# Field Considerations

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8/2/21

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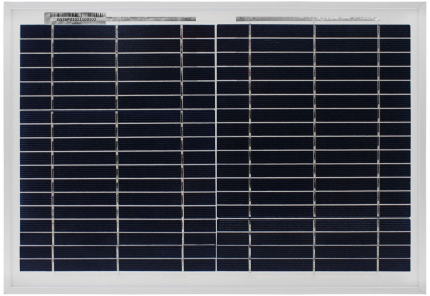
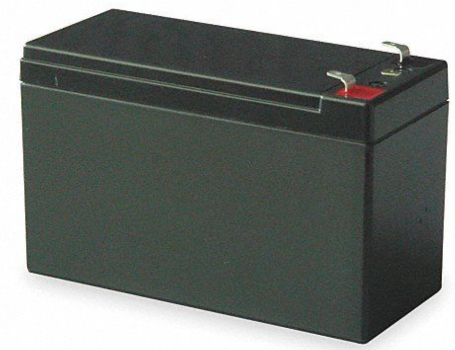
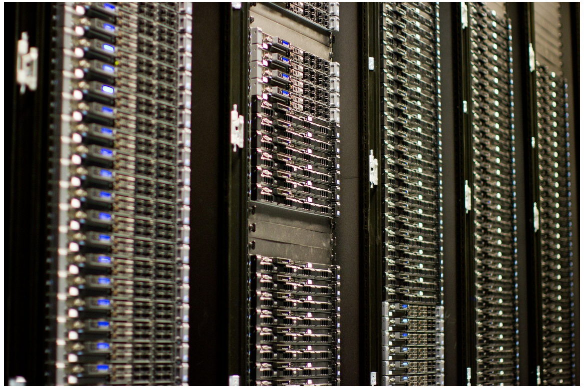
# Making instruments in the lab is great, but there are many factors to consider when deploying the instrument







Images: WikiPedia, Walmart, Grainger, Polycase

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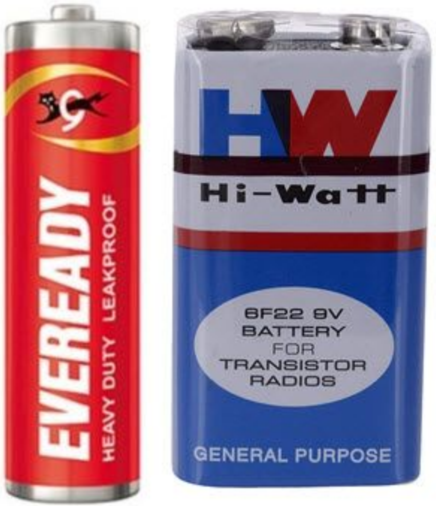
# Batteries are very application specific and environment sensitive

## Primary




## Secondary

Image: ElectronicsHub, Grainger

# Some key things to consider when looking for batteries

- Size
- Weight
- Power Density
- Price
- Voltage
- Recharge Requirements
- Recharge Gasses/Sensitivity

