



## **Wavecom Blue Paper**

# RIPlink: Deploy IP (Internet Protocol) Applications on Any Network

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## Executive Summary

The majority of communication systems are now designed around Internet Protocol (IP), which is the most standard and widely deployed architecture. By defining a clear separation between networks and services, IP offers interoperability and extensibility, resulting in lower up-front investments, maintenance cost savings and future-proofing of long-life products. M2M (machine-to-machine) applications remain the exception to the rule since they do not yet widely use IP technology. One of the reasons is that many M2M solutions cannot efficiently support IP from end-to-end. The burden on resource-constrained devices and limited bandwidth networks has until now been considered a show stopper.

To overcome these technological barriers that currently limit connected M2M growth, Wavecom has designed an innovative technology that extends IP networks' reach low-resource machines. This Remote IP – RIPlink<sup>TM</sup> – technology was designed specifically to save resources (memory, CPU, battery life, bandwidth) while enabling standard TCP and UDP applications to be ported on any device and connected over any non-IP network. This includes in particular low power RF networks, such as ZigBee or Power Line Communication (PLC) wired networks.

Thanks to a RIPlink Gateway device that is connected on one side to the IP network, and on the other side to one or more non-IP networks, standard TCP or UDP applications can run on non-IP devices and have access to the IP network resources. No IP stack is required on the device; the underlying non-IP network remains unchanged. The application on the device is independent from the non-IP network, in the same way that IP applications are independent from their underlying IP network.

With RIPlink, IP solutions can easily operate over heterogeneous IP and non-IP networks. For example, the same application designs can directly be ported straight from one network environment to another.

RIPlink technology has been successfully ported and demonstrated over several non-IP networks, including ZigBee or PLC. In order to ensure that the M2M community benefits to the fullest from RIPlink technology, Wavecom is making RIPlink available as an industry standard, with freely available specifications and with solutions available from Wavecom and other RIPlink adopters.

RIPlink provides a unique opportunity for the M2M community to leverage IP standards, while choosing the best network technology suited to each specific M2M application. A number of important benefits can be derived by deploying a standard IP application, including: significant cost savings, better and faster integration with information systems or consumer equipment, and maximized investment protection for long-life products. By choosing the right network interface for each solution, power consumption, equipment cost, or performances can be further optimized.

## Why IP, Why RIPLink?

### Choosing a communication technology

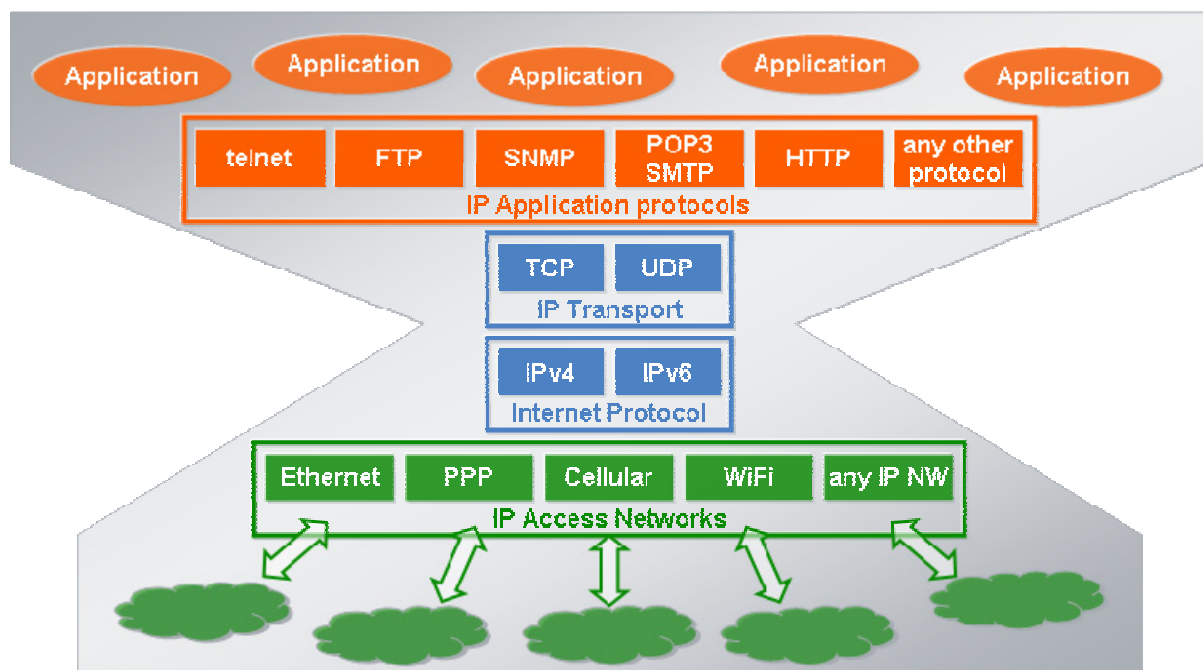
Machine-to-machine (M2M) solutions, by definition require “inter-connecting” machines. The choice of the communication technologies is complex, and key for obtaining the best possible result. It will directly impact the cost (deployment and operation) and the quality of the end solution.

But this choice will also determine how fast and easy, or how long and complex, the application development, porting and evolution will be. Decoupling the communication and the application, with a standard, well-known and future-proof interface is the right way to save development resources, focus on the end solution, and protect the overall investment.

