range
- Coordinator is bottleneck
- No Interaction between nodes

# STAR



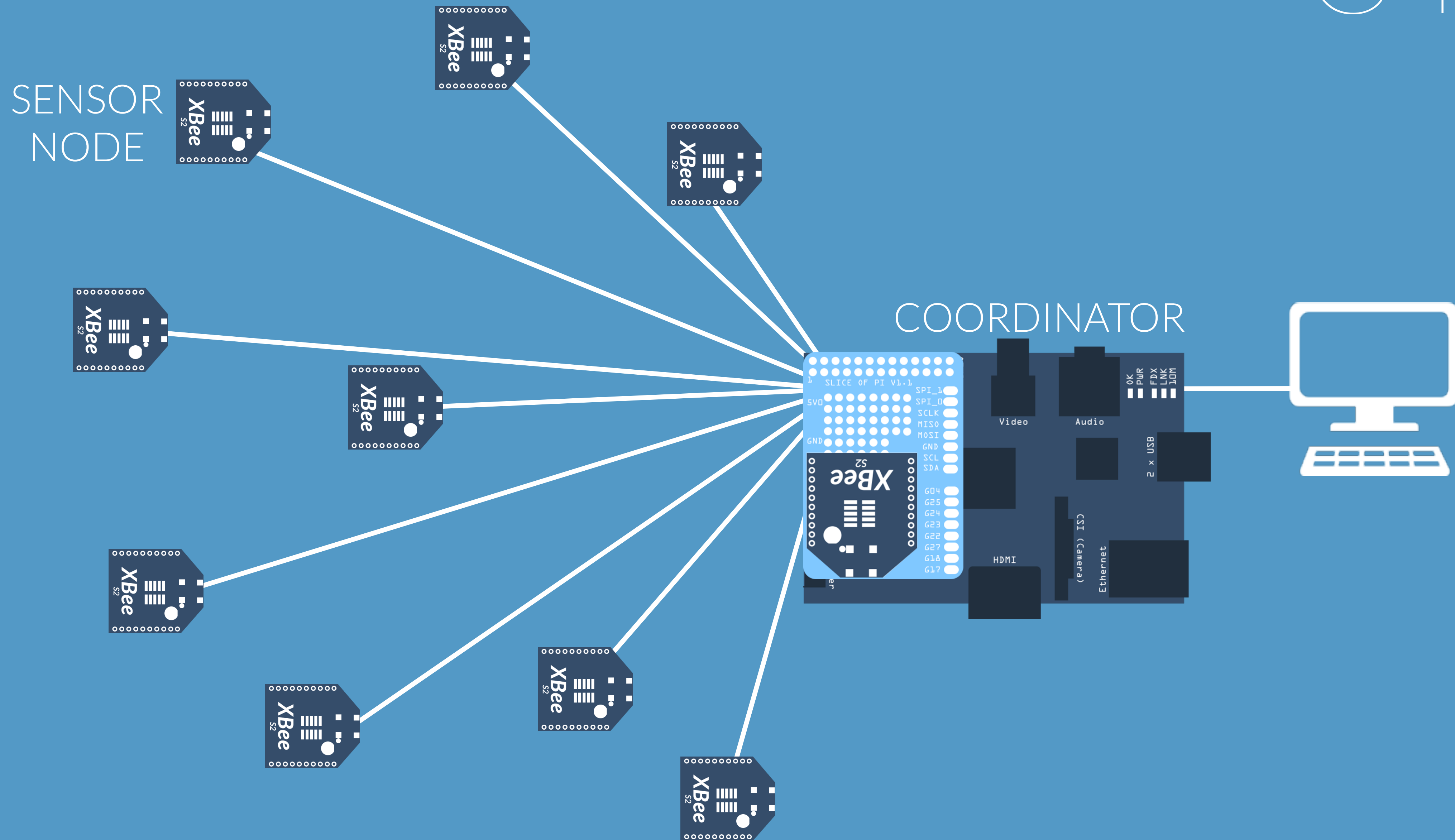
# COORDINATOR



Slice of Pi



# STAR



# RASPBERRYPI SETUP

- Debian Wheezy Linux hard float
- JDK 8 for ARM
- Slice of Pi add on board
- XBee Series 2 (configured as coordinator)
- Access Xbee using Java xbee-api

# RASPBERRYPI SETUP

- Store every 5 minutes to database
- Publish live Xbee data via MQTT
- Push notifications to mobile clients every hour
- Tweet Xbee data every hour
- Populate Xbee data via XMPP on demand



# CONCLUSION

- Xbee based Sensor network is a perfect fit
- Raspberry Pi works nicely as a Gateway
- Java 8 works great on the Raspberry Pi



1

MONITOR 9 ROOMS



2

STORE DATA

3

VISUALIZE ON RASPBERRY PI

4

OTHER CLIENTS

STORE

DATA

# STORE DATA

- Which database ?
- Which hardware ?
- Where to store the data ?

WHICH

DATABASE ?

MONGGO

DB



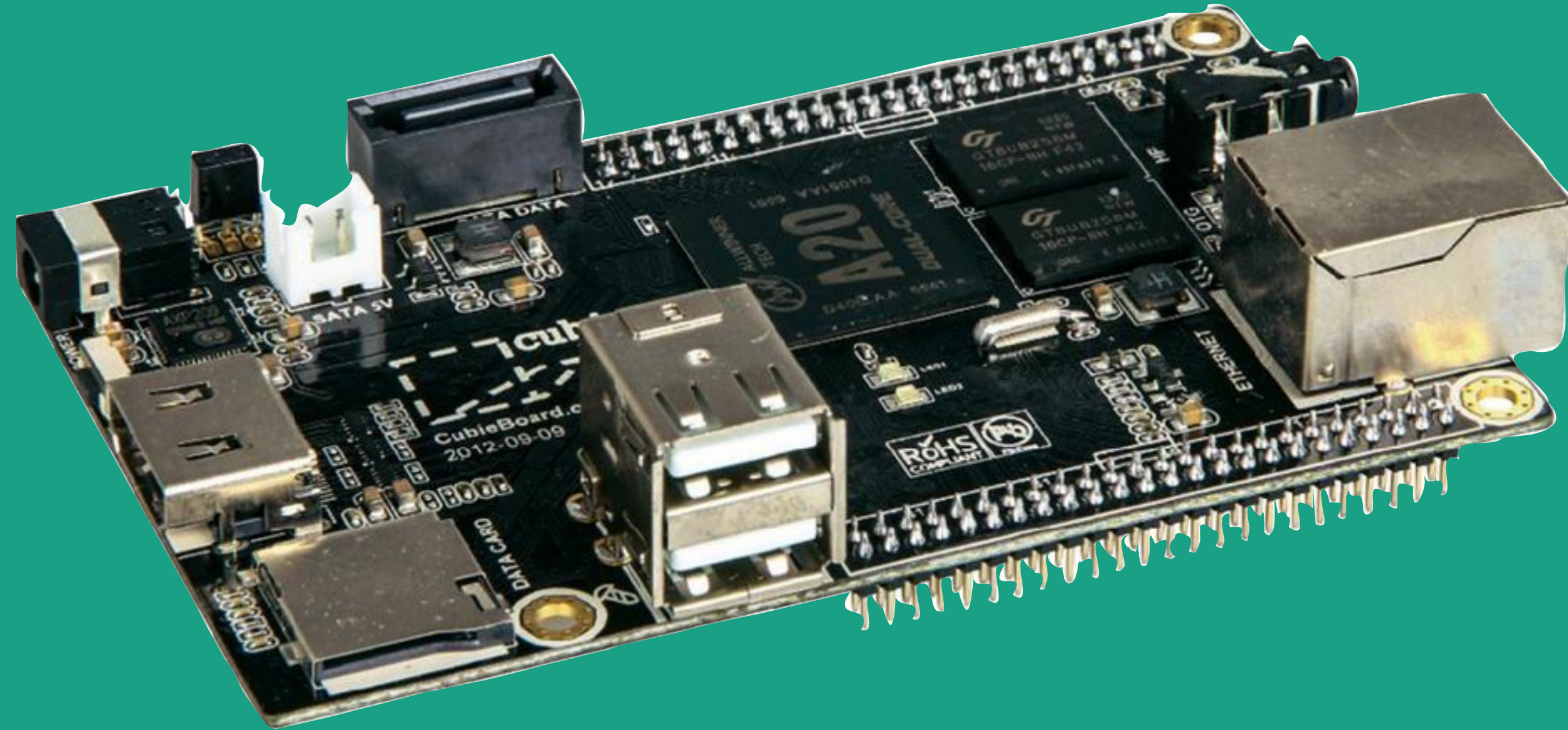
# MONGODB

- Flexible
- Developer friendly
- Free
- ARM port available
- Java driver available

WHICH

HARDWARE ?

# CUBIEBOARD 2



- DualCore ARM A7 1GHz
- Mali-400 MP GPU
- 1 GB RAM
- 1 Micro SD
- **1 SATA 2.0**
- Ethernet
- I<sub>2</sub>C, SPI, LVDS

# CUBIBOARD 2 SETUP

- Debian Wheezy Linux hard float
- JDK 8 for ARM
- Act as mongodb server
- Collect Xbee data of last 7 days every 5 minutes
- Allow communication over MQTT





# CONCLUSION

- MongoDB works nicely on an ARM device
- CubieBoard 2 with SSD is a perfect fit
- Java 8 works nicely on the CubieBoard 2

1

MONITOR 9 ROOMS



2

STORE DATA



3

VISUALIZE ON RASPBERRY PI

4

OTHER CLIENTS

VISUALIZE ON

RASPBERRYPI

# VISUALIZE ON PI

- Show current weather condition
- Show environmental values
- Show live measured data
- Show history of last 7 days
- Show sensor voltage history
- Show daily temperature distribution

# 1. APPROACH



GOING

"BIG"