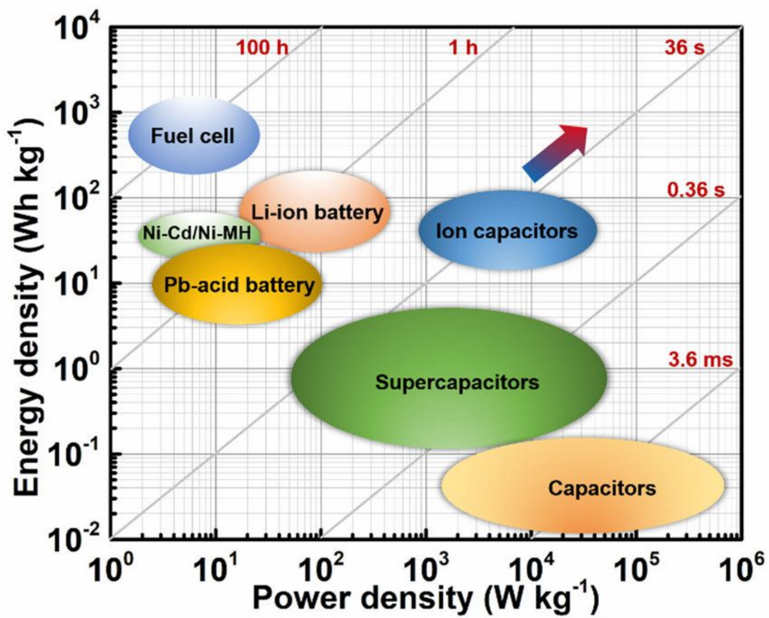



Image: ResearchGate

# Batteries are rated in Ah and have unique discharge characteristics

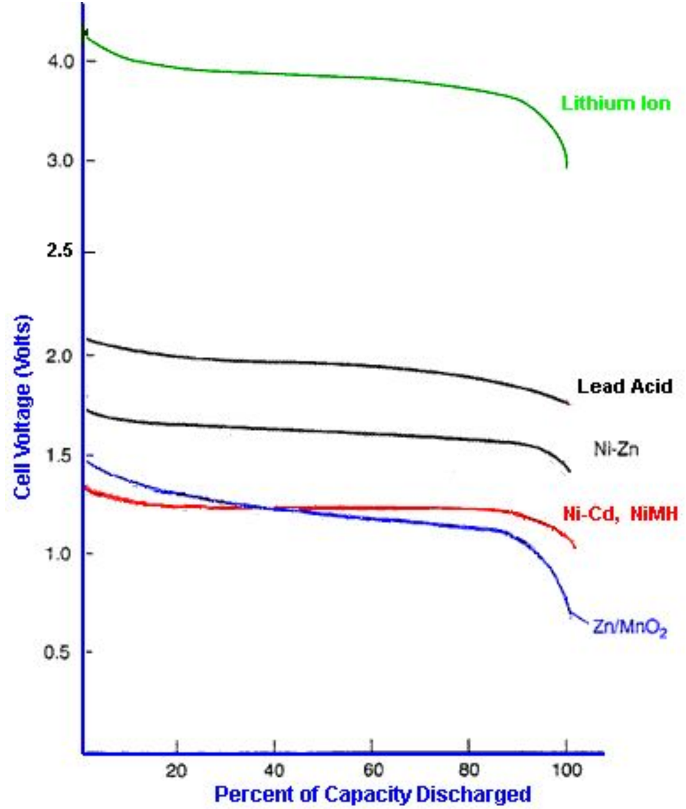



Image: Electropedia

# Power capability measured in C’s

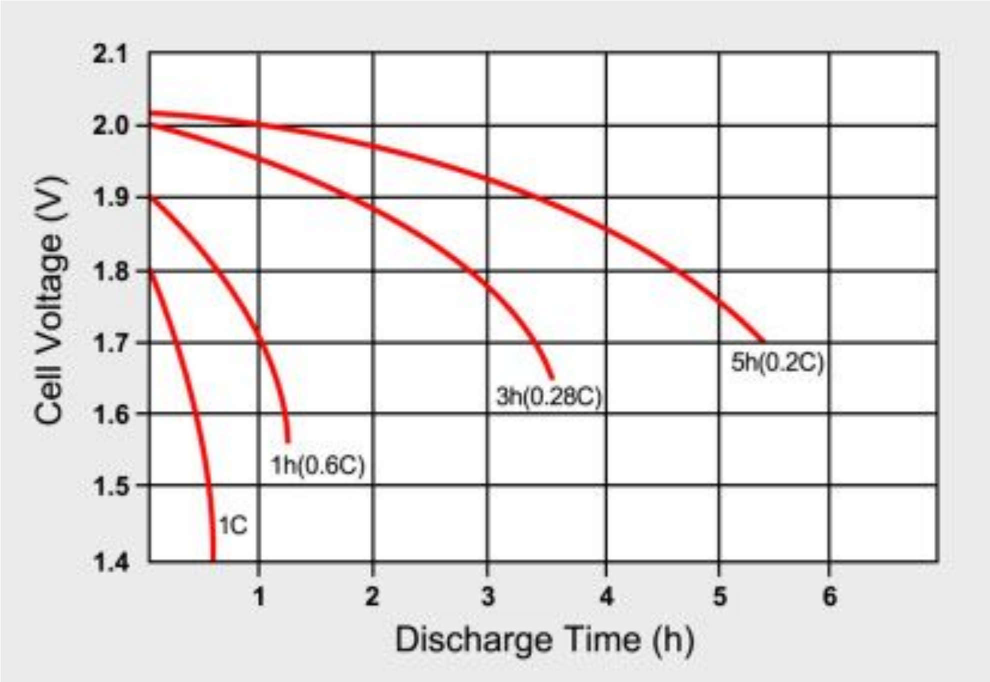



Image: Battery University

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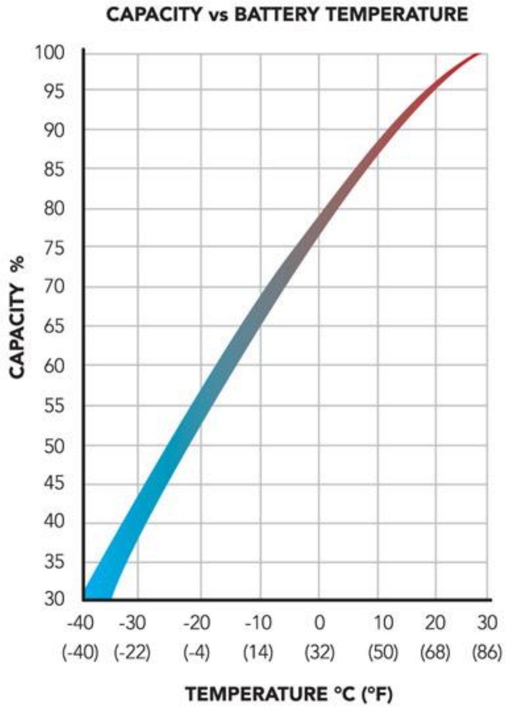
# Self discharge and temperature are important factors for long term deployments of battery powered systems

| Battery chemistry | Rechargeable | Typical self-discharge or shelf life |
|---|---|---|
| Lithium metal | No | 10 years shelf life[3] |
| Alkaline | No | 5 years shelf life[3] |
| Zinc–carbon | No | 2–3 years shelf life[3] |
| Lithium-ion | Yes | 2–3% per month;[3] ca. 4% p.m.[4] |
| Lithium-polymer | Yes | ~5% per month[5][better source needed] |
| Low self-discharge NiMH | Yes | As low as 0.25% per month[6] |
| Lead–acid | Yes | 4–6% per month[3] |
| Nickel–cadmium | Yes | 15–20% per month[3] |
| Nickel–metal hydride (NiMH) | Yes | 30% per month[3] |