### IP is now also the reference architecture for M2M

Internet Protocol (IP) architecture has been several years now, the undisputed reference for communicating applications. There is no system design today that does not consider inter-connecting to IP.

The range of applications available today on TCP and UDP Transport protocols is almost unlimited, benefitting from a long list of popular application-layer protocols (telnet, FTP, SNMP, POP3/SMTP, HTTP, etc.) and a very strong and active IETF (Internet Engineering Task Force) standardization organisation. The telecom industry has invested significant resources over years to design, validate and deploy a wide range of TCP and UDP-based solutions, both for industrial and consumer applications.



**Internet Protocol based architecture**

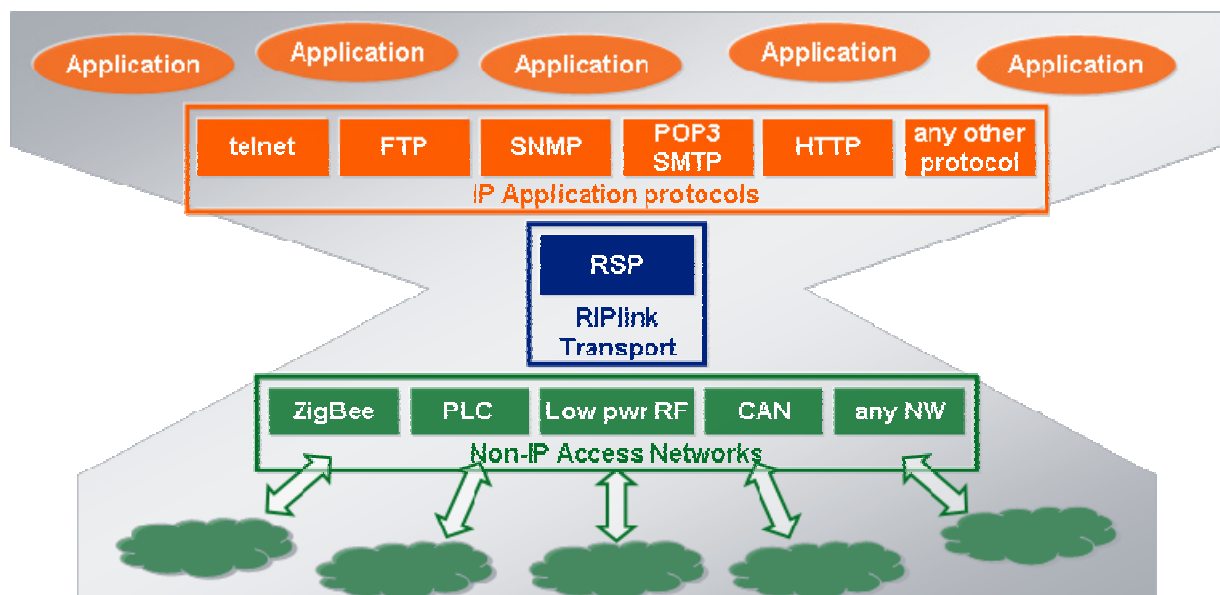
While benefitting from such developments, machine-to-machine (M2M) industry players must invest more in the coming years in communicating application design, to address its fragmented market: automotive Telematics, vehicle and assets tracking, healthcare, metering, payment terminals, vending machines, home and building automation, alarm and security systems, etc. The best way to secure such investment is by relying on the most future-proof communication protocols: TCP and UDP. This is the guaranty for best transition path while communication technologies – in particular wireless –

evolve. It will facilitate the integration with existing companies' information systems, and other machine networks or consumer applications.

On the other hand, M2M applications have their specific constraints, often implying the use of specific wired and wireless networks optimized for power consumption, limited function devices, coverage, deployment costs, etc. Many of such networking technologies do not natively support Internet Protocol networking.

### ***RIPlink enables IP applications on any network – easily***

RIPlink, standing for Remote IP link, is a technology specifically conceived to allow standard TCP/UDP applications to be run on any non-IP devices and inter-connect over any non-IP and IP networks. RIPlink technology, with its specific Remote Socket Protocol (RSP), offers to the application the same independence to the physical network as regular IP network does.



***RIPlink offers same abstraction level to IP Applications as IP Transport layers***

RIPlink was designed by Wavecom with the goal of simplicity, portability and resources optimization. Since Wavecom recognizes that each byte to be transmitted in a machine network has a cost, they must thus have a value.

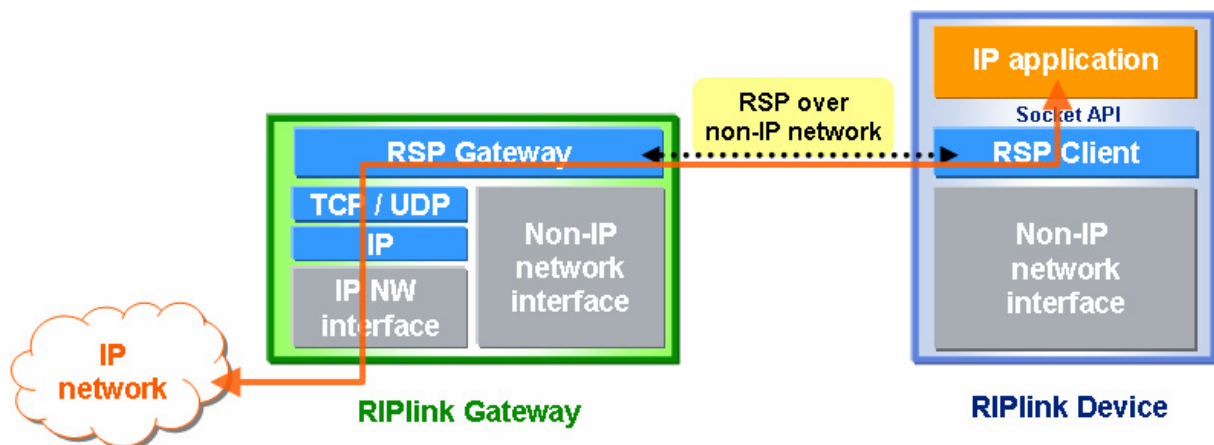
RIPlink technology's simplicity and portability resides in the ability to fully re-use the existing networking layer. RIPlink can be easily ported on any standard or proprietary solution, wired or wireless, whatever the topology (ad-hoc, tree, mesh, etc.). RIPlink even allows the exact same application to run across heterogeneous networks.