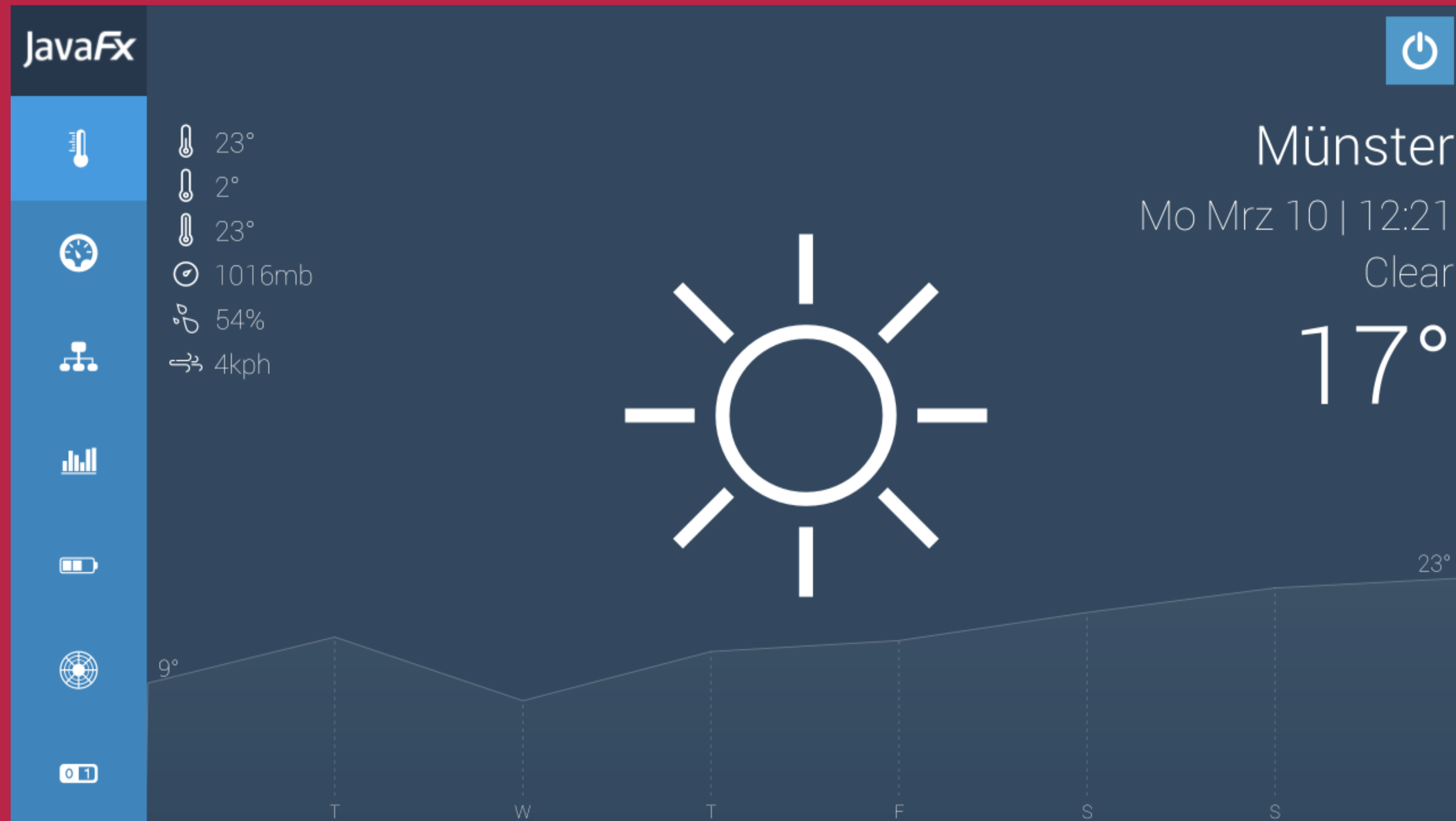
# 10" TOUCH LCD

THE

INTERFACE

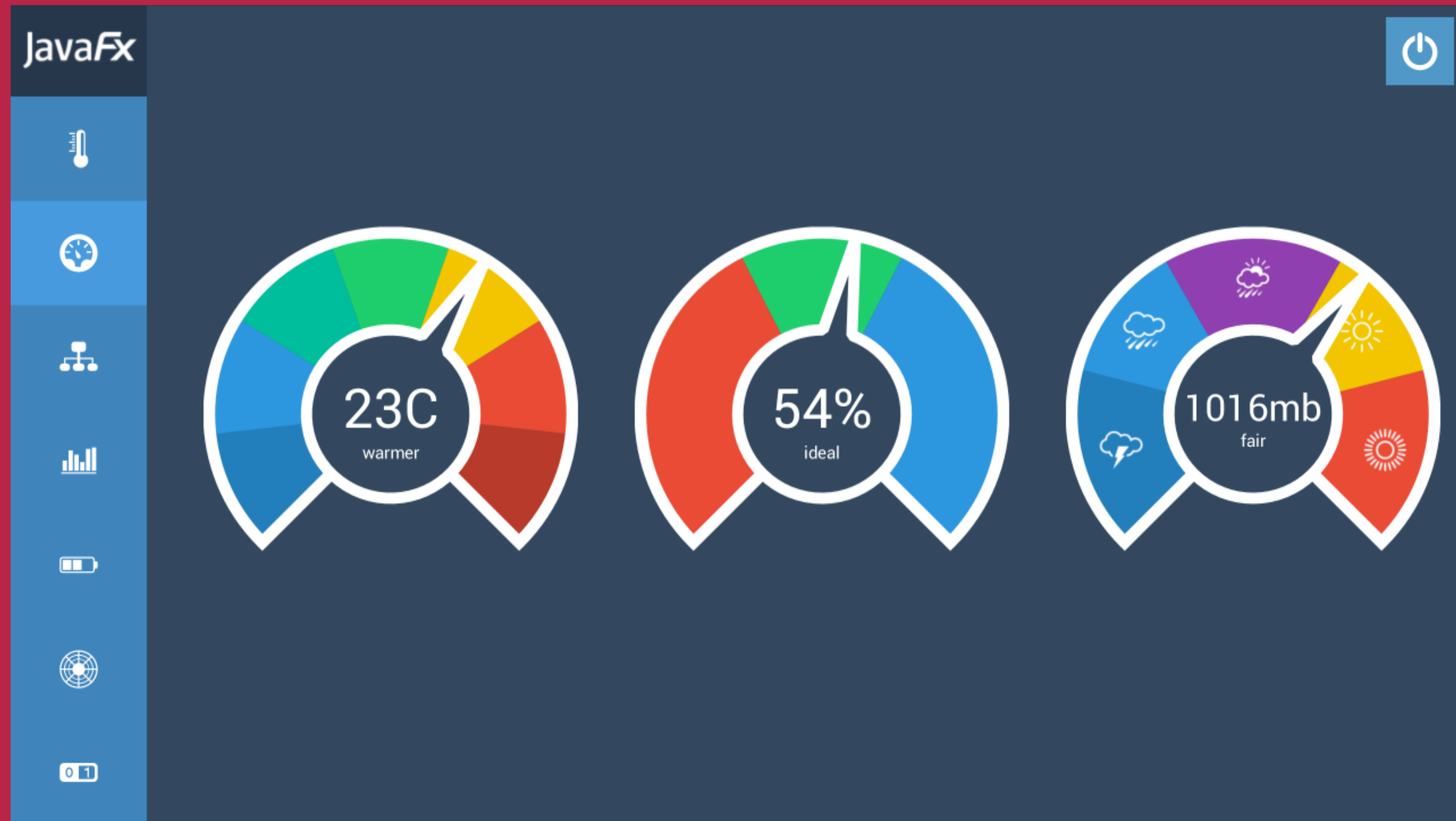


# WEATHER

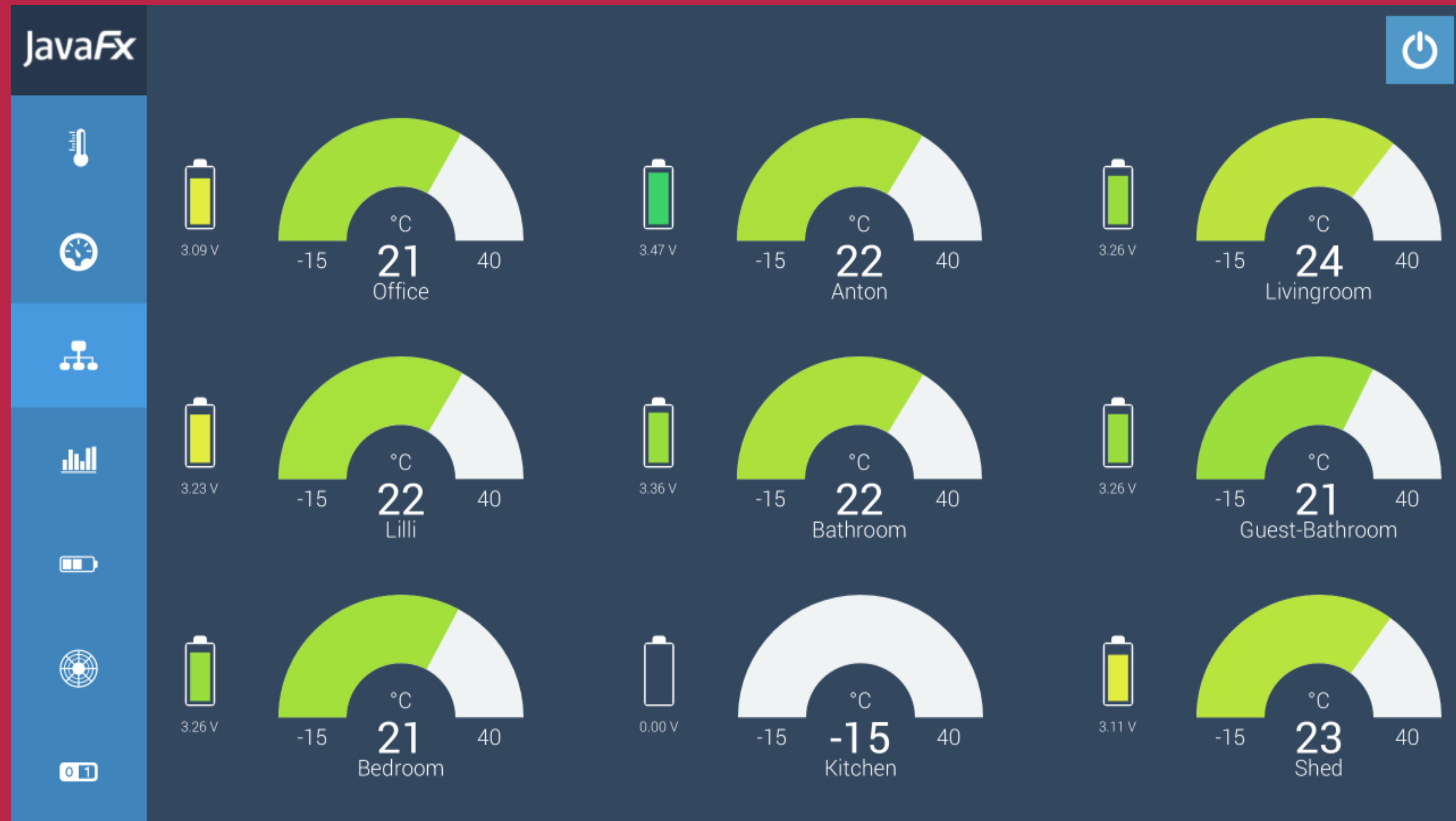




# ENVIRONMENT

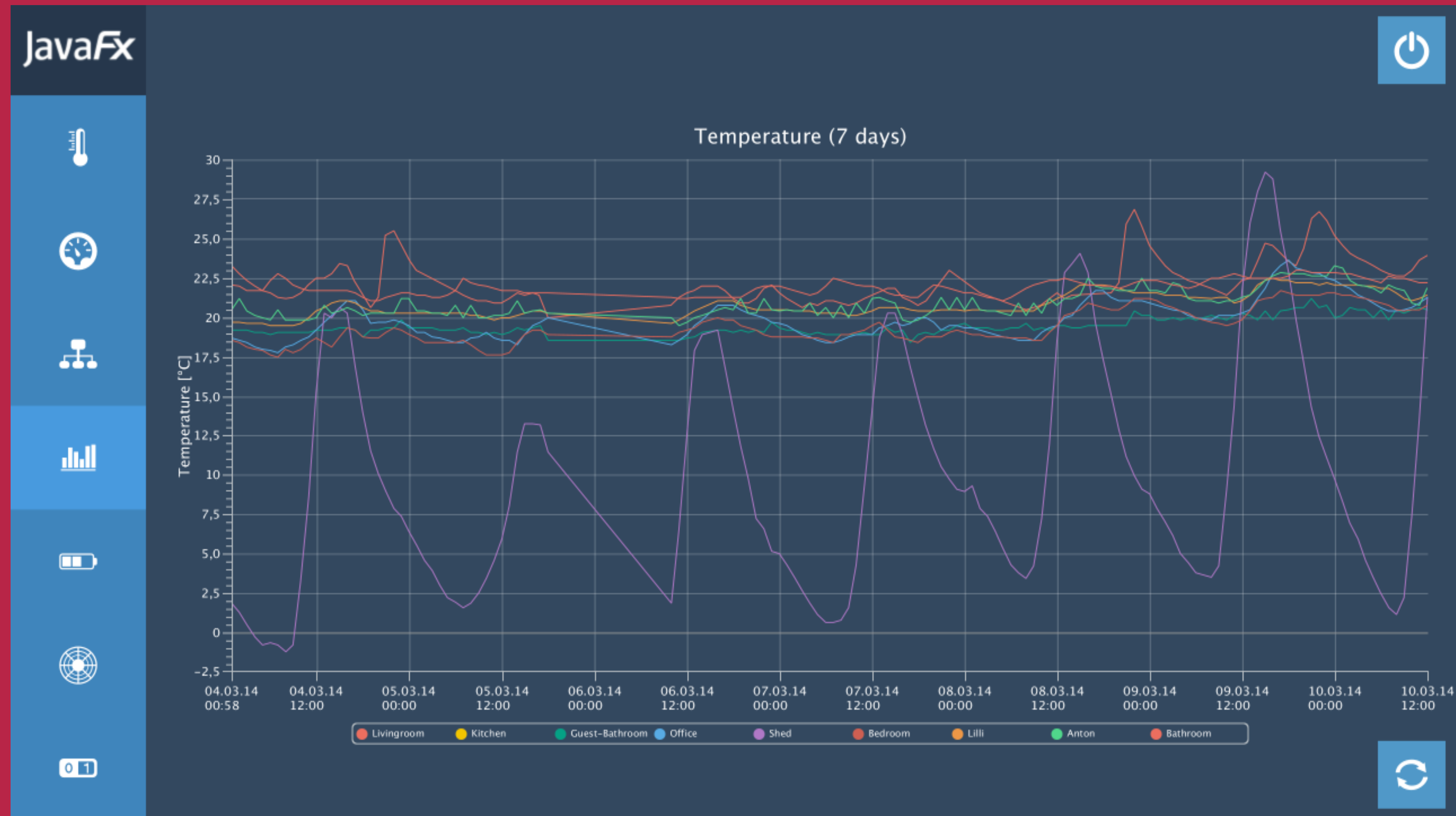