Images: Wikipedia, Sunxtender

# Batteries also vary their capacity and characteristics with discharge rate

| Industry Reference | Voltage | Nominal Capacity Ampere Hours @ 25° C (77° F) to 1.75 Volts per cell | | | | | | | | | Length | | Width | | Height | | Weight | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 Hour Rate | 2 Hour Rate | 4 Hour Rate | 8 Hour Rate | 24 Hour Rate | 48 Hour Rate | 72 Hour Rate | 100 Hour Rate | 120 Hour Rate | in | mm | in | mm | in | mm | Lbs | Kg |
| Group 31 | 12v | 79 Ah | 100 Ah | 103 Ah | 113 Ah | 129 Ah | 139 Ah | 144 Ah | 146 Ah | 149 Ah | 12.90 | 328 | 6.75 | 171 | 8.96 | 228 | 75 | 34.0 |

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Image: Sunxtender

# Lead acid batteries are a common choice with lots of permutations for secondary battery needs

- Inexpensive
- High Capacity
- High Discharge Rates

- Low Power Density
- Heavy
- Temperature Performance


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Images: Adafruit, Blacksmithint

# Alkaline batteries are the most common of the primary batteries

- Easy to get (popular)
- Safe
- Well known
- Long Shelf Life
- 100 Wh/kg density

- Low capacity
- Non-rechargeable



Images: Adafruit, Blacksmithint

# NiCad is an older technology, but one still in use

- Inexpensive
- Standard Sizes
- Easy to recharge
- Low self discharge

- Low power density
- Memory effects
- Toxic metals


Images: Adafruit, Blacksmithint

# NiMH can be a good NiCAD replacement in some situations

- Somewhat Inexpensive
- Standard Sizes
- Somewhat easy to recharge
- High power density
- Better capacity than alkaline

- High self discharge
- Shorter service life




Images: Adafruit, Blacksmithint

# Li-Ion and LiPoly are common, but not always the best solution for field instruments

- Very light
- High power
- High capability
- High cell voltage

- Expensive
- Delicate
- Fire is the failure mode
- Hard to charge
- Poor temperature performance


Images: Adafruit, Blacksmithint

# Lithium primary batteries are becoming common for single use deployment batteries

- Very light
- High density
- High cell voltage
- High shelf life

- Non-rechargeable
- Low current capability
- Odd sizes


Images: Adafruit, Blacksmithint, Digikey

# If you are using a secondary battery consider solar charging and careful power budgeting

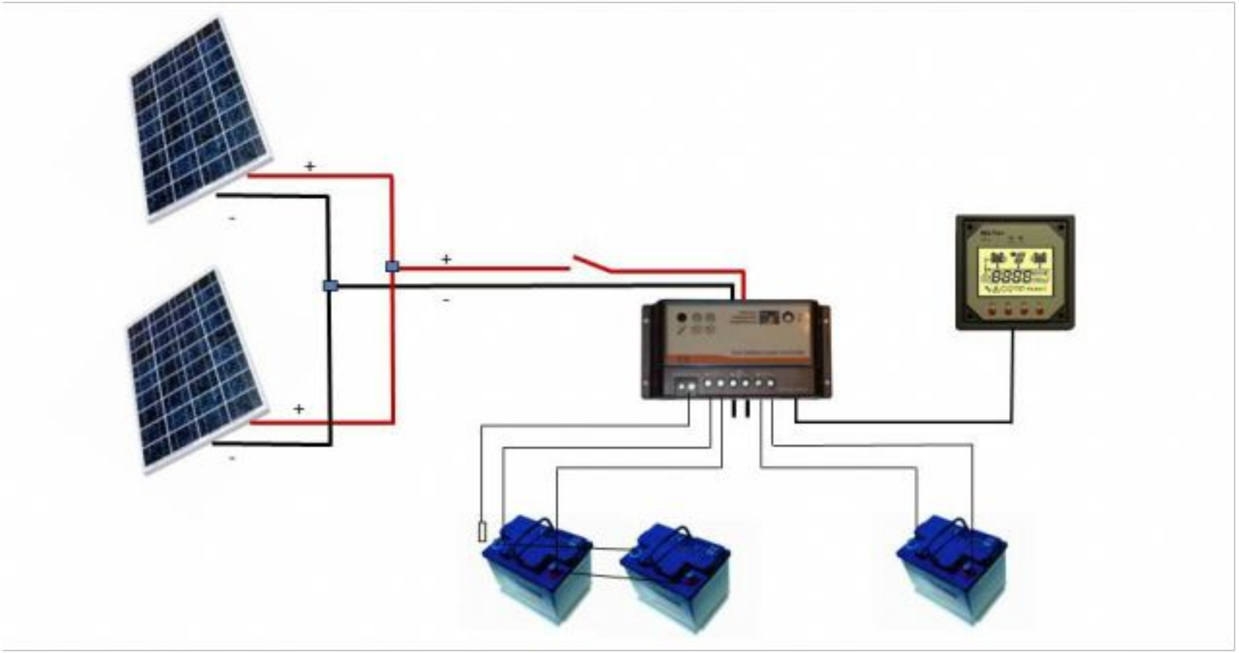




Image: Custom Marine Products

# Example power budget problem


Image: Shutterstock

# Enclosures are a whole other topic, but a few factors to consider

- Don’t reinvent the wheel
- Case pressure equalization
- Case condensation
- Gas buildup
- Greenhouse effect/internal temperature
- Camouflage


