Intelligent Street lighting management using ZigBee®

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Agenda

• Digi Overview
• What is ZigBee?
• Typical M2M Scenario and the challenges
• The Digi solution: ZigBee Modules, Gateways and iDigi™ for easy M2M networking
• Business case: Owlet systems architecture for public lighting network
Digi International Background

- Founded in 1985 as DigiBoard®
  - Public offering in 1989 – NASDAQ: DGII
  - Based in Minnetonka, MN
  - 650+ employees worldwide

WorldWide Presence

www.digi.com
Digi Europe & MEA

- **HQ in Paris**:
  - European Management
  - Marketing & Sales
- **Sales offices**:
  - Belgium, Denmark, France, Germany, Russia & Eastern Europe, Spain, The Netherlands, UK
- **Admin & Support Center in Dortmund**:
  - Finance & Administration
  - Product Specialists
  - Technical Support
- **R&D locations**:
  - Breisach, Germany
  - Logroño, Spain
  - Ilkley, UK
- **Distribution Channel**:
  - Strong network of distribution partner and Integrators
Core Competencies

- Processor Modules
- Wireless and M2M
- Design Services
- Wireless Gateways
- Device Management Services
Digi Provides the Broadest Platform of Network Connectivity Solutions

Connectivity Solutions
- USB & Serial Connectivity
- Devices & Terminal Servers
- Wireless Gateways
  - RF, ZigBee, Satellite, Cellular
- Console Management
- Cellular Routers
- RF & ZigBee Adapters
  - 868 MHz – 900 MHz – 2.4 GHz

Embedded
- Processors
  - 8 and 32 bits
- Embedded DeviceServers
- Core Modules
  - Rabbit & Digi
- RF & ZigBee Modules
  - 868 MHz – 900 MHz – 2.4 GHz
- Satellite modems

Management Platform

www.digi.com
What is ZigBee?

The wireless mesh networking standard for monitoring & control

- Reliable & robust (self-healing)
- Interoperable (multiple vendors)
- Simple (self-configuring)
- Flexible (mesh topology)
- Secure (built-in AES Encryption)

<table>
<thead>
<tr>
<th>Market Name</th>
<th>Wi-Fi™</th>
<th>Bluetooth™</th>
<th>ZigBee™</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underlying Standard</td>
<td>802.11b</td>
<td>802.15.1</td>
<td>802.15.4</td>
</tr>
<tr>
<td>Application Focus</td>
<td>Web, Email, Video</td>
<td>Cable Replacement</td>
<td>Monitoring &amp; Control</td>
</tr>
<tr>
<td>Battery Life (days)</td>
<td>0.5 - 5</td>
<td>1 - 7</td>
<td>100 - 1,000+</td>
</tr>
<tr>
<td>Network Size</td>
<td>32</td>
<td>7</td>
<td>2 to 1000s</td>
</tr>
<tr>
<td>Bandwidth (K bits/s)</td>
<td>11,000+</td>
<td>720</td>
<td>20 - 250</td>
</tr>
<tr>
<td>Range (meters)</td>
<td>1 - 30+</td>
<td>1 - 10+</td>
<td>1 - 100+</td>
</tr>
<tr>
<td>Network Architecture</td>
<td>Star</td>
<td>Star</td>
<td>Mesh</td>
</tr>
<tr>
<td>Optimized For</td>
<td>Speed</td>
<td>Convenience</td>
<td>Reliability, Low Power, Scalability</td>
</tr>
</tbody>
</table>
The ZigBee Alliance

“The ZigBee Alliance is a global ecosystem of companies creating wireless solutions for use in residential, commercial and industrial applications. The ZigBee Alliance companies work together to enable products based on an open global standard. The ZigBee Alliance membership comprises technology providers and original equipment manufacturers worldwide. Membership is open to all.”