# LIVE XBEE DATA

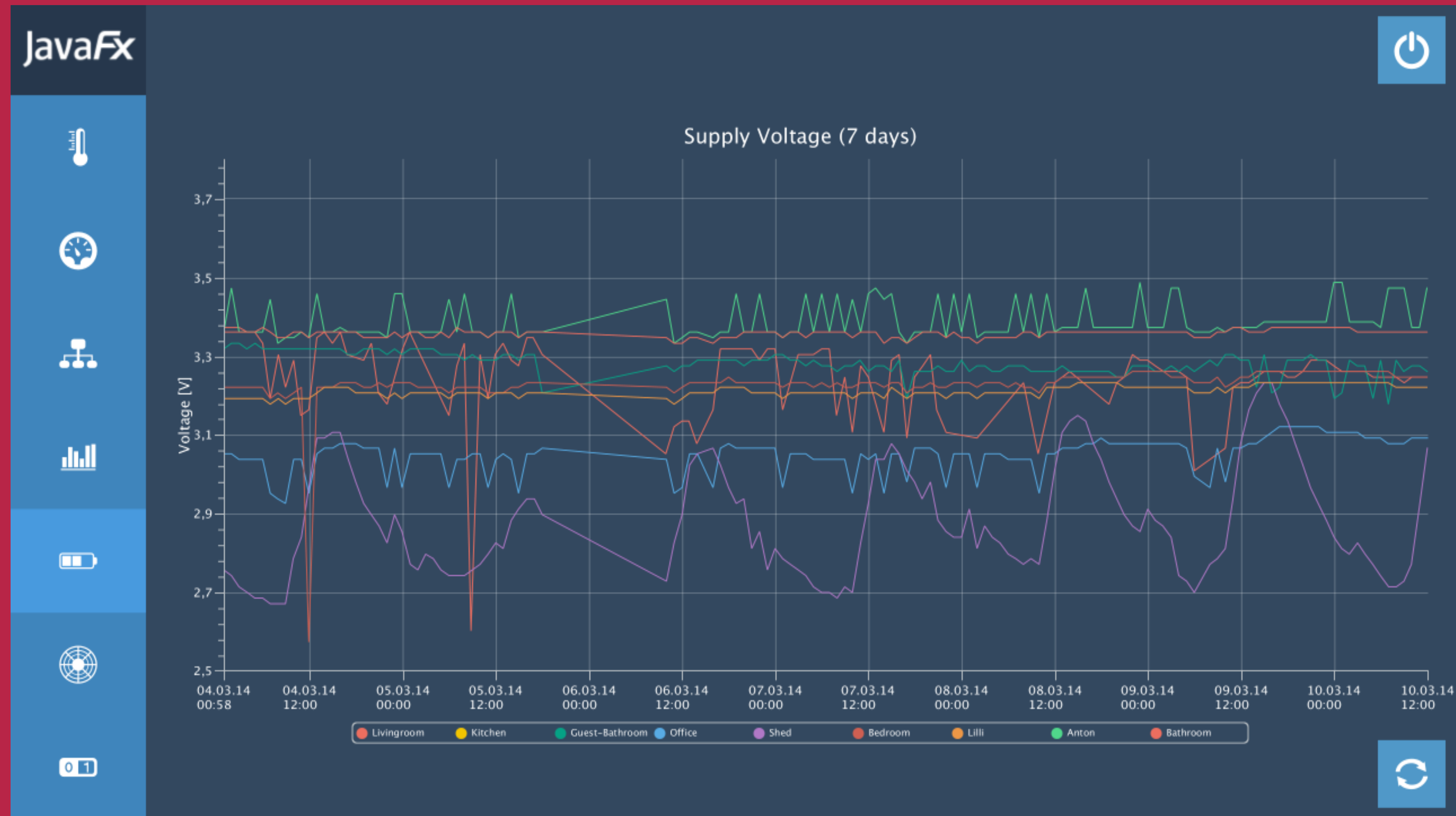




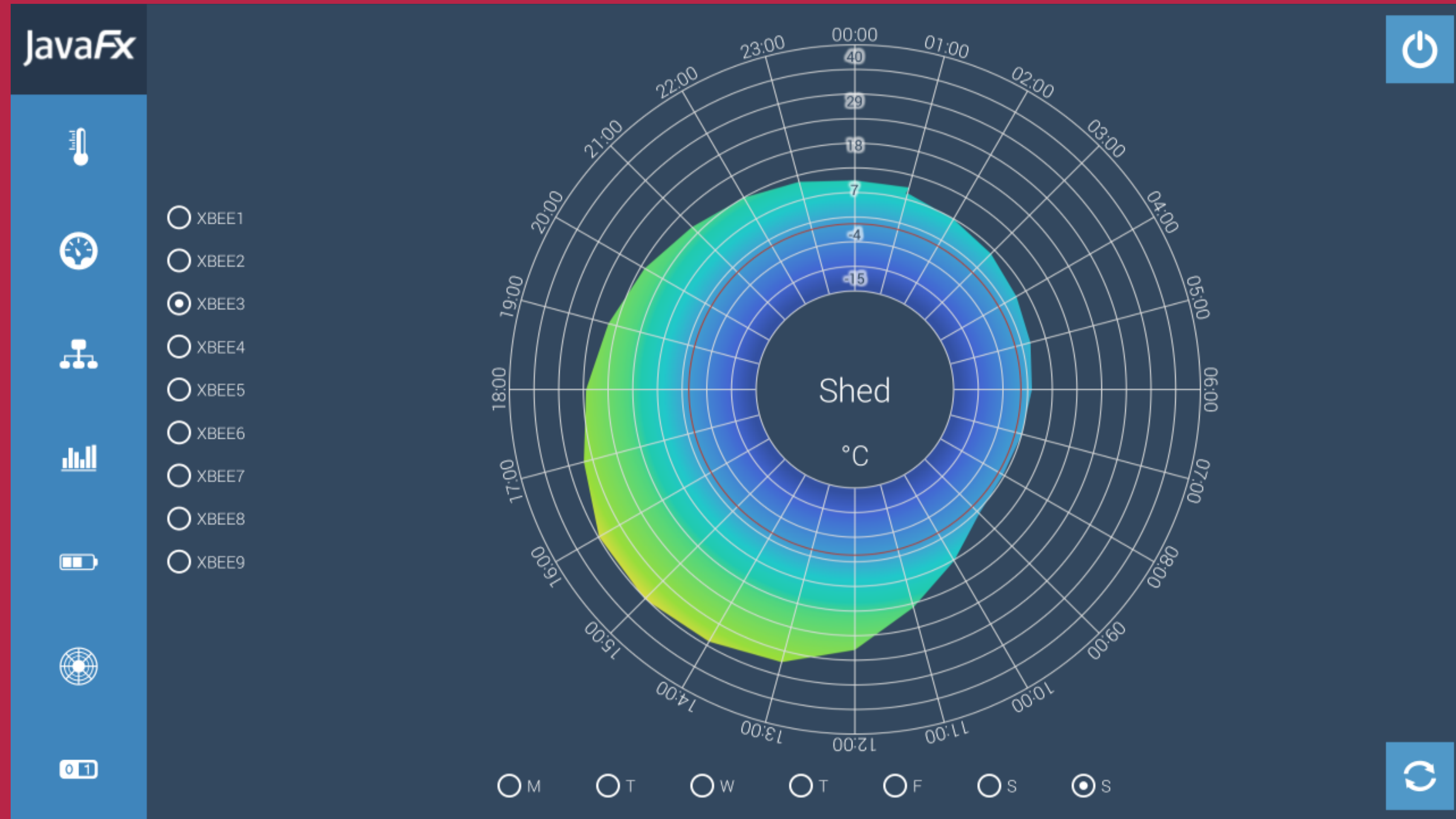
# TEMPERATURE HISTORY



# VOLTAGE HISTORY



# DAILY DISTRIBUTION



# 2. APPROACH

GOING

"SMALL"