Image: Polycase, Nanuk

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# Telemetry or getting your data back can be very beneficial compared to local storage

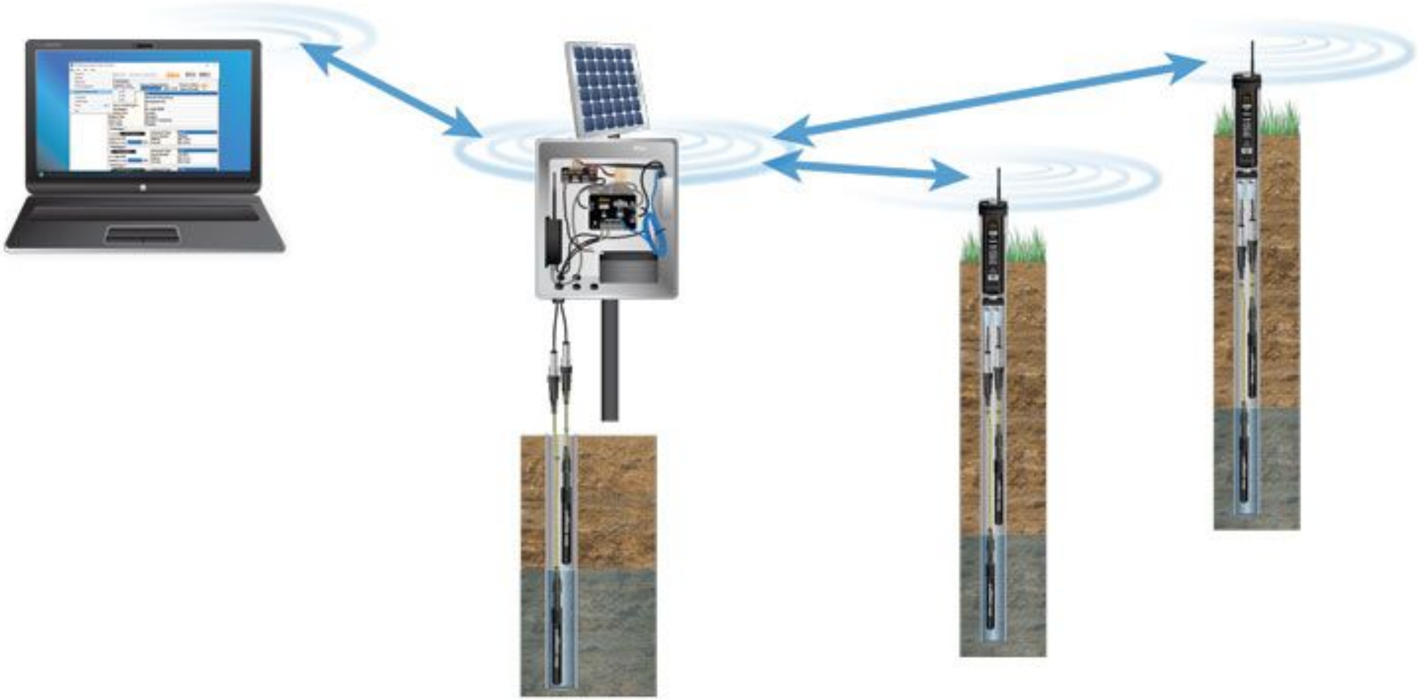



Image: Solinst

# Generally the goal is to get to the internet for cloud computing or storage of the data. Local data centers are for larger projects.