RIPlink is resource-friendly; it does not require the non-IP device to run any IP or TCP stack, thus saving cost, power consumption and complexity.

## RIPlink Technology Overview

### How RIPlink works?

RIPlink technology relies on a RIPlink Gateway running the IP, TCP and UDP stacks, and connected to IP network or hosting local IP applications. The RSP protocol, acting as a remote procedure call protocol, exposes the RIPlink Gateway TCP/UDP socket Application Programming Interfaces (APIs) to the applications running on RIPlink Devices. RIPlink Device does not need any IP, TCP nor UDP stack, but simply an RSP Client.



*RIPlink Device and Gateway Device – Layers view*

The IP application running on the RIPlink Device is seen from the IP network as running on a port of the RIPlink Gateway. It can be a client or a server application.

Several IP applications can run on the same RIPlink Device. The RIPlink Gateway can manage simultaneously several RIPlink Devices, on one or more different non-IP networks.

### Benefits

RIPlink, by allowing standard IP applications to run on non-native IP devices, drastically simplifies M2M application design and deployment and helps protect investment:

- **Application design is standard and portable**, using BSD-like TCP/UDP socket APIs: applications are easily developed and portable across usual operating systems; re-use is maximized for both IP and non-IP networks;
- Applications are **network independent**: no need to learn about the non-IP network specificities; no need to modify the non-IP network: routing capabilities, including mesh when available, are unchanged; no network specific application profile is required;
- Application **operates on heterogeneous devices**, across any heterogeneous **non-IP and IP networks**, simply using standard IP;
- Application **operates on heterogeneous devices**, across heterogeneous **non-IP and IP networks**, using standard IP addressing principles (address and port).

RIPlink has been designed to optimize the scarce network and device resources by re-using the existing networking and transport layers of the IP and non-IP network:

- **IP without IP overhead** allowing more devices to be connected and resulting in battery life savings: only 3 bytes overhead for TCP data and a few bytes to establish a connection, far below the usual 40 byte overhead for TCP plus IP;



- **No IP routing need in the device:** with the RIPLink Gateway IP address used to address all attached RIPLink Devices, RIPLink can be deployed on IPv4, IP routing is not impacted and remains located into the IP network. As a counterpart, as for a NAT architecture, RIPLink Devices are not individually addressed by an IP address but at application level;
- **Minimal – software only – impact,** typically few kilobytes of code (<10kB), low data memory, no significant CPU requirement, no real-time constraints, no OS required on RIPLink Device; this is to be compared to few hundreds of kilobytes of code, and of RAM, for usual TCP/UDP/IP stacks.

With such combined performance, simplicity and flexibility, RIPLink can be introduced now and smoothly. RIPLink can co-exist with legacy devices and applications. When needed, non-IP applications can be used in conjunction with IP based applications.

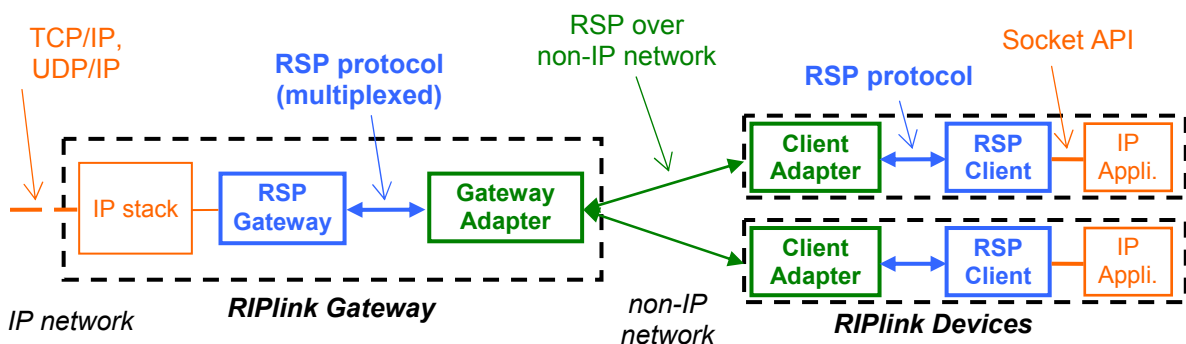
## Existing Alternatives to RIPLink

Today, the main alternative proposals to RIPLink, for providing IP access to non-IP networks, are:

- Using IP networking evolution to address these specific networks, in particular considering ongoing IETF specification activities such as 6lowPAN and ROLL. Even if the long term benefit is to fully integrate all devices in the IPv6 networks, a gateway device between IP and 6lowPAN networks will be needed for long time, as usual IP networks do not support 6lowPAN – or even IPv6 – from Day One. In addition, this kind of approach imposes some trade-offs on routing and networking capabilities, thereby losing part of the specifics and optimization of each network technology.
- Designing an application-level gateway. The gateway embeds an application that on one side connects to the IP world, and on the other side is designed specifically for the non-IP network. Such an approach presents the disadvantage of requiring the re-design of the application, on the gateway and on the end-devices, for each network. It makes the gateway more and more complex as it handles different non-IP networks. In addition, interoperability at the application level requires defining a specific application profile for each network, and for each application.