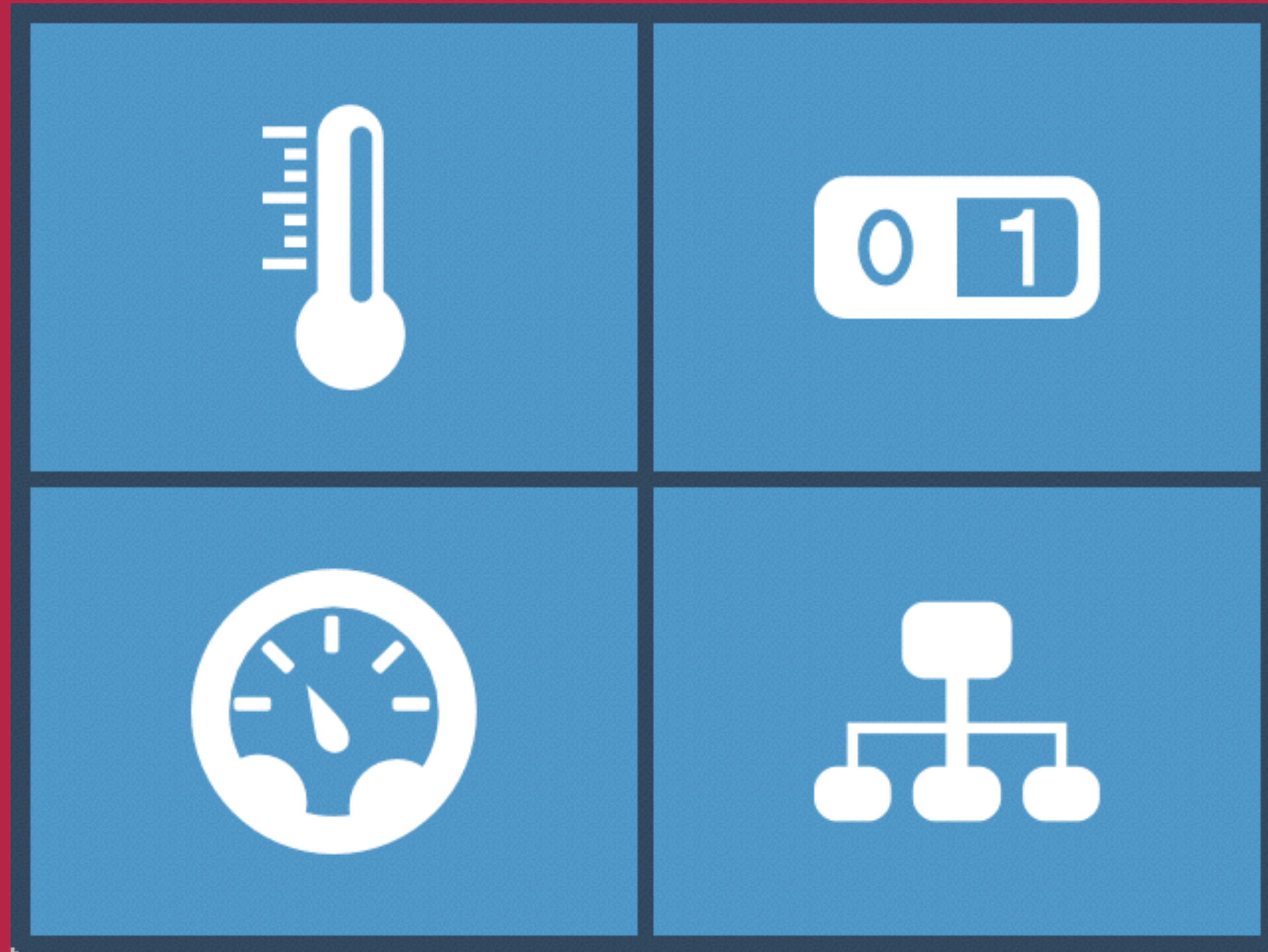




2.8" TOUCH LCD



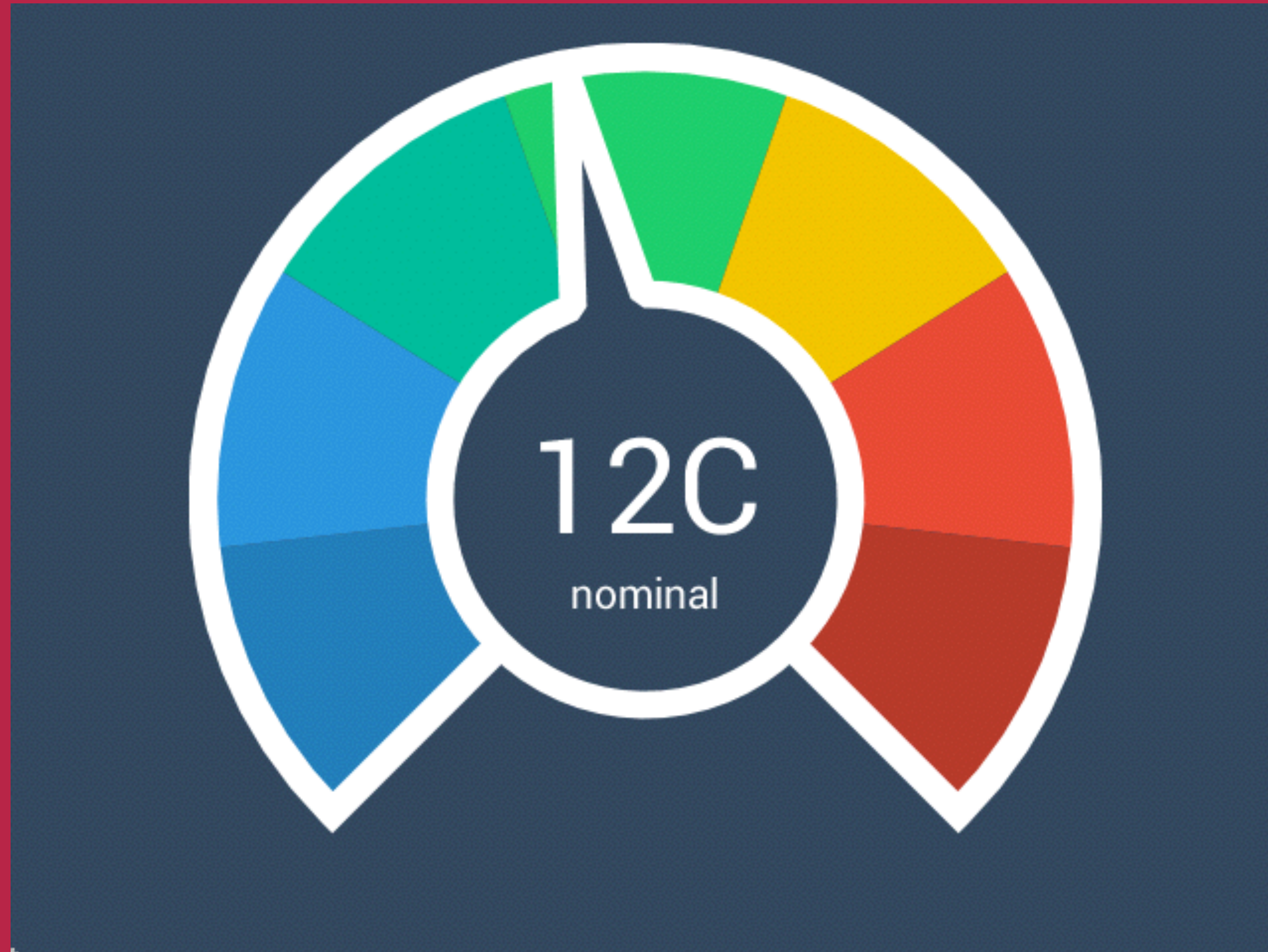
# THE INTERFACE



# WEATHER

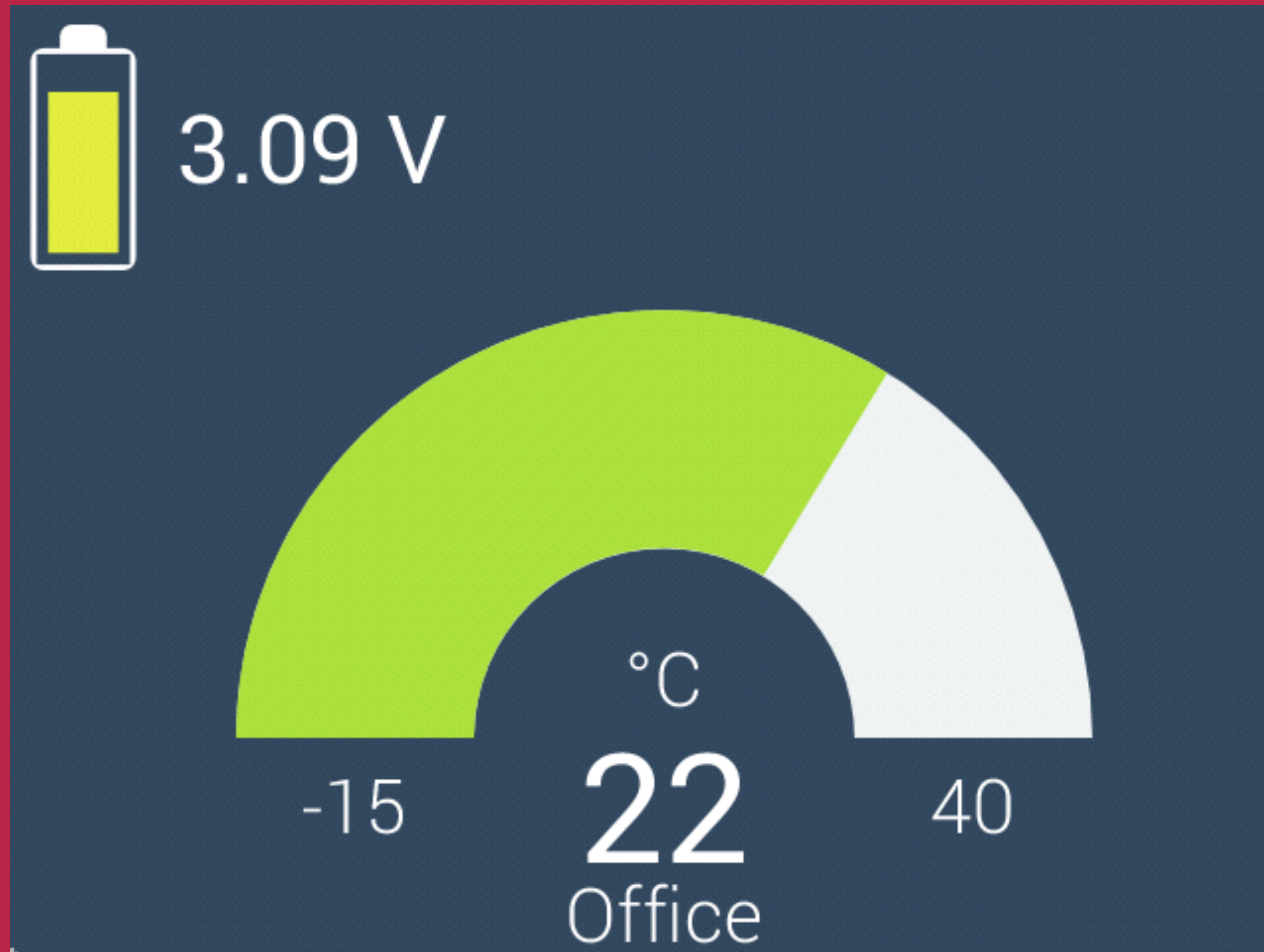


# ENVIRONMENT





# LIVE XBEEEDATA



# 7 DAY HISTORY



TOO SMALL

# DEMO



# RASPBERRY PI VERSION

# CONCLUSION

# CONCLUSION

- Raspberry Pi can be used for visualization
- Diff. screen sizes are possible (down to 2.8")
- Java(FX) 8 works great on the Raspberry Pi

1

MONITOR 9 ROOMS



2

STORE DATA



3

VISUALIZE ON RASPBERRY PI



4

OTHER CLIENTS

OTHER

CLIENTS

# POSSIBLE JAVAFX PLATFORMS

- Desktop (Windows, OS X, Linux)
- ARM (Cubox-i based on i.MX6)
- iOS (iPad, iPhone)
- Android (Nexus 7)
- Android (SmartWatch)