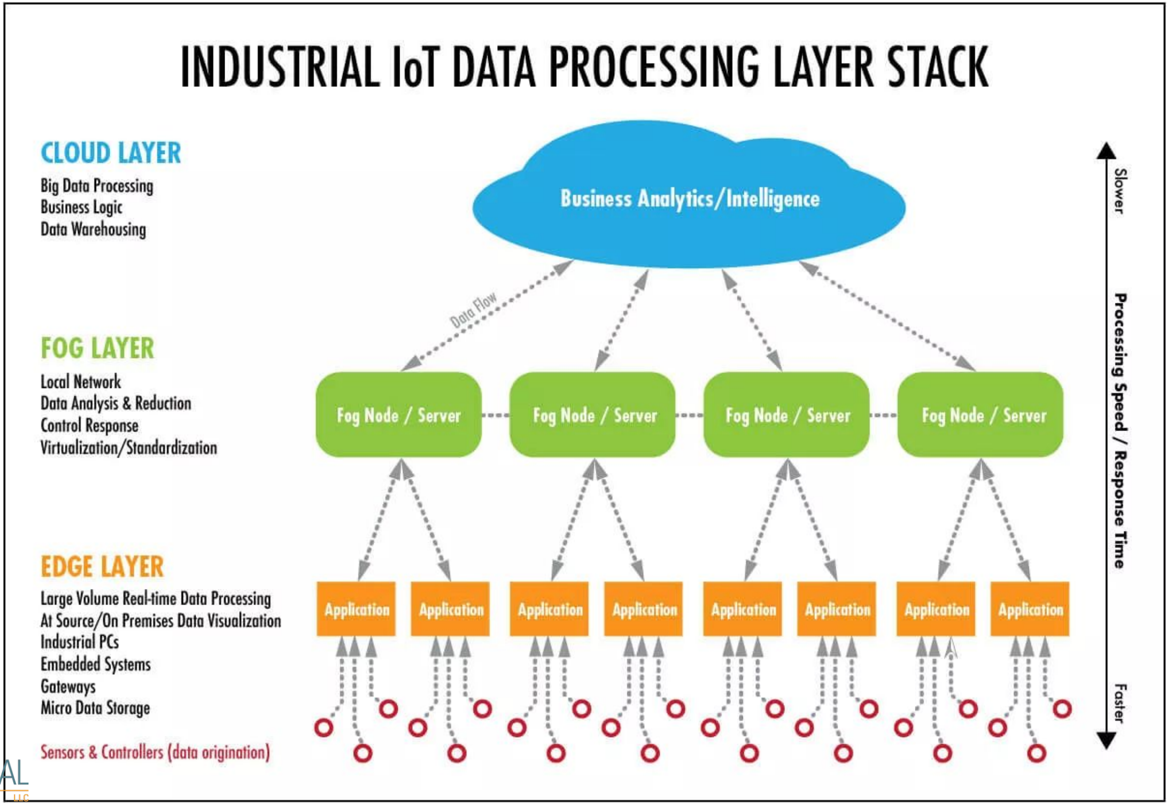


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Image: Winsystems

# Wired/serial connections to a computer are the easiest, fastest, and most reliable connections for telemetry

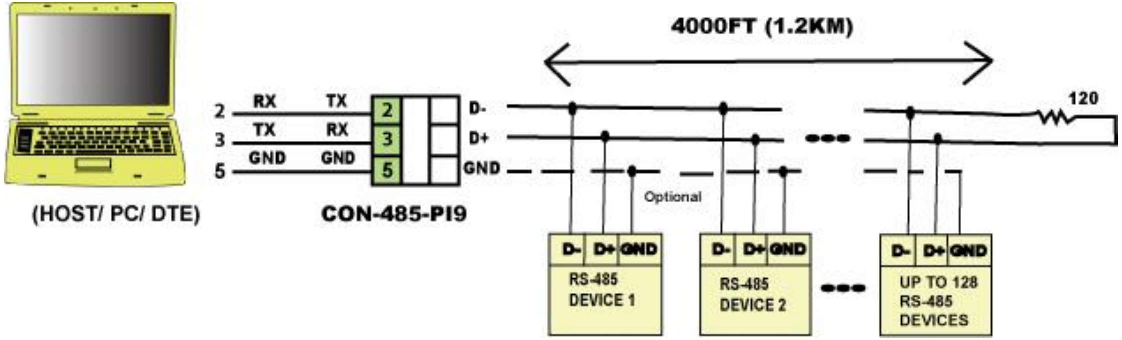



Image: Business Insider, RS232-Converters

# WiFi is becoming more ubiquitous, but can get expensive

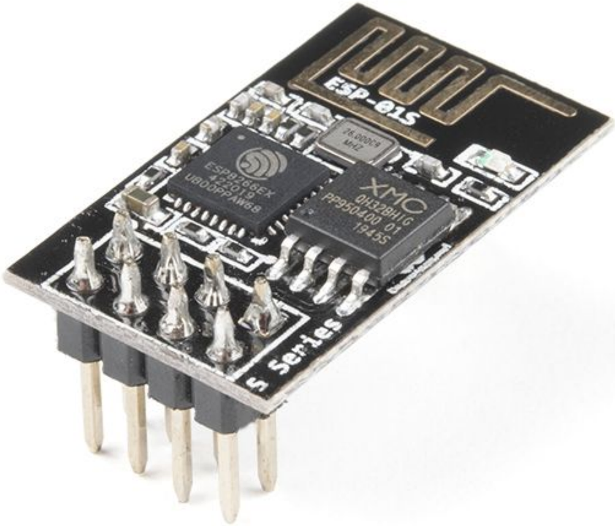





Image: Ubiquity, Sparkfun

# Xbee is a mid-range radio link that can get data in from a small field area to a telemetry node. They have mesh capabilities