More than 300 members, including Digi International
Owlet System Architecture

Central Management System with Database and Web Services

Segment Controller

Webbrowser

ZigBee - Meshnet

Lamp

Ballast

Luminaire Controller
M2M Application Example

Street 1

Intelligent Gateway

Street 2

Remote Information Assets

Business Applications

Internet VPN

HQ

- Public Street Light
- Connect Port X4
- XBee Module
- XBee Adapter
- XBee Wall Router
- WAN/IP Traffic
- XBee/WPAN Traffic
Typical M2M Scenario

Collect & Transfer & Present Information

Remote Information Assets

Network

Business Applications
Typical M2M Scenario

Collect & Transfer & Present Information

Remote Information Assets

Network

Business Applications
Typical M2M Scenario

Collect & Transfer & Present Information

Remote Information Assets

Network

Business Applications

Use Mobile Connectivity

Use Corporate Access
Typical M2M Scenario

Collect & Transfer & Present Information

Remote Information Assets → Carrier Network → Public Internet → Business Applications

Use Mobile Connectivity

Use Corporate Internet Access

It becomes complex and there are several challenges
Typical M2M Scenario

Collect & Transfer & Present Information

Remote Information Assets ➔ Business Applications

But don’t worry

• It is possible!
• It is prooven!

• Use your partners knowledge
• Focus on your business
• We can build solutions together

Here are the solutions -→
M2M Building Blocks from Digi

• **Gateways = Connectport X**
  – Provide WAN to PAN connectivity (Cellular, WiFi, Ethernet..)
  – Intelligent = Programmable in Python

• **Embedded RF Modules = XBee**
  – Mesh or Point-to-Multi Point topology
  – ZigBee® (incl. Smart Energy Profile) at 2.4GHz
    Wireless M-Bus and proprietary at 868 and 900Mhz
  – Many partners developed energy devices such as thermostats, displays, meters, sensors, and load control devices.

• **Adapters and Sensors based on Embedded RF Modules**
  – RS232, RS485, Digital & Analog I/O
  – Smart Plug, Sensors (Temp, Humidity, Light), Wall Routers
  – Migration path for existing assets

• **Communication & Service Platform = iDigi**
  – Solutions for easy connectivity and management
  – Consists of Python framework (iDigi DIA) and Hosted service (iDigi platform)
What is XBee?

- Rapidly create wireless Machine-to-Machine (M2M) solutions using Xbee modules
  - Common Footprint
  - Common API
  - RF Certified
  - Various Protocols

- Complete solution with a Hardware Profile and a Networking Protocol (firmware)
What is iDigi?

iDigi is a Machine-to-Machine (M2M) Management Cloud Service Platform. The iDigi Platform provides 3 CORE capabilities:

1. **Connectivity** for Digi & 3rd party gateways over all network types
2. Web-services protocol for application **integration**
3. Centralized **management** of gateways and end-devices

Key Message: *iDigi provides...*

**Connectivity** | **Integration** | **Management**
What is iDigi-Dia?

- Digi’s iDigi -Device integration Application (iDigi-Dia) is software that runs on Digi gateways. It is NOT a solution in itself, but an enabler that dramatically accelerates building M2M solutions.
- iDigi-Dia makes collecting and using remote data easy, providing a powerful environment for rapid M2M solution creation.
- iDigi-Dia collects & logs data from any device which can communicate with a Digi gateway. It also can change (transform) that data before presenting to a customer-defined application.
- iDigi-Dia is written in Python, is supported by Digi, and is provided to customers for their use and optional customization.
- iDigi-Dia is free for Digi customers to use with Digi products.
iDigi Connectivity

iDigi-Dia Concept

- Device Driver
- Device Control
- Channeling / Multiplexing + Logging
- Presentation (e.g. Web)
- Presentation (e.g. XML)
- Presentation (e.g. Modbus)

Two-Way Data Flow
iDigi Application Integration

iDigi Platform as a hosted service
• Application is addressing gateways and devices by ID / name (no IP addressing)
• Gateway is converting Webservice to required Device communication
• iDigi Server connects both sides
• iDigi is secure, easy – Build your M2M solution in short time
<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authentication</td>
<td>Auto-detect and authorize gateways in the network</td>
</tr>
<tr>
<td>Account Management</td>
<td>Set-up user accounts with specific access and privileges</td>
</tr>
<tr>
<td>Configuration</td>
<td>Modify configuration of gateways and devices</td>
</tr>
<tr>
<td>Software Update</td>
<td>Update firmware on gateways</td>
</tr>
<tr>
<td>Group Update</td>
<td>Batch update firmware on groups of gateways</td>
</tr>
<tr>
<td>Gateway Framework</td>
<td>Program gateway functions</td>
</tr>
<tr>
<td>Storage</td>
<td>Persist and store network data</td>
</tr>
<tr>
<td>Web Services</td>
<td>Integrate applications via a web services protocol</td>
</tr>
</tbody>
</table>
Welcome to the iDigi Platform.