## RIPLink Reference Architecture

The RIPLink Reference Architecture defines software components and interfaces, to allow modular and interoperable implementation of RIPLink across various devices and non-IP networks.



**RIPLink Reference Architecture**

The RIPLink Reference Architecture software components are:

- The RSP Gateway which is part of the RIPLink Gateway is independent from the non-IP network. RSP Gateway does interface to the RIPLink Gateway TCP/UDP/IP stack. RSP Gateway implements the Remote Socket Protocol server side.

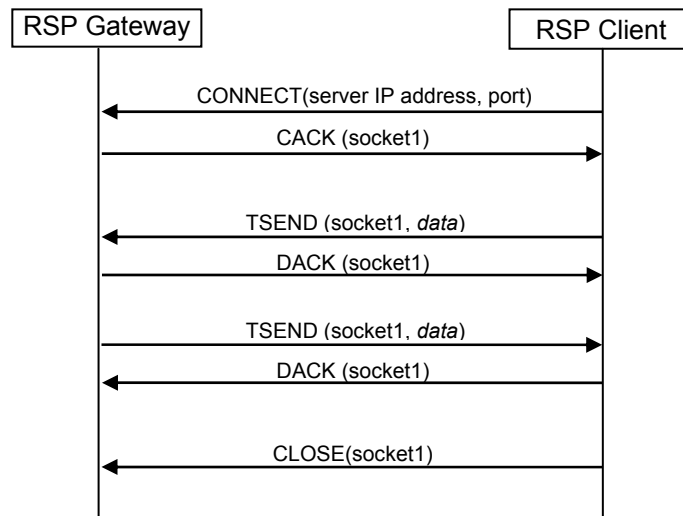
- The RSP Client which is part of the RIPlink Device and is independent from the non-IP network. RSP Client exposes the RIPlink socket APIs to the IP Application running on RIPlink Device. RSP Client implements the Remote Socket Protocol client side.
- The Gateway Adapter and Client Adapter are respectively part of RIPlink Gateway and RIPlink Device, and dependent of the non-IP network. They perform a reliable transport channel of the Remote Socket Protocol between RSP Client and RSP Gateway, adapted to the non-IP network specificities. Gateway Adapter manages in addition non-IP network specific addressing.

RIPlink Reference Architecture allows easy integration and testing of various RIPlink building components to form a complete system, mapped onto various hardware architectures. Thanks to RSP protocol, Gateway Adapter and RSP Gateway may run on different processors, as well as Client Adapter and RSP Client. Thanks to CRSP API specification, Client Adapter and RSP Client can be integrated as two well defined software components. Of course, it is developer choice to follow or not the specification for interfaces that would remain internal to an implementation.

## RSP Protocol

RIPlink relies on the Remote Socket Protocol (RSP), specifically designed for RIPlink technology. RSP is a simple protocol including RIPlink Gateway and Device binding management (GW\_INIT, BIND, etc.), socket management commands (CONNECT, LISTEN, CLOSE, etc.) and commands for TCP and UDP data sending (TSEND, USEND, etc.). Exact same RSP protocol is used whatever the non-IP network. However, the way RSP is transported over a non-IP network may be adapted to optimize its efficiency.

The flow chart below illustrates how RSP protocol can be used to connect to a TCP server, exchange data over that connection, and close that connection.