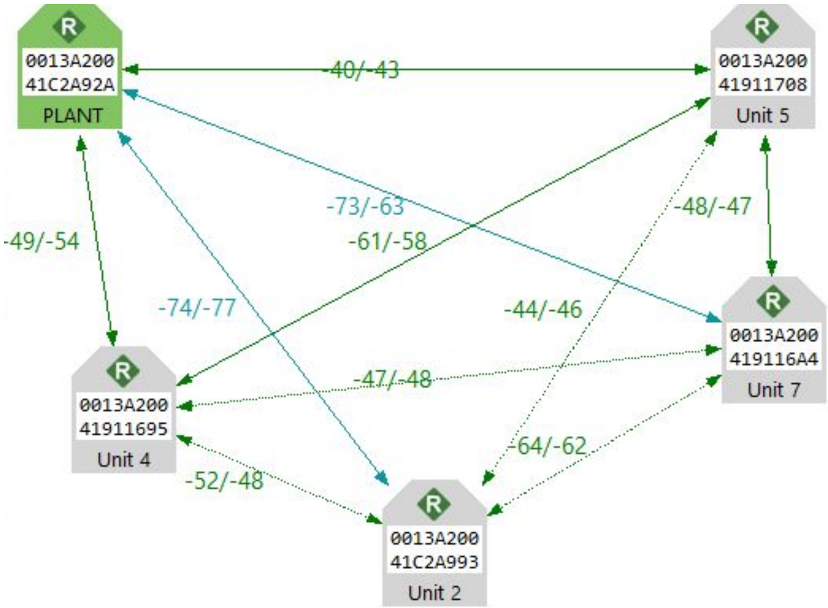
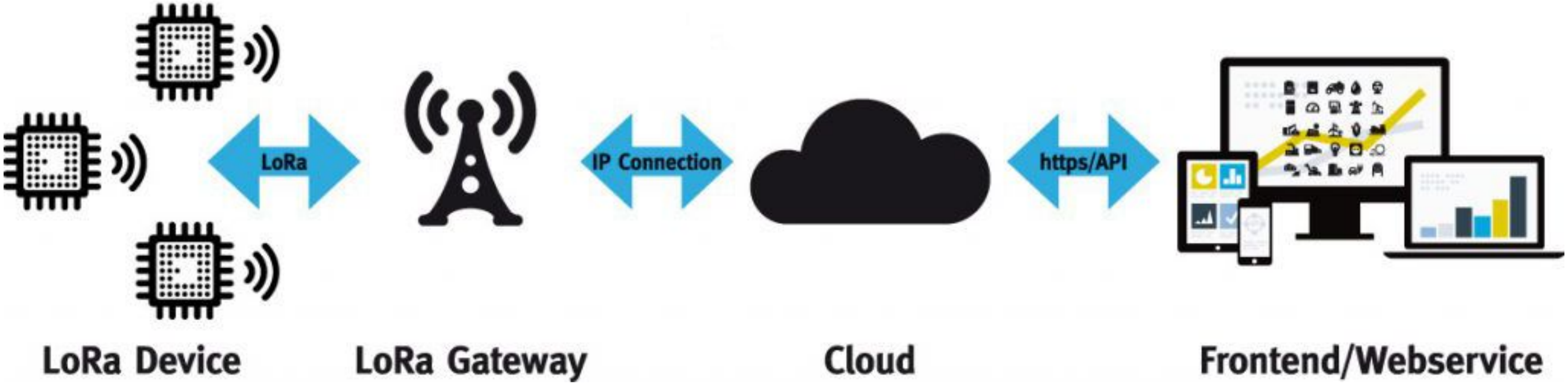
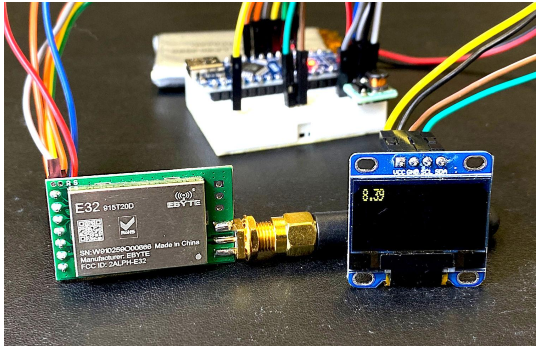


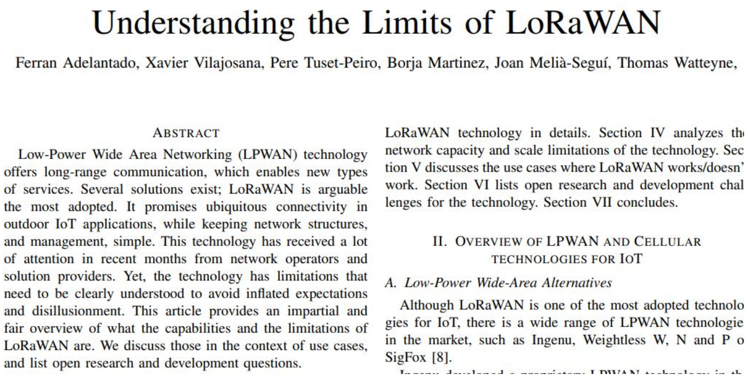



Image: Digi

# LoRa/LoRaWAN are emerging, but limited to low data rates



## Understanding the Limits of LoRaWAN

Ferran Adelantado, Xavier Vilajosana, Pere Tuset-Peiro, Borja Martinez, Joan Melià-Seguí, Thomas Watteyne,

ABSTRACT

Low-Power Wide Area Networking (LPWAN) technology offers long-range communication, which enables new types of services. Several solutions exist; LoRaWAN is arguable the most adopted. It promises ubiquitous connectivity in outdoor IoT applications, while keeping network structures, and management, simple. This technology has received a lot of attention in recent months from network operators and solution providers. Yet, the technology has limitations that need to be clearly understood to avoid inflated expectations and disillusionment. This article provides an impartial and fair overview of what the capabilities and the limitations of LoRaWAN are. We discuss those in the context of use cases, and list open research and development questions.

LoRaWAN technology in details. Section IV analyzes th network capacity and scale limitations of the technology. Sec tion V discusses the use cases where LoRaWAN works/doesn' work. Section VI lists open research and development chal lenges for the technology. Section VII concludes.

II. OVERVIEW OF LPWAN AND CELLULAR TECHNOLOGIES FOR IoT

*A. Low-Power Wide-Area Alternatives*

Although LoRaWAN is one of the most adopted technolo gies for IoT, there is a wide range of LPWAN technologie in the market, such as Ingenu, Weightless W, N and P o SigFox [8].