# DESKTOP

524x744

DESKTOP  
VERSION

iOS

768x1024

**IPAD MINI  
VERSION**

# ANDROID

320x295

SmartWatch  
Version

# OTHER CLIENTS



# JavaFX





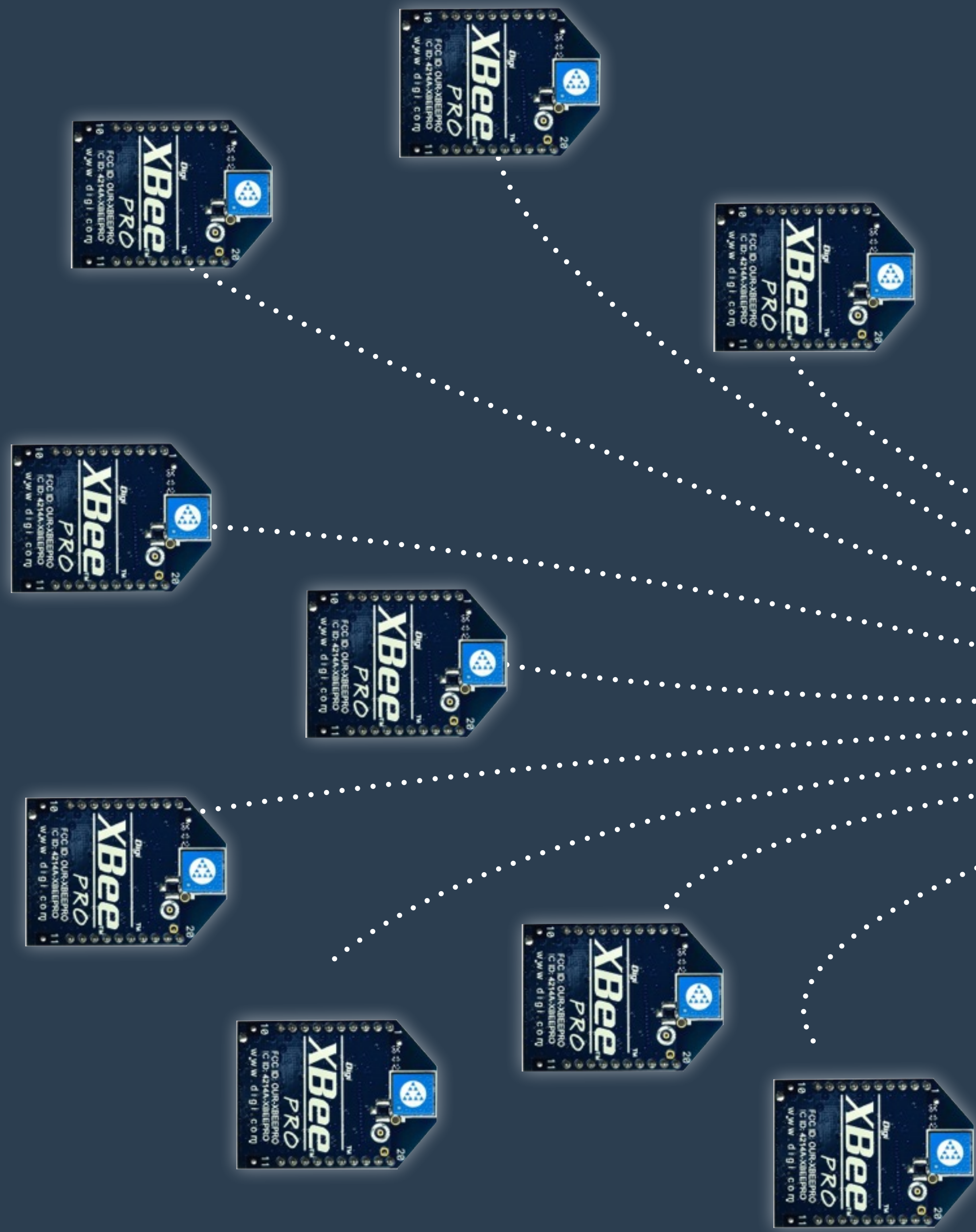


# CONCLUSION

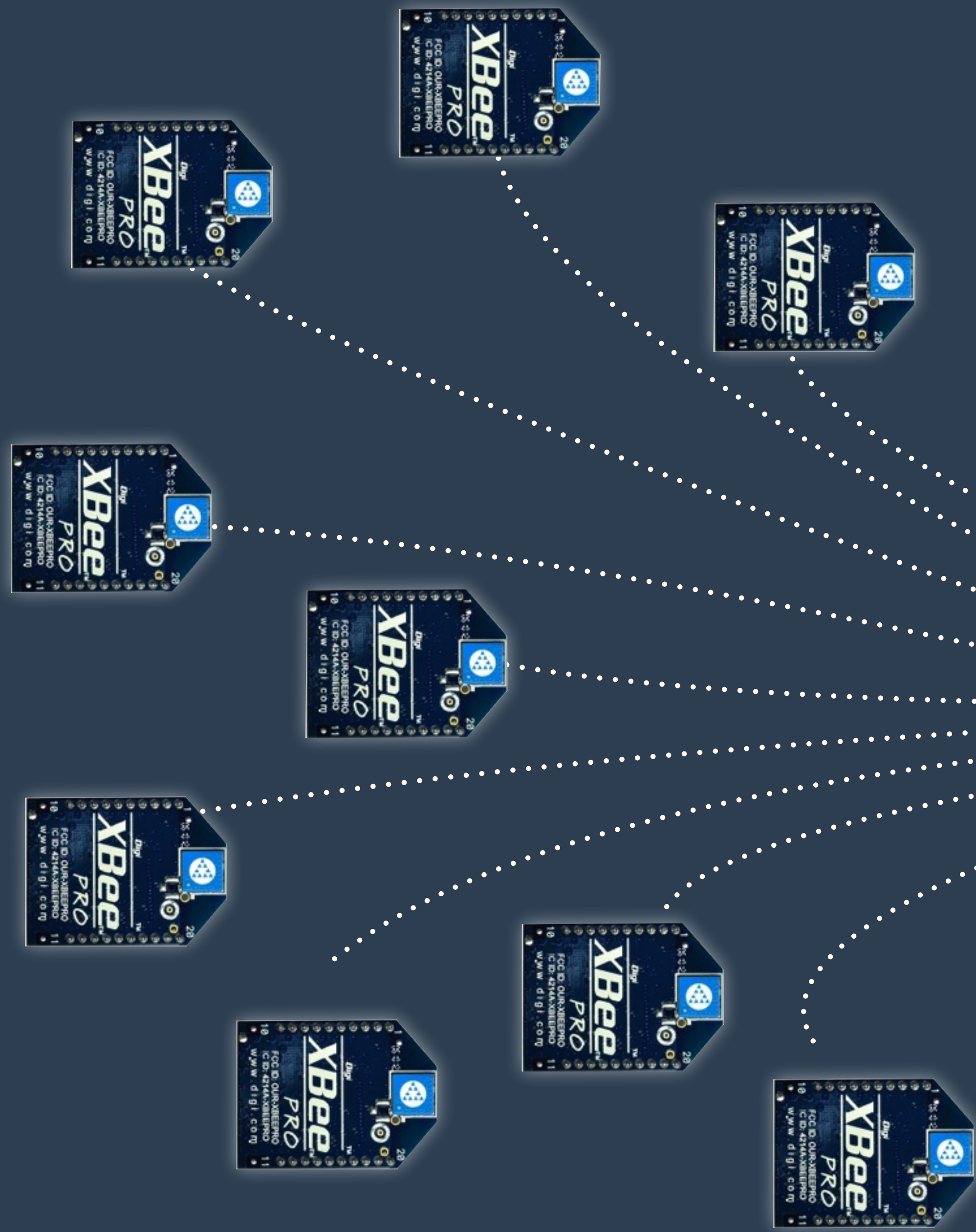
- Java(FX) can be used on iOS and Android
- Performance depends on hardware
- You face similar problems as every mobile developer (different screen sizes etc.)