**RSP protocol flow chart example: connect to a TCP server on the IP network through RSP Gateway and exchange data**

## RIPLink Applications

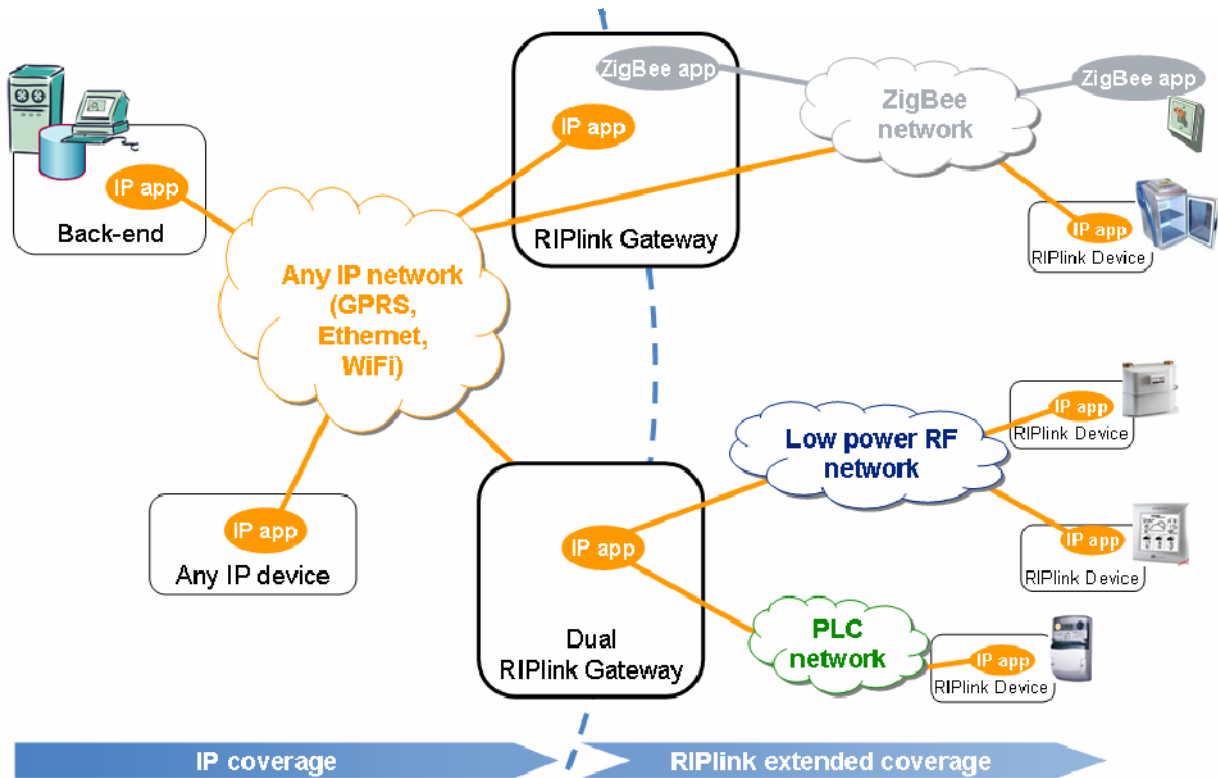
RIPLink perfectly answers the increasing demand from M2M and automotive industries for gateways interconnecting a variety of local devices while offering remote access through a wide area network: Telematics, assets tracking, healthcare, metering, building automation, home and security.

RIPLink is particularly well suited to low power RF networks, either standard or proprietary, as such end-nodes are usually resource constrained, and IP transport is not defined nor suited to such networks. But RIPLink also applies to wired connectivity, such as Power Line Communication (PLC) or Controller Area Network (CAN), for the same reasons. Likewise, a RIPLink Gateway can connect to any IP network such as GPRS, Ethernet or WiFi.

### Variety of use cases

RIPLink allows for choosing the right topology for deploying IP applications, taking into account key criteria such as scalability, performance and device capabilities constraints. As the solution evolves and expands, applications can be added or moved to new devices. RIPLink extends the IP application domain to heterogeneous networks.

RIPLink suits to a variety of use cases. Actual deployment will usually be a combination of the main use cases described below, and depicted in the Figure below.



**Example of RIPLink application with ZigBee, PLC and other Low Power RF network**



## Transparent use case

In some deployment scenarios, RIPLink Gateway is transparent to the application.

The IP application running on RIPLink Devices connects directly to an IP application hosted in the back end – or another device – in the IP network. In such use case, the RIPLink Gateway is generic and does not require knowledge about the application.

As pictured above, the ZigBee “smart fridge” application is connected directly to the back-end IP application, transported transparently by the RIPLink Gateway.

A typical application is device administration: a light server application runs on the RIPLink Device, to which the back-end can connect, thus controlling or configuring device settings.

## Non-Transparent use case

In other deployment scenarios, some IP applications can be hosted in the RIPLink Gateway itself.

The RIPLink Gateway application connects on one side to IP applications running on the RIPLink devices, and on the other side, over the IP network, to a back-end server. RIPLink Gateway applications typically perform data collection, filtering, compression, but also any other feature.

In the Figure above, the electricity and gas meters are connected respectively over PLC and Low Power RF networks to the RIPLink Gateway, which acts as a concentrator by reporting energy consumption to the back end server.

## Local use case

RIPLink can also be used simply in a local environment, without external IP connectivity, taking the benefits of the simple IP style application development. In the Figure above, this is the case of the in-home display connected to the RIPLink Gateway to display of energy consumption.

## RIPLink Gateway with several non-IP networks

The above use-cases can be simply extended to the case of several non-IP networks. An RIPLink Gateway can support simultaneously several non-IP networks. Applications running on the RIPLink Devices from the different non-IP networks communicate with each other, to the RIPLink Gateway IP application and to any back-end or remote IP application over the IP network.

In addition, the RIPLink Gateway can of course be designed also to manage devices not supporting RIPLink as represented in the Figure for the ZigBee switch. Such devices will not be addressable directly from IP network.