Image: Microtronics, MakerPortal

Bluetooth isn’t common for field devices other than for setup, but can be used in very small networks

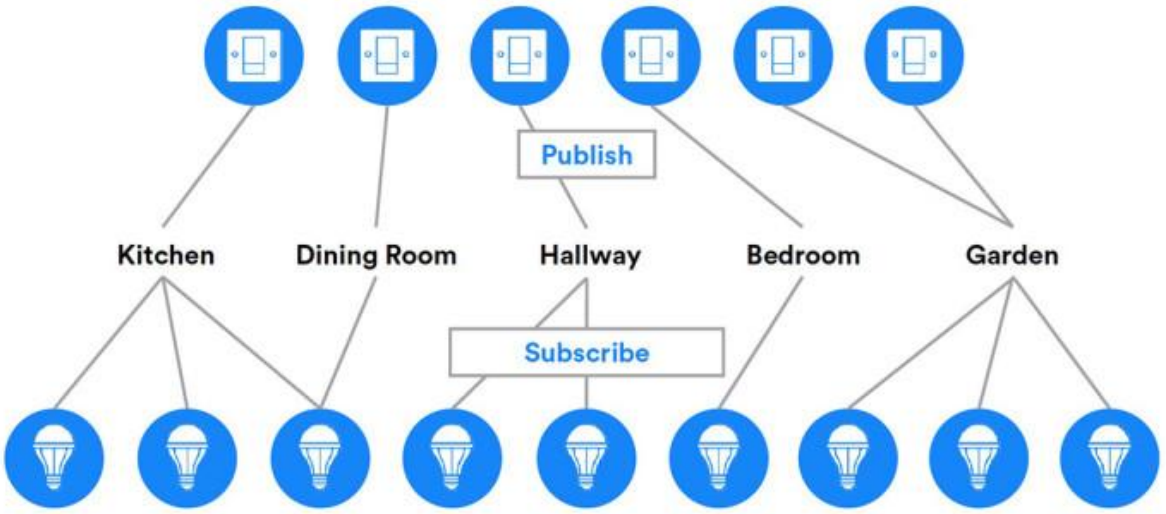
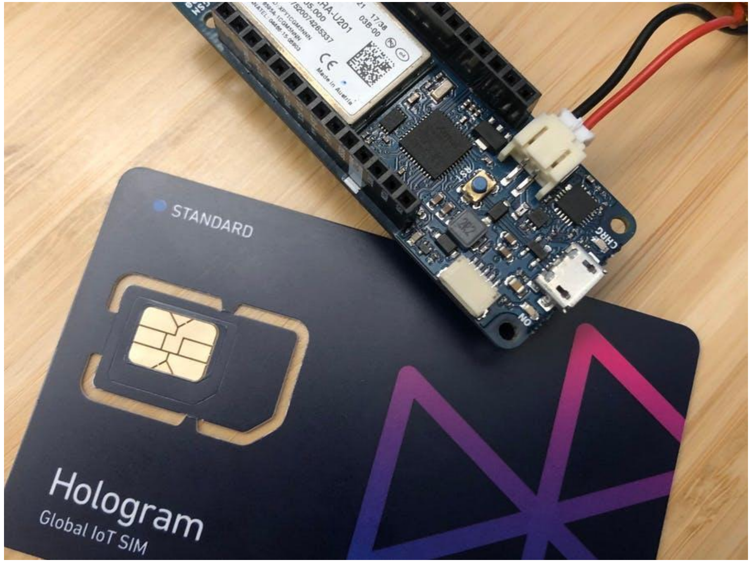