You are minutes away from being able to provision your first device. Here are a few tips to get you started.

**The Devices Tab**
Add and manage your devices on the Devices tab. Click the plus button on this tab to add devices.

**The Services Tab**
Monitor and control your iDigi service subscriptions on the Services tab.

**iDigi Connectivity Server**
To access and manage your devices remotely, they must be configured to connect to an iDigi Connectivity Server address. This address can be found in the blue banner on this page.

Ready

Read my.idigi.com
iDigi Value Proposition

iDigi is the industry’s price performing leading solution

- Free sandbox for up to 5 gateways
- Zero cost to implement
- Zero cost for infrastructure
  - utilizes existing corporate broadband network
  - does not require hardware
  - does not require software licenses
- No long-term contract
- Low monthly subscription fee incl. Management
M2M Building Blocks from Digi

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Benefits in brief:

- Energy saving
- Energy metering
- Better maintenance
- Less greenhouse gases
- Improves reliability and security
Owlet System Architecture

Up to 150 Nodes per SeCo

Antenna Options: 2/10/50mW

2mW / 100m pole to pole distance
ZigBee-Mesh-Net

**Luminaire Controller Interface = XBee**
- Router Configuration
- ZigBee® at 2.4GHz
- API Mode

**Segment Controller = Connectport X**
- WAN to PAN connectivity (Cellular, Ethernet..)
- Owlet functionality programmed in Python working on iDigi DIA
Pilot Installation „Powerline Solution“

Knowledge about Grid Structure

- Noise fluctuates in mix grid’s
- Attenuation have to be measured

Attenuation values:
- 0 dB
- 54 dB
- 48 dB
- 66 dB
- 72 dB
- 54 dB
- 36 dB

Classification:
- excellent
- good
- bad
- no chance
Pilot Installation „Proprietary RF Solution“

Range is important in a non mesh net.

Channel’s are limited, e.g. 868MHz/1 Ch.

Bandwith is limited in low frequency net’s.
Pilot Installation with a ZigBee mesh network

Range extended by mesh hopping

Channel’s 16 available & auto assigned

Plus self healing adv. routing
# Antenna Selection: Range Tests

## Range tests:

<table>
<thead>
<tr>
<th>Transmit power</th>
<th>Range [meter] / Averaged of 5 measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dipol-Antenna</td>
</tr>
<tr>
<td>-7dBm = 0,2mW</td>
<td>328,5</td>
</tr>
<tr>
<td>-1dBm = 0,8mW</td>
<td>515,7</td>
</tr>
<tr>
<td>+3dBm = 2mW</td>
<td>665,1</td>
</tr>
</tbody>
</table>

Slave Node

Loop Back Adapter

Master Node in top of a car roof
Interference field tests – Coexistence WiFi / ZigBee

WLAN Kanal 1.
Netto-Übertragungsrate 340kbit/s

ZigBee Kanal 12.
Netto-Übertragungsrate 10,5kbit/s
Interference field tests – Coexistence WiFi / ZigBee

WLAN Kanal 1.
Netto-Übertragungsrate 340kbit/s

ZigBee Kanal 12.
Netto-Übertragungsrate 10,5kbit/s
# Interference field tests – Coexistence WiFi / ZigBee

## Interference Field tests

### 'Worst Case Scenario’

<table>
<thead>
<tr>
<th>Baud rate without WLAN activity</th>
<th>Relative decreasing baud rate [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 Hops</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>100%</td>
<td>48%</td>
</tr>
</tbody>
</table>

| Baud rate with 100% WLAN activity | 30% | 24% | 17% |

## Interference consideration

### 'Normal Case Situation’

- **802.11**
  - Kanal 1
  - Kanal 6
  - Kanal 11
  - 2400 MHz
  - 2412 MHz
  - 2437 MHz
  - 2462 MHz
  - 2483.5 MHz

- **802.15.4**
  - Kanal 1
  - Kanal 6
  - Kanal 11
  - 2400 MHz
  - 2405 MHz
  - 2410 MHz
  - 2415 MHz
  - 2420 MHz
  - 2425 MHz
  - 2430 MHz
  - 2435 MHz
  - 2440 MHz
  - 2445 MHz
  - 2450 MHz
  - 2455 MHz
  - 2460 MHz
  - 2465 MHz
  - 2470 MHz
  - 2475 MHz
  - 2480 MHz
  - 2483.5 MHz

**this is still 5x faster than PowerLine**
Questions?