## *Example of application*

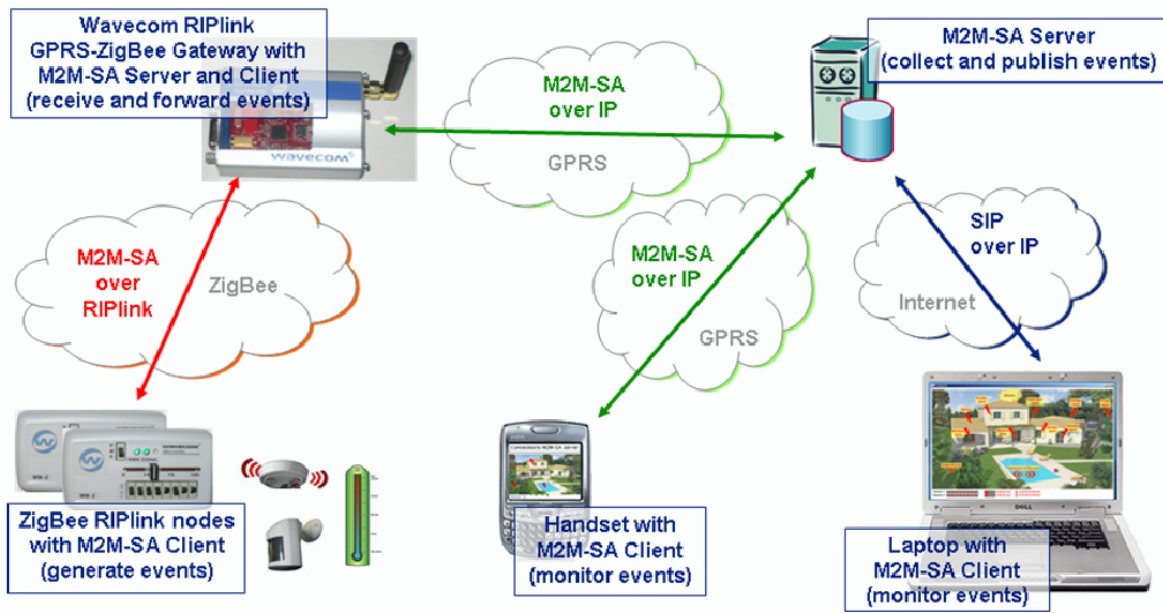
### Wavecom RIPLink Gateway demonstration on ZigBee

To demonstrate RIPLink efficiency and simplicity, Wavecom has developed a simple home alarm application using RIPLink (i.e. implementing RSP protocol), ZigBee and GPRS technologies.

The demonstration involves ZigBee sensors, a GPRS-ZigBee gateway built on Wavecom Fastrack Supreme product, a back-end server, and standard laptop and handset equipment.

The application is using an event management client-server light protocol developed by Wavecom, named M2M Service Agent (M2M-SA), and running on top of TCP/IP, thus also on top of RIPLink.

The application (the M2M-SA Client) running on each simple ZigBee sensors, report the sensor state change (the events) to a small light server (the M2M-SA Server) embedded into the Wavecom Gateway. The M2M-SA protocol is transported over ZigBee thanks to RIPLink, without any change or adaptation compared to its transport over regular IP network, GPRS for example. The same M2M-SA protocol is used to report event changes to the M2M-SA Server running in the back-end. Any device (laptop, mobile, etc.) on the IP network can be informed immediately of sensors state changes.

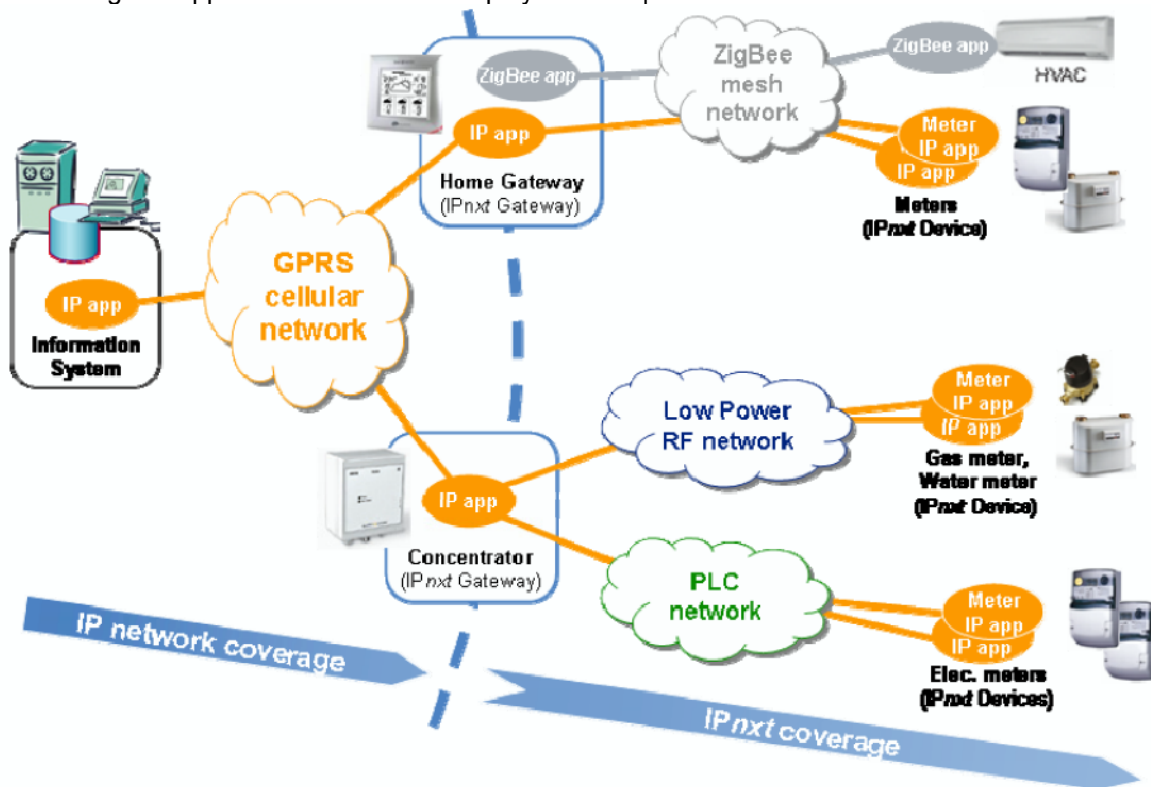


**RIPLink over ZigBee demonstration for Home Alarm application**

## RIPLink based concentrator in Smart Metering

RIPLink perfectly answers to the increasing demand in smart metering for interconnecting a variety of devices (data loggers, meters, home displays, domestic appliances, etc.) to an information system, by offering IP end-to-end.