Figure 4 - Publish/Subscribe



Image: Circuit Cellar

# Cell modems are becoming inexpensive as long as coverage is available and the project is ground based




Images: Particle, Arduino

# As always these main three methods have a tradeoff space

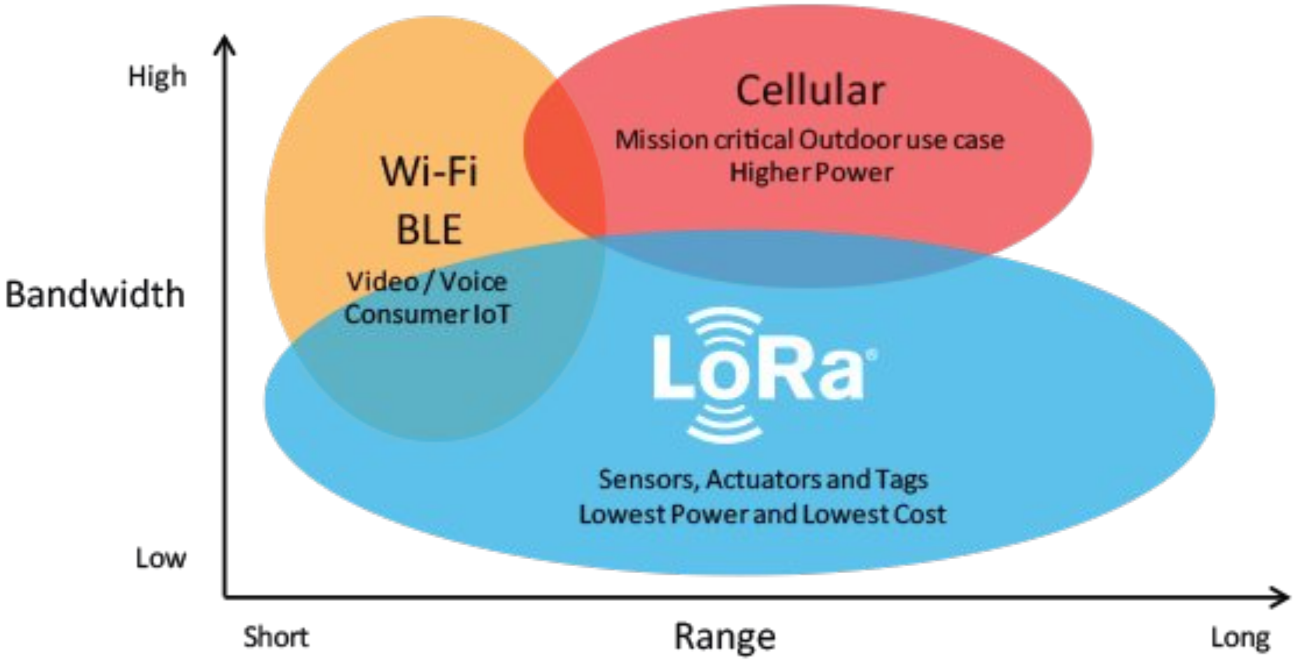



Image: Semtech

# Finally satellite data can be the easiest, but most expensive solution

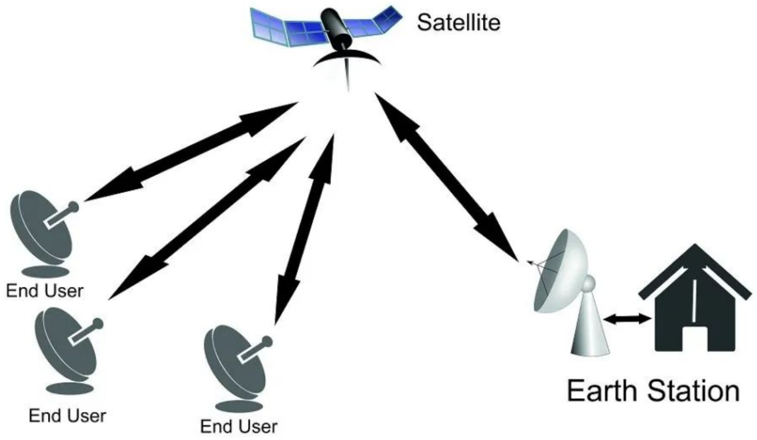



Image: CFI, Iridium Communications

# The key to any system is to plan the entire stack and data management system well in advance

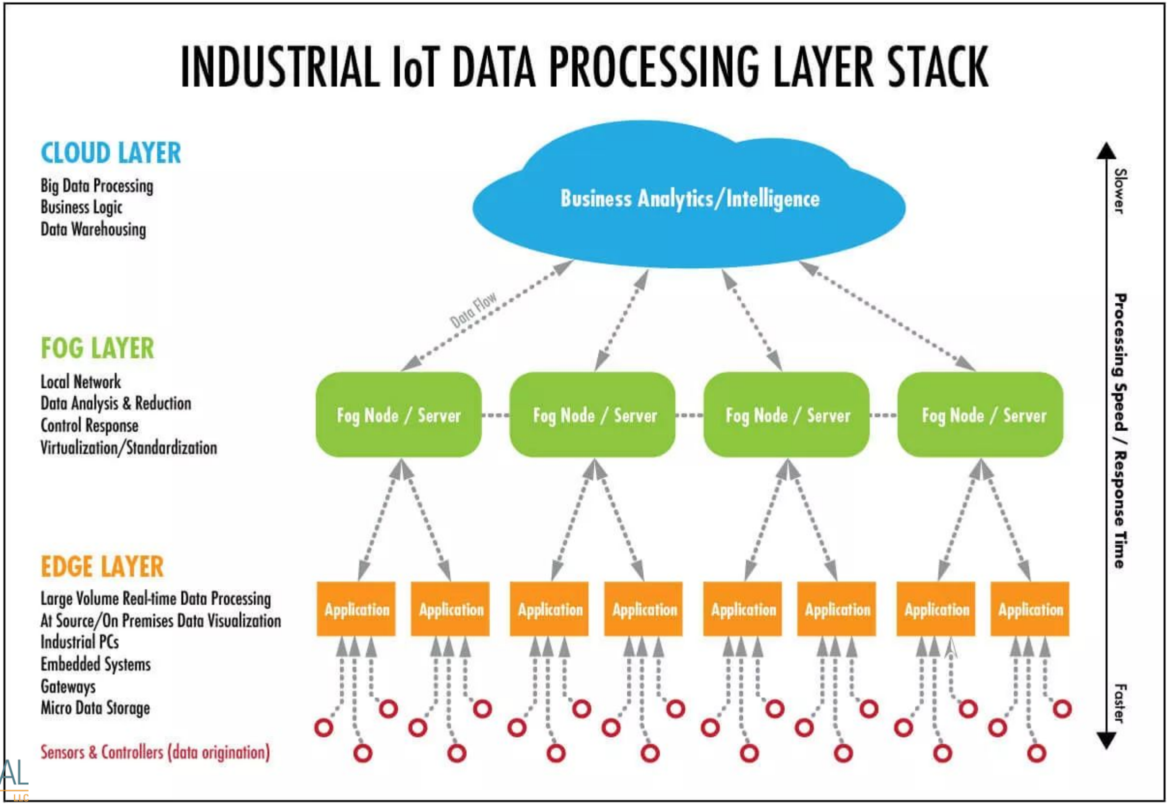



Image: Winsystems

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# We use AWS to house data produced and telemetered by many of these methods

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300534060707730_20210704.txt
300534060707730_20210705.txt
300534060707730_20210706.txt
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