FINAL

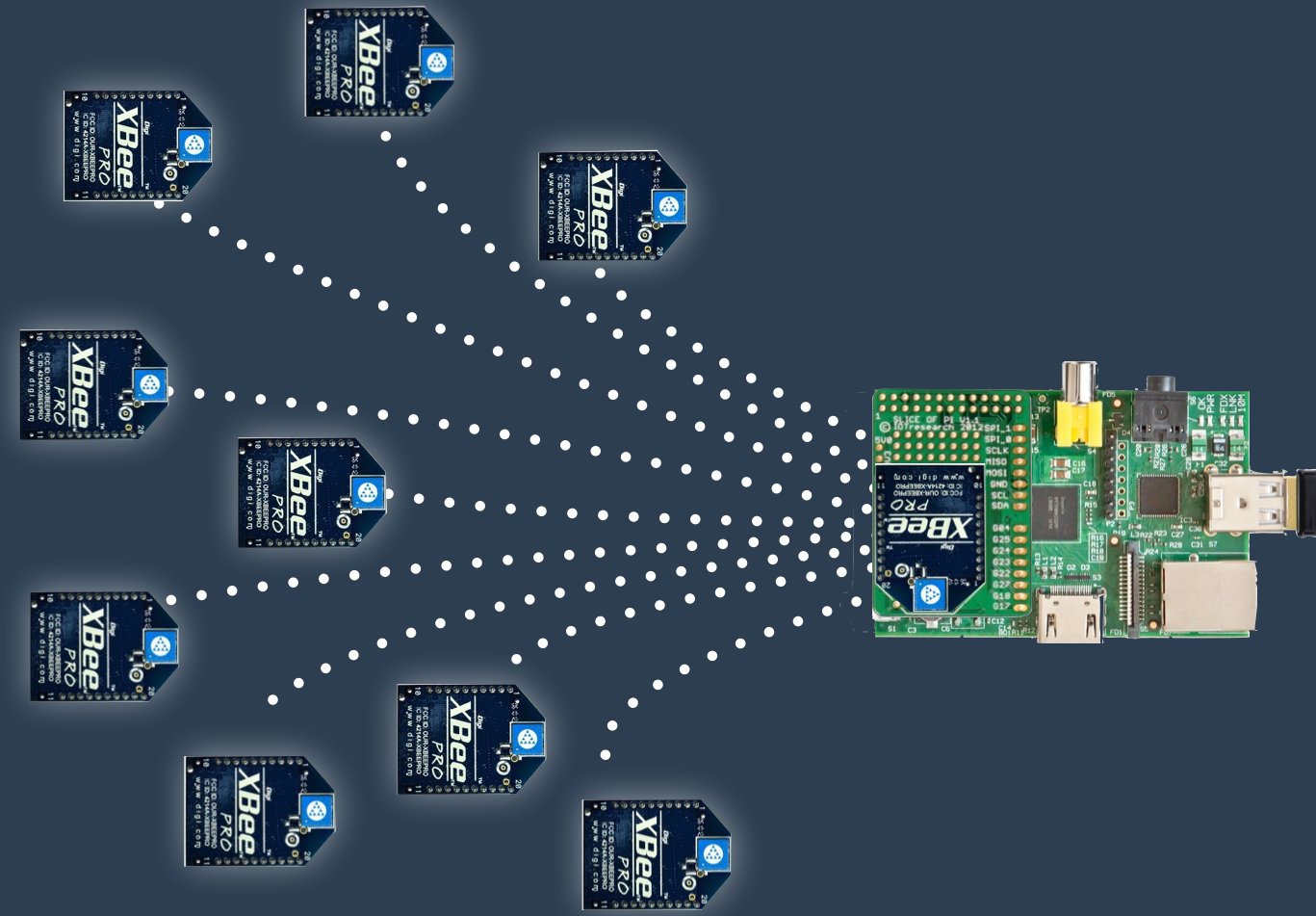
SETUP



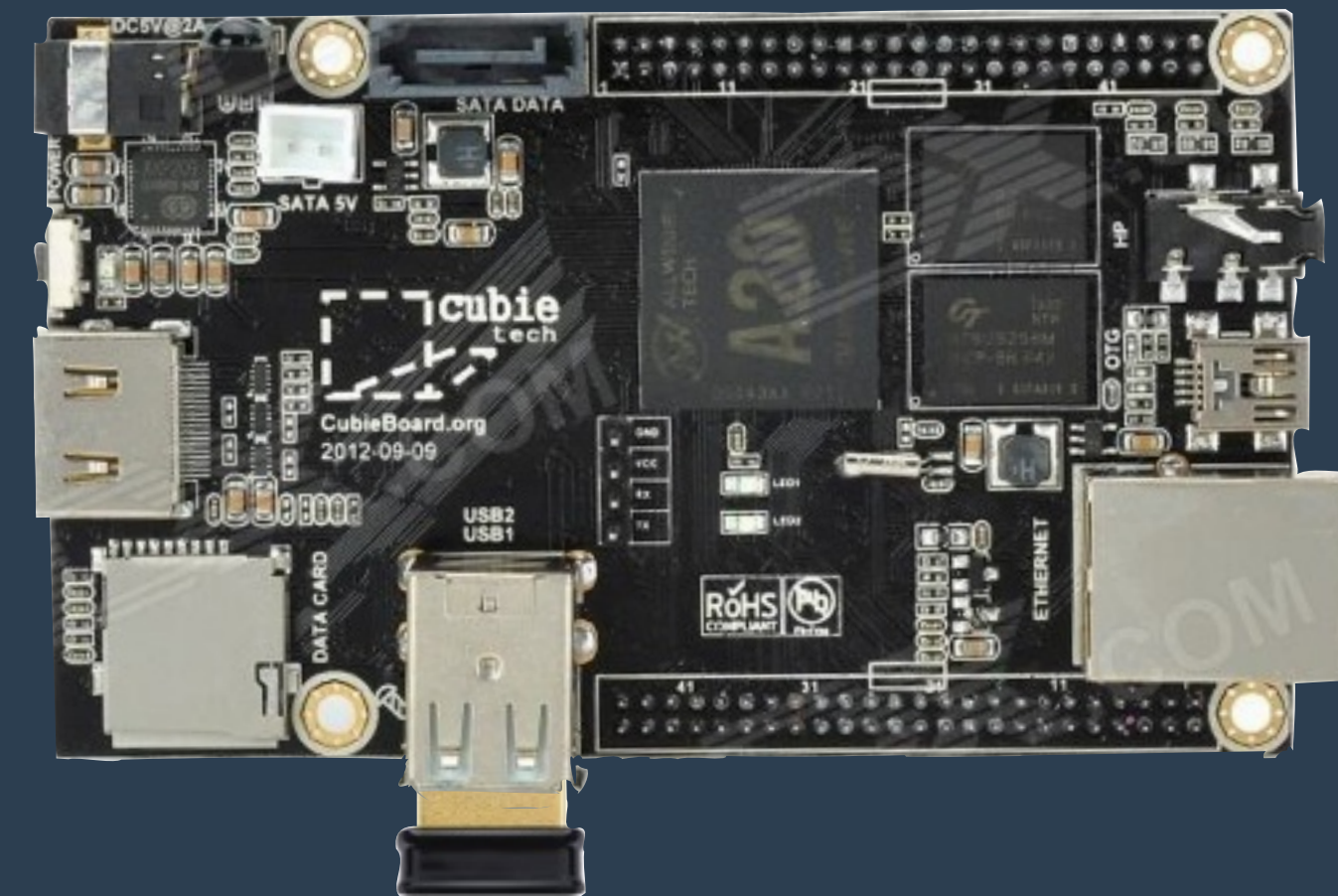




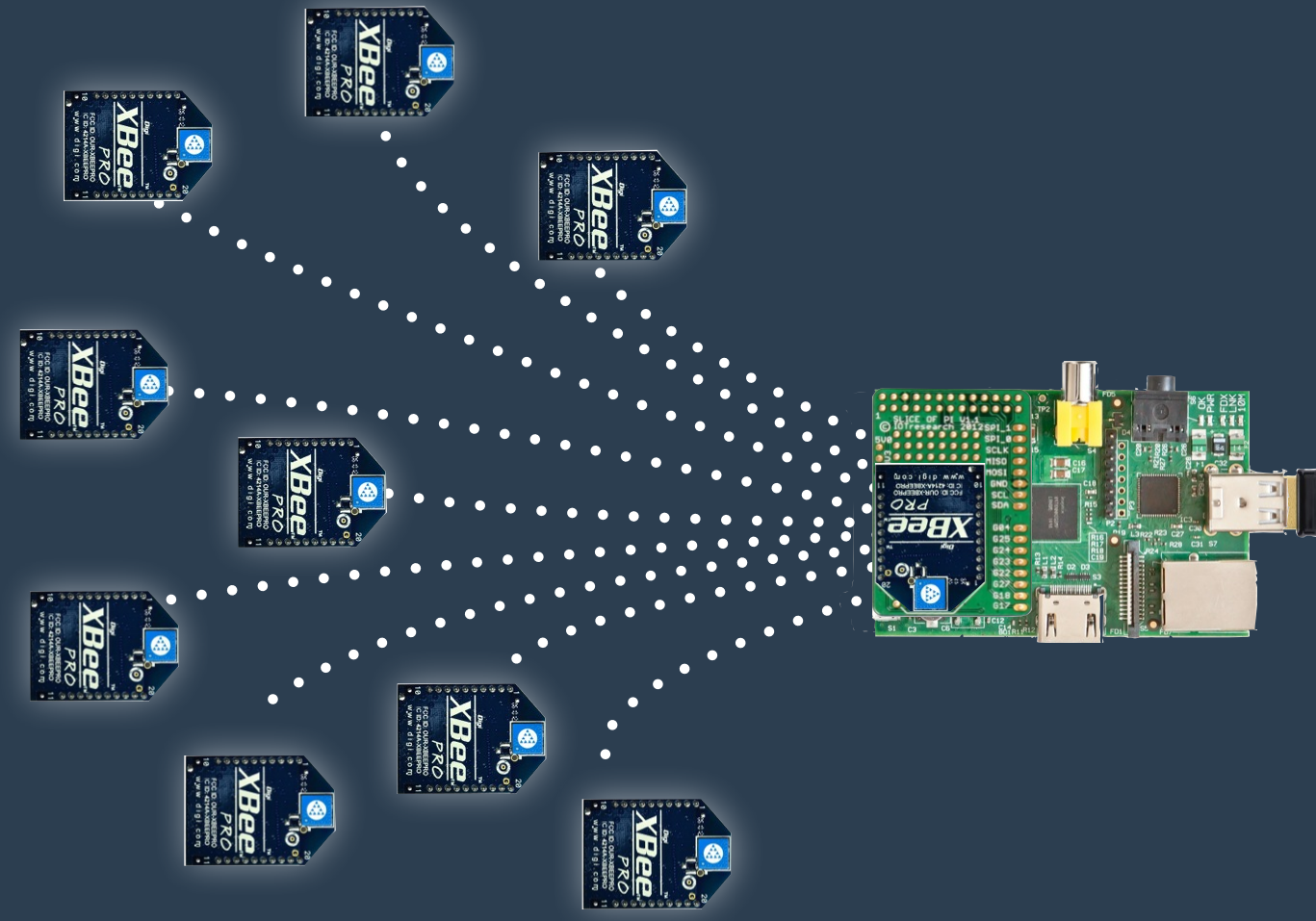




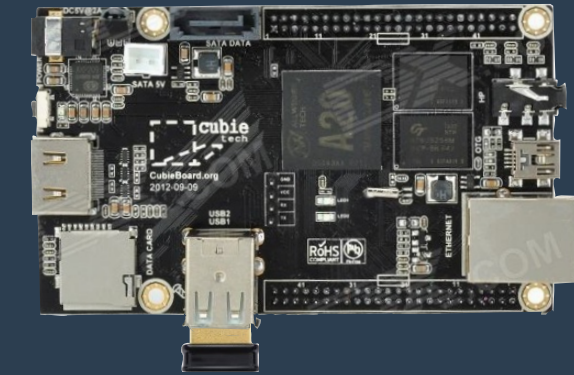
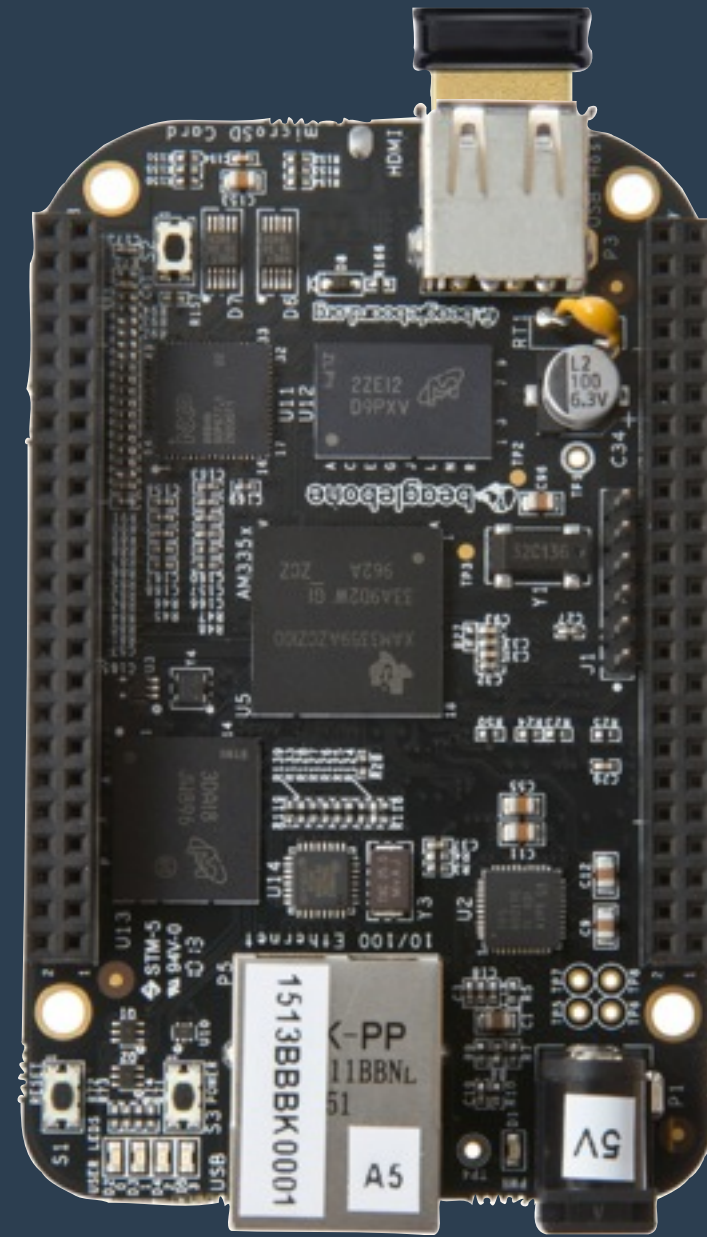
# SensorNetwork