A typical implementation of RIPLink is depicted below for a multi-energy smart metering infrastructure. GPRS cellular network access is used by concentrators, home gateways or meters to connect to the information system through IP. This IP network is then extended over Power Line Communication (PLC), or over low power RF technologies (ZigBee or any proprietary technology) to electricity meters, water and gas meters, but also domestic appliances. With RIPLink, the same IP application can run on all meters for data collection, whatever the retained architecture. As RIPLink is not exclusive, a standard ZigBee application can also be deployed when preferred.



## *RIPlink in Smart Metering*

# **RIPlink as an Industry Standard**

## ***M2M applications need gateways, and standardization***

M2M applications require connecting more and more devices, across local and/or wide area networks. For technical, historical and economical reasons, and despite standardization efforts, the connectivity technologies are numerous, and will remain numerous.

IP is a powerful way to simplify M2M applications development and deployment, while keeping open the choice for the right connectivity, for each specific application. In this approach, RIPlink is a key building block for maintaining a unified application even when non-IP networks (e.g. low power RF, PLC, etc.) are to be used.

With RIPlink, M2M actors can introduce new LAN technologies without impacting their application. RIPlink provides M2M applications with new networking options.

It is important to ensure RIPlink is not only the right technical solution, but is itself future-proof and as open as IP can be. Turning RIPlink into a freely available standard, with a variety of adopters, makes it possible.

## ***RIPlink eco-system***



After having designed and demonstrated RIPlink, Wavecom is contributing to turn RIPlink into an industry standard, with an eco-system of companies developing RIPlink based solutions. This eco-system will provide software, tools or complete products to allow fast deployment of RIPlink Devices and RIPlink Gateways, on a variety of bearers.

Wavecom contributes in particular by publishing RIPlink specifications (RIPlink Reference Architecture, RSP protocol, and RSP Client reference interface) and providing some use cases and products. Other companies contribute by making available their software implementation of RIPlink Gateways and Devices, adapted to various non-IP networks such as ZigBee, PLC, or some other low power RF technologies.

Wavecom further contributes by initiating a forum and a wiki to help making RIPlink resources more easily available to all interested M2M companies.

## Wavecom Multi-Technology Gateway Offering

### Native RIPLink support

RIPLink support is one of the building blocks of the Wavecom multi-technology gateway value proposition.

The Wavecom IP Gateway feature (WIP Open AT® Plug-In) is extended with the RSP Gateway component, thus providing RIPLink Gateway features.

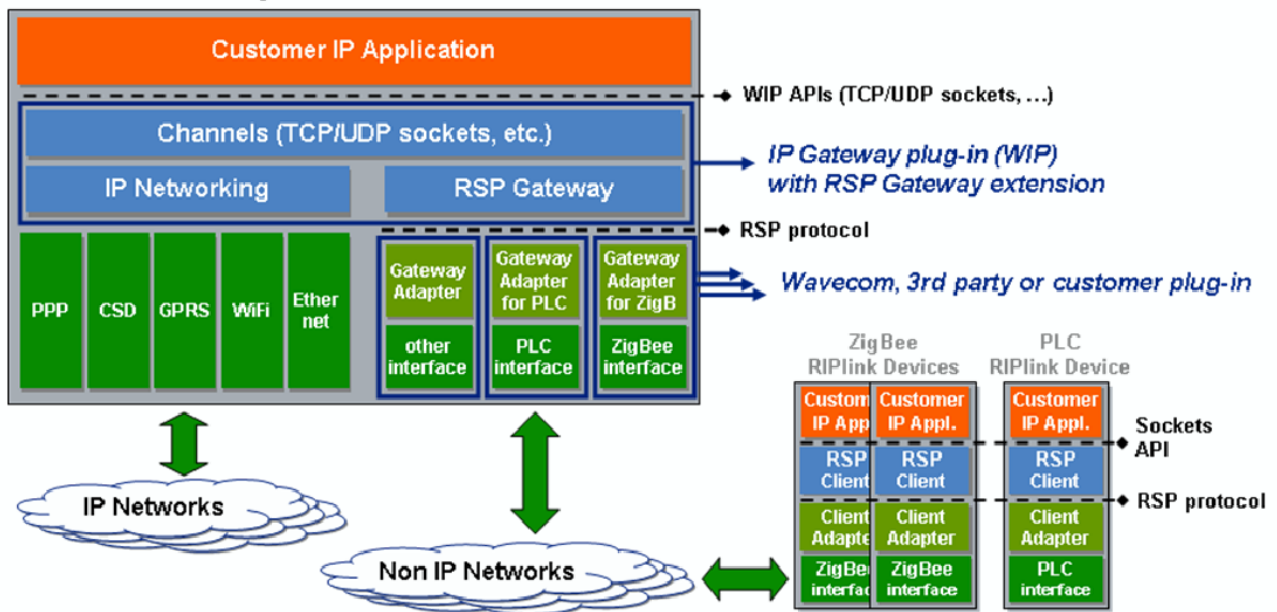
Using RIPLink can remain fully transparent: the customer IP application does not need to know whether it is transported over regular IP or RIPLink. By natively integrating the RSP Gateway component to its IP stack, Wavecom offers WIP socket APIs as a unified way to address any device, over any IP or non-IP network.

