Importance of long range –low energy radio technologies for Africa

in "IoT for sustainable development in Africa"

IoT Week 2018
Bilboa, Spain, June 6th, 2018

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IoT: development for rural areas
Long-range Sensing Applications

Moisture/ Temperature of storage areas

10-15kms

Pay subscription
Limitation of coverage
High energy consumption

<table>
<thead>
<tr>
<th>Technology</th>
<th>2G</th>
<th>3G</th>
<th>LAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range (I=Indoor, O=Outdoor)</td>
<td>N/A</td>
<td>N/A</td>
<td>O: 300m 1: 30m</td>
</tr>
<tr>
<td>Tx current consumption</td>
<td>200-500mA</td>
<td>500-1000mA</td>
<td>100-300mA</td>
</tr>
<tr>
<td>Standby current</td>
<td>2.3mA</td>
<td>3.5mA</td>
<td>NC</td>
</tr>
</tbody>
</table>
Low-power & long-range radio technologies (LPWAN)

Energy-Range dilemma

Long-range Low-power

- SIGFOX
- LoRa
- ZigBee 802.15.4
- Bluetooth 802.15.1

IEEE 802.22
IEEE 802.20
WiMax IEEE 802.16
2G/3G/4G

WiFi 802.11
802.15.3
802.15.3a
802.15.3c

Low throughput

Data Rate (Mbps)

Energy
Increasing range?

- Generally, robustness and sensitivity can be increased when transmitting much slower.
- A Sigfox message is sent relatively slowly in an ultra narrow band of spectrum. Max throughput =~ 100 bps.
- LoRa also increases time-on-air when maximum range is needed. But LoRa uses spread spectrum approach. Throughput =~ 300 bps - 37500 bps.
Other "long-range" technologies

- Weightless N, P
- LTE Cat-M1 Cat-M2
- 802.11ah
- RPMA (Ingenu)
- NWave
- Telensa
- Amber Wireless
- NB-IoT
- WavioT
NB-IoT: IoT cellular technology

- Narrow-Band-IoT radio technology can be deployed without changing the hardware already in place in operator's base station
- Can reuse GSM frequency bands
- uBlox, Quectel,…

From G. Gupta, D. Patil, "LoRa and NB-IoT"
## LoRa vs NB-IoT

<table>
<thead>
<tr>
<th>Feature</th>
<th>LoRa</th>
<th>NB-IoT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Licensed/Unlicensed Spectrum</td>
<td>Unlicensed Band</td>
<td>Licensed Band</td>
</tr>
<tr>
<td>Reuse of Cellular Network</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Development Status</td>
<td>Existing</td>
<td>Yet to develop</td>
</tr>
<tr>
<td>Modulation</td>
<td>SS chirp</td>
<td>QPSK</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>500 Hz - 125 KHz</td>
<td>180 KHz</td>
</tr>
<tr>
<td>Data Rate</td>
<td>290 bps - 50 kbps</td>
<td>250 kbps max</td>
</tr>
<tr>
<td>Device cost/complexity</td>
<td>1-5 $ (Ref- LPWA survey)</td>
<td>&lt; 5$ per module (Ref-IETF)</td>
</tr>
<tr>
<td>Latency and Battery Lifetime</td>
<td>&gt; 10 years</td>
<td>&lt;10 seconds, &gt;10 years battery (Ref-IETF)</td>
</tr>
<tr>
<td>Type of Standard</td>
<td>Proprietary</td>
<td>open</td>
</tr>
</tbody>
</table>

From G. Gupta, D. Patil, "LoRa and NB-IoT"
Needs, constraints, cost, design approach, control mechanism

Challenge: Bridging the digital divide
IoT in Africa usually means...

... deploying IoT in very isolated areas!
Private, ad-hoc LR network

Add LoRa radio module to your preferred dev platform

Install a LoRa gateway and start collecting data

Soil moisture
Leaf wetness

10-15kms

No subscription
Deploy own network
Low energy consumption

Libelium LoRa
HopeRF RFM92W/95W
Modtronix inAir9/9B
LoRa1276
NiceRF LoRa1276
Long-range IoT architecture

Devices
- Pet tracking
- Smoke alarm
- Water meter
- Trash container
- Vending machine
- Gas monitoring

Gateways
- LoRaWAN, SigFox
- LoRaWAN, TCP, UDP, MQTT,

Network Servers
- TCP, UDP, MQTT,

Application Servers
- HTTP, REST API, MQTT, SMS,

End-users
- IoT cloud

IoT cloud
- HTTP, REST API, MQTT, SMS,
1-hop connectivity to gateway is difficult to achieve in real-world, remote, rural scenarios
2-hop long-range approach

- **smart, transparent** relay node should be able to be inserted at anytime between end-devices and gateway to increase range.
Affordable technologies to empower rural economics

Exploit advanced research capitalizing on IoT and Big data state-of-the-art findings

Develop IoT solutions and applications meeting African needs

waziup.eu
Waziup IoT
Waziup

waziup.community@create-net.org
Ready-to-use templates

Moisture/
Temperature of
storage areas

Physical sensor

Physical sensor

Physical sensor

10-15kms

Physical sensor

Physical sensor

Physical sensor

Arduino Pro Mini @3.3V

AES encryption

Long-range transmission

Logical sensor mgmt

Activity duty-cycle, low power

setup

xxxxxx

measure

(encrypt)

transmit

sleep

wake-up

Moisture/
Temperature of
storage areas
From generic to specific applications

- GPS collar
- Image sensors
- Buoy for water quality
- Soil Moisture
- Weather Station
- Waste Mngt

Photo from EGM
Bin presented at Woelab

Photo from Unparallel
Data post-processing stage

Incoming data parsing block

- Handle downlink data
- AES encryption decryption
- LoRaWAN interoperability
- Handle data from other radio interfaces
- Periodic task
  - Monitor gateway temperature

Post-processing

stdout

Cloud definition

- cloud_script_1
- cloud_script_2
- cloud_script_n

Local database

user/app-specific

RPI 3
- WiFi
- LoRa

RPI ZeroW
- WiFi
- LoRa+2G/3G shield

RPI 3
- WiFi
- LoRa
- PoE
- 2G/3G dongle
- DHT22 in-case sensor

cloud_script_1 cloud_script_2 cloud_script_n

WAZIUP

Radio bridge program

stdout stdin

JSON

JSON

Standards
Open, versatile gateway

MongoDB

WiFi

PHP

jQuery
Conclusions

- IoT is growing fast, with new cutting-edge radio technologies and frameworks
- NB-IoT is pushed hard by most of operators but they are also rolling out large-scale SigFox and LoRa networks (just-in-case 😊)
- In the Africa context, both operator coverage and Internet access issues must be taken into account
- Good long-range radio candidates must allow ad-hoc deployment and local gateway on customer premises