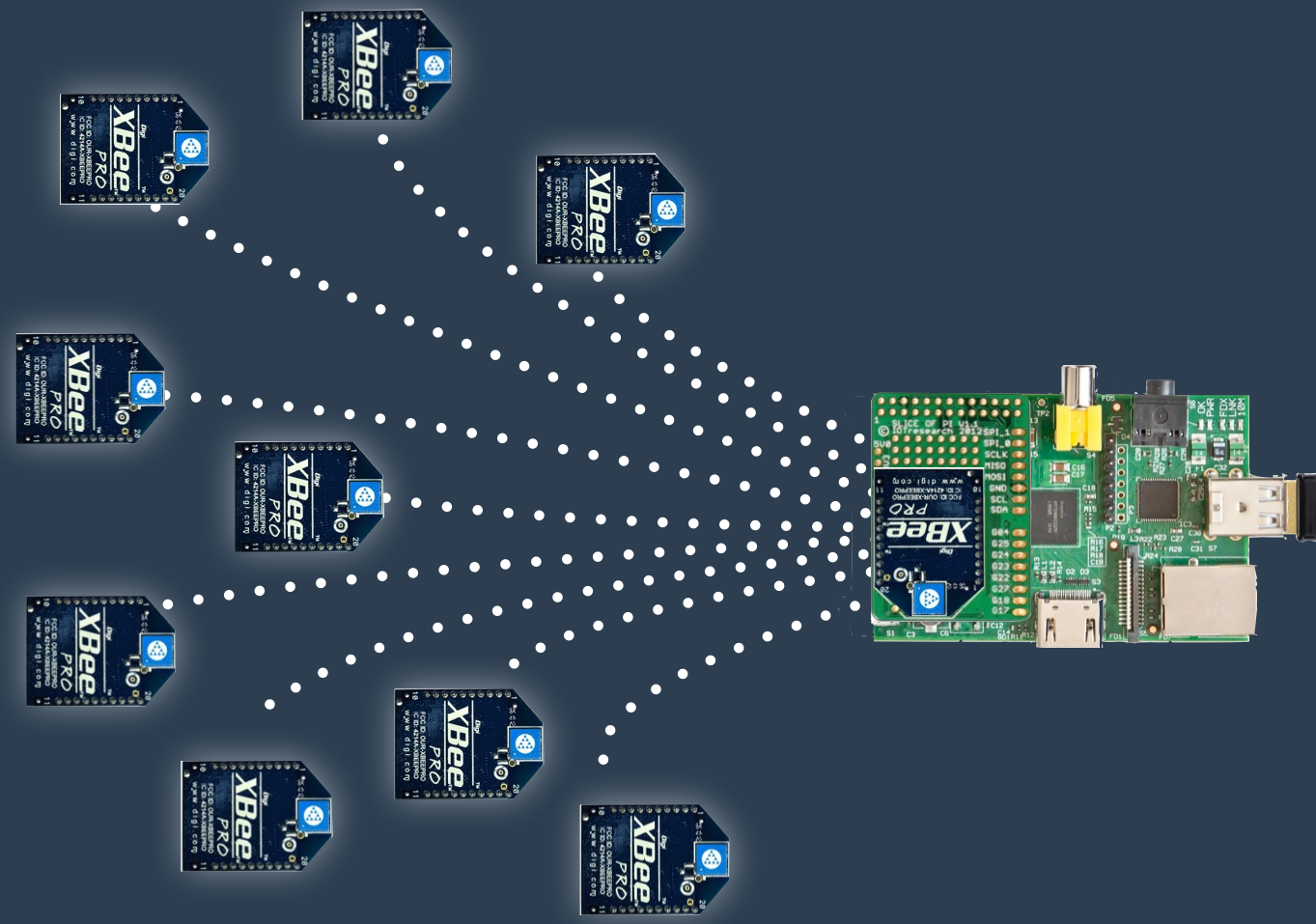


SensorNetwork

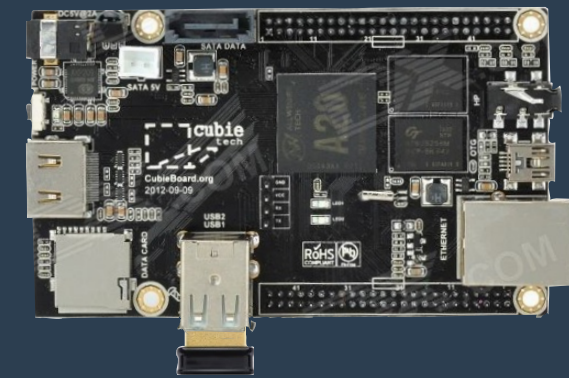


Database Server

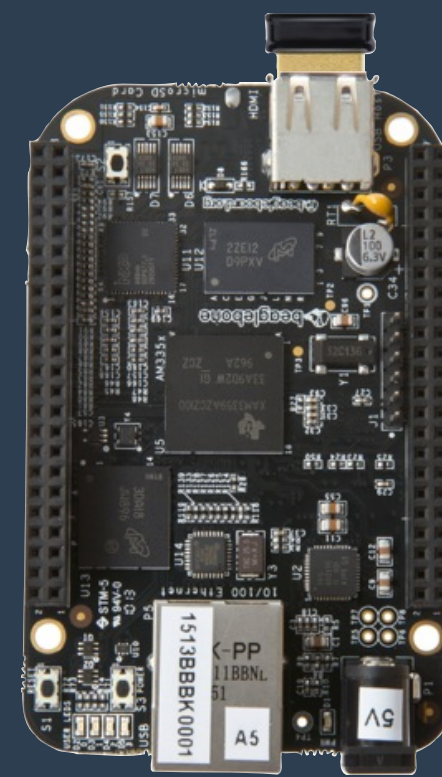




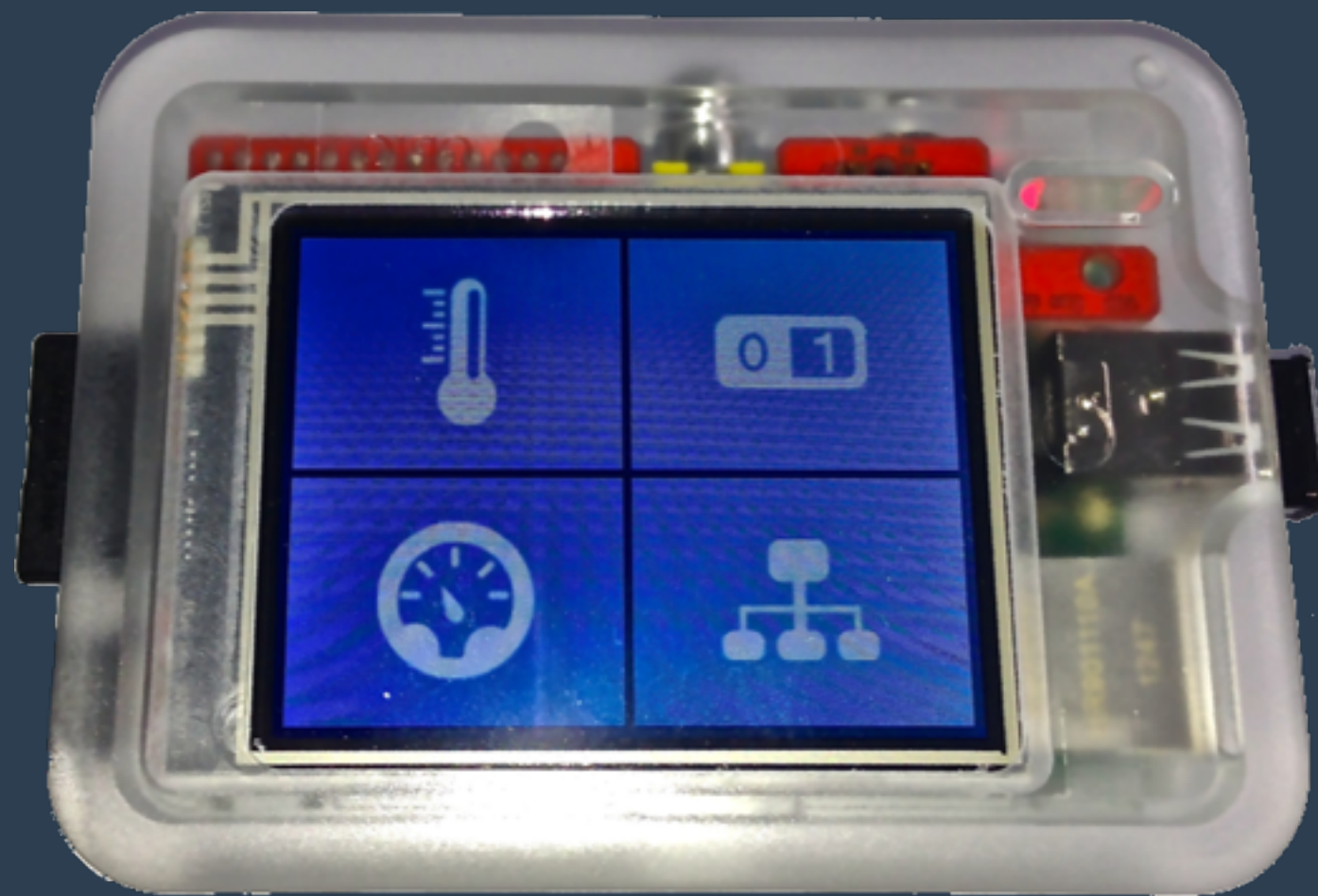
SensorNetwork



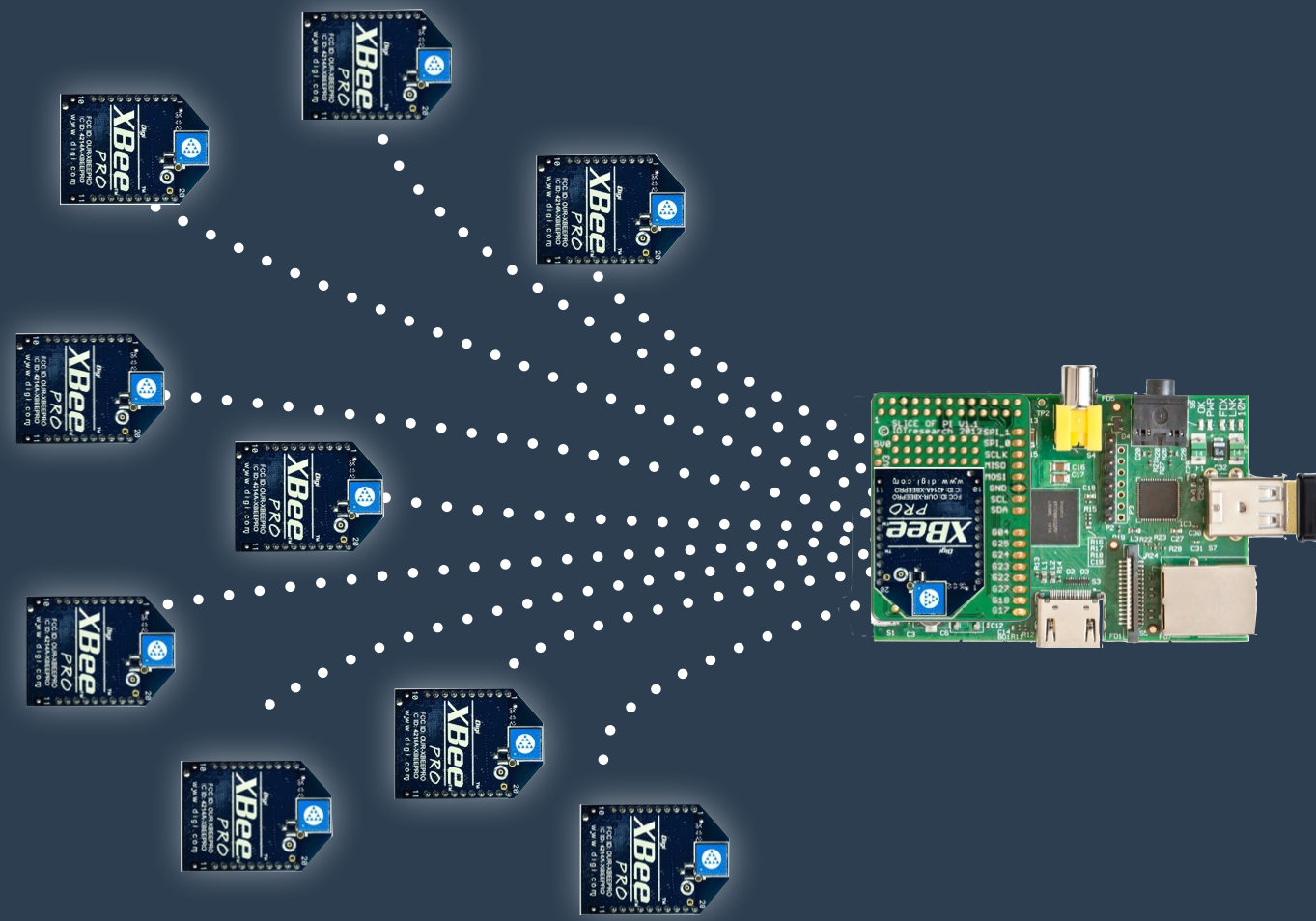
Database Server



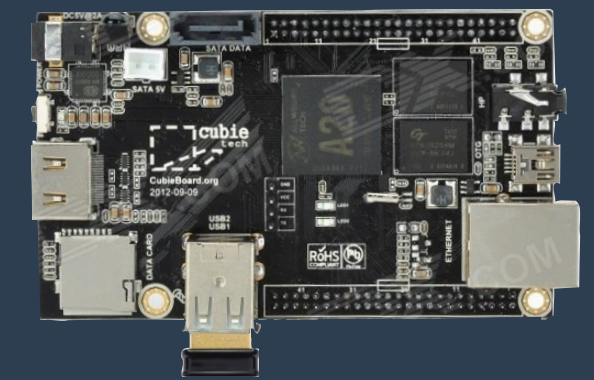
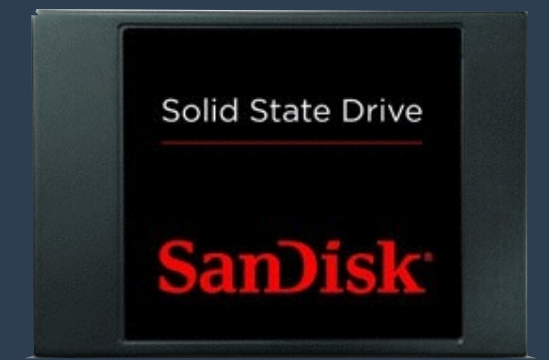
MQTT Broker