### Your connectivity option easily “plugged in”

Wavecom customers can benefit from Open AT software Plug-Ins, and hardware, provided either by Wavecom or partners. This is an easy and efficient way to add new network interface such as ZigBee for example, to the native cellular connectivity. On Wavecom Fastrack Supreme Plug-and-Play Wireless CPU®, this can be done by inserting an extension board (IESM) in the dedicated slot.

When not already available, customers can connect the specific network hardware of their choice (Low Power RF, PLC, etc.) to Wavecom Wireless CPU. At software level, thanks to RIPLink documentation and sample code, the specific Gateway Adapter can easily be developed. This adapter can either run on the network hardware or, when preferred (for performances and flexibility) be developed and run on Wavecom Wireless CPU using Wavecom ANSI-C development environment (Open AT® Software Suite and IDE).

**RIPLink Gateway based on Wavecom W-CPU**



**RIPLink Gateway and RIPLink Device components**

## ***RIPlink Devices design***

In order to design the RIPlink Devices that will connect to the RIPlink Gateway over the non-IP network, customers can either rely on RIPlink implementation available from partners, or develop their own RSP Client and Client Adapter based on documentation and sample code available from Wavecom or partners.

## ***Keeping a close eye on remote assets***

M2M Gateways in general and RIPlink Gateways in particular, extend the reach to local networks. Such local networks usually require some remote administration capability that can be performed by the M2M Gateway. With Wavecom remote device management service (Wavecom IDS), local network administration can be easily integrated to standard device management, including remote software upgrades of the RIPlink Devices when supported by the local network technology.

## **Conclusion**

IP, thanks to its ability to decouple application and network layers, has become the undisputed reference architecture for information systems, telecommunication systems and consumer applications.

While the benefits of using IP are well understood by the greater M2M community, support of IP transport remains a burden for limited devices, or specific optimized networks. Choosing the best connectivity option for the application often takes precedence over choosing IP architecture, slowing down M2M migration to IP.

By expanding IP networks to non-IP network technologies, RIPlink offers a unique opportunity to easily and rapidly develop and deploy IP applications on a variety of heterogeneous machine networks. RIPlink offers a way to better integrate machines to existing systems, thus increasing M2M capabilities and services. By leveraging IP strengths, RIPlink will significantly lower M2M solution design and deployment costs, protect investments, and offer improved time-to-market.

And as interoperability is a key success factor, Wavecom is making RIPlink a freely available technology, to be widely available through a rich eco-system of industry players providing RIPlink solutions.

With its contribution to RIPlink, Wavecom expects M2M market to capture new opportunities and be significantly fostered.



## More about RIPlink

- [R1] RIPlink website (Wiki, downloads, FAQs)  
<http://www.wavecom.com/riplink>

## Glossary

### Acronyms

- **API**: Application Programming Interface
- **BSD**: Berkeley Software Distribution
- **CAN**: Controller Area Network
- **GW**: Gateway
- **IETF**: Internet Engineering Task Force
- **IP**: Internet Protocol
- **RIPlink™**: Remote IP link
- **LAN**: Local Area Network
- **M2M**: Machine-to-Machine
- **M2M-SA**: M2M Service Agent protocol (a Wavecom protocol)
- **NAT** : Network Address Translation
- **PLC**: Power Line Communication
- **RSP**: Remote Socket Protocol
- **RPC**: Remote Procedure Call
- **TCP**: Transmission Control Protocol
- **UDP**: User Datagram Protocol
- **WIP**: Wavecom IP stack (Open AT Plug-In)

### Definitions

- **Non-IP Network**: Network which does not support IP. Usually a LAN, wired (PLC, CAN, ...) or wireless (ZigBee, other Low Power RF, ...)
- **RIPlink Gateway**: Device connected to an IP network (or running locally IP applications) and to a non-IP Network, and acting thanks to RIPlink technology as a gateway between the devices connected to the non-IP Network and the IP network or applications.
- **RIPlink Device**: Device connected to RIPlink Gateway on a non-IP Network, and supporting RIPlink technology.
- **Remote Socket Protocol (RSP)**: Bearer independent client-server protocol allowing connection between a RIPlink Gateway (server side) and a RIPlink Device (client side).

WAVECOM S.A. : 3 esplanade du Foncet - 92442 Issy-les-Moulineaux - France - Tel: +33 1 46 29 08 00 - Fax: +33 1 46 29 08 08  
Wavecom, Inc: 430 Davis Drive, Suite 300 Research Triangle Park, North Carolina, USA - Tel: +1 919 237 4000 - Fax: +1 919 237 4140  
WAVECOM Asia-Pacific: Unit 201-207, 2nd Floor, Bio-Informatics Centre No. 2 Science Park West Avenue, Hong Kong Science Park,  
Shatin, New Territories, Hong Kong (PRC) - Tel: +852-2824 0254 - Fax: +852-2824 0255

[\[Online contact details, GPS and maps\]](#)

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