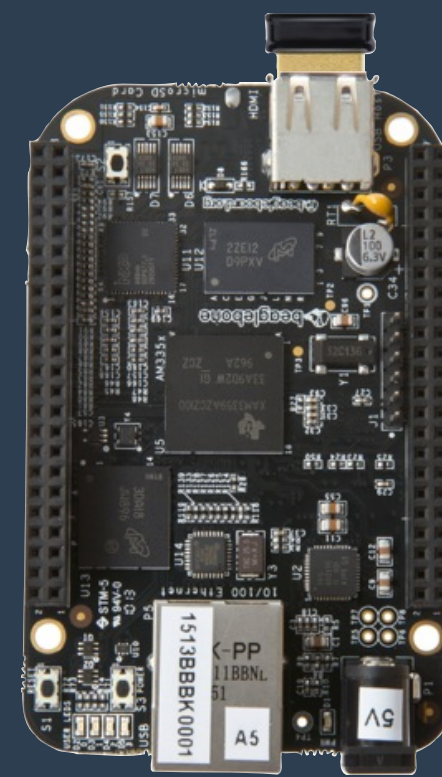




SensorNetwork



Database Server



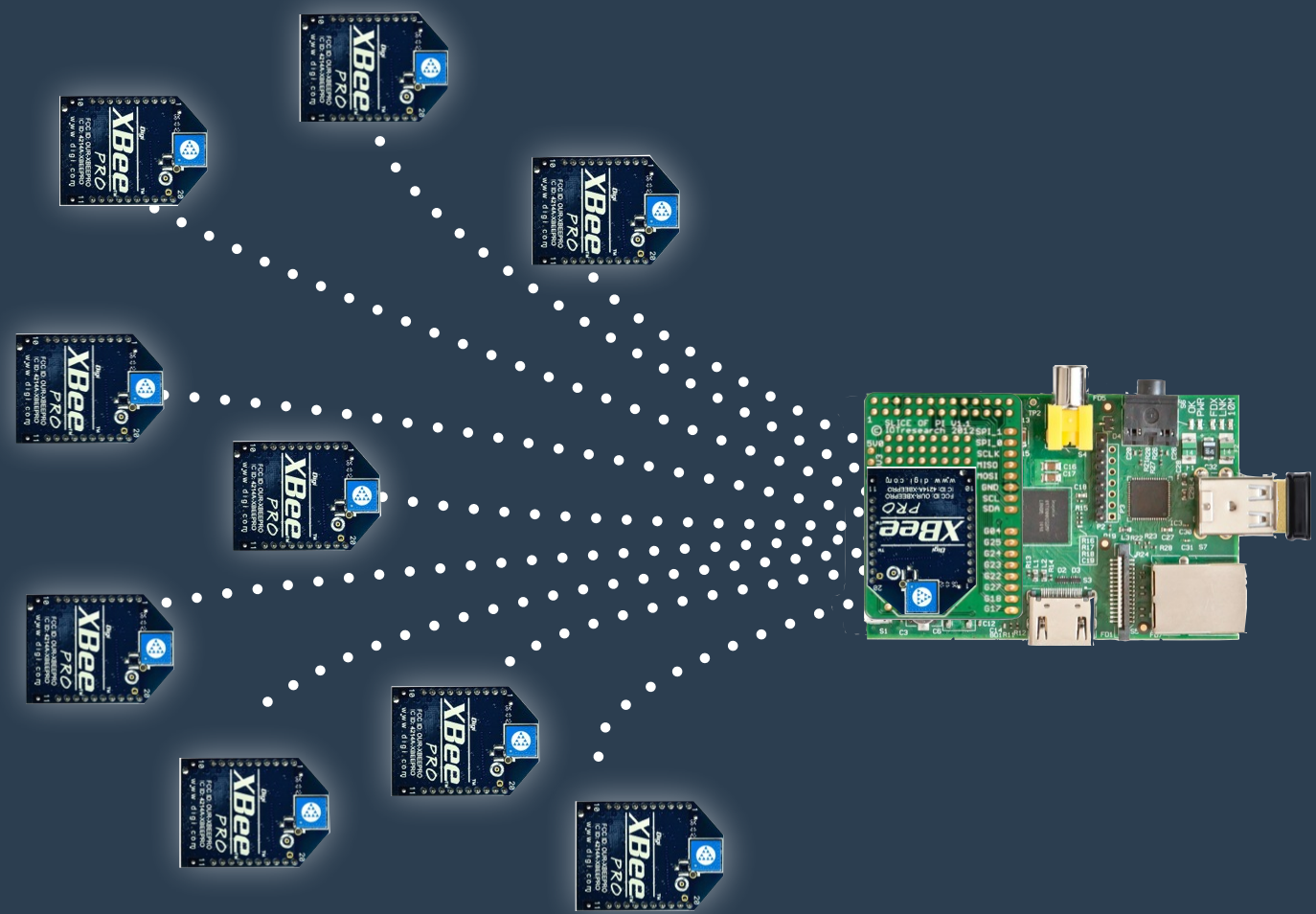
MQTT Broker



Raspberry Pi Visualization



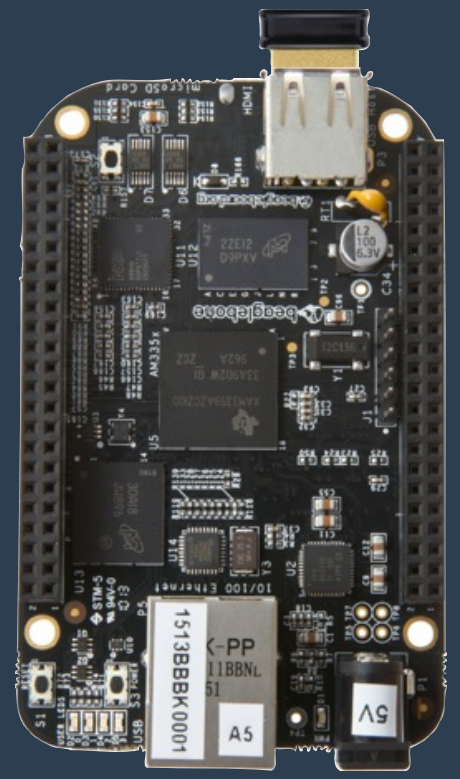




SensorNetwork



Database Server



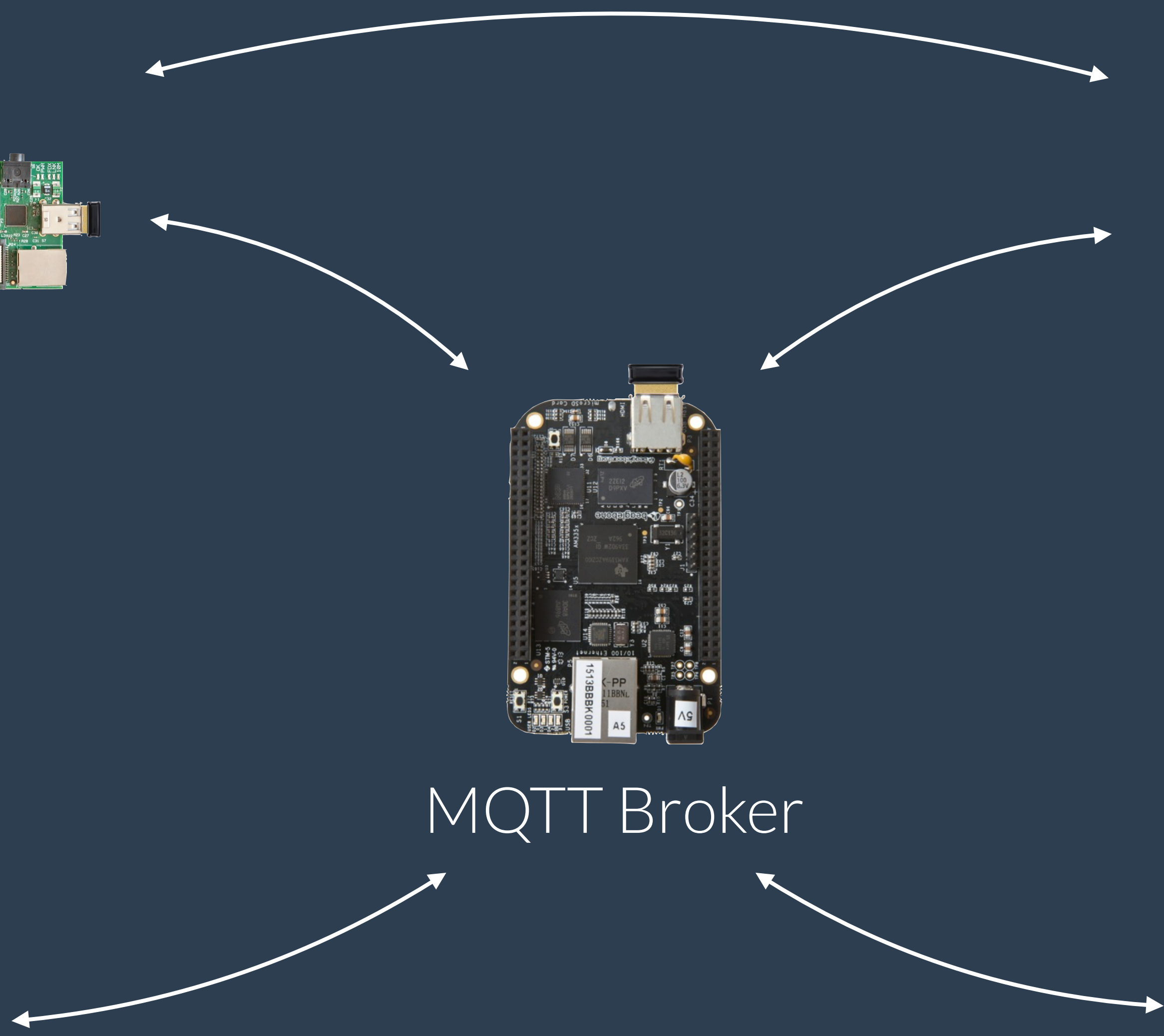
MQTT Broker



Raspberry Pi Visualization



Other clients





# CONCLUSION

# CONCLUSION

- One can create a "cheap" sensor network (using XBees only)
- One could save money by using embedded technology
- One could run nearly all of the systems on standard Java





KEEP CODING