

# **ascom** Powerline Communications

*Welcome to the second invention of power*



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## 1 Applications and Products

The Ascom Powerline Communications (PLC) System uses the existing power lines to bridge the last mile and to provide home networking. As universal high speed communication system it transports equally well data, voice, and video traffic.

### Ascom PLC is Unique

The Ascom PLC System enables future-oriented communications services across existing low voltage power distribution networks. As an "all inclusive technology", Ascom PLC brings voice, data and services to every socket in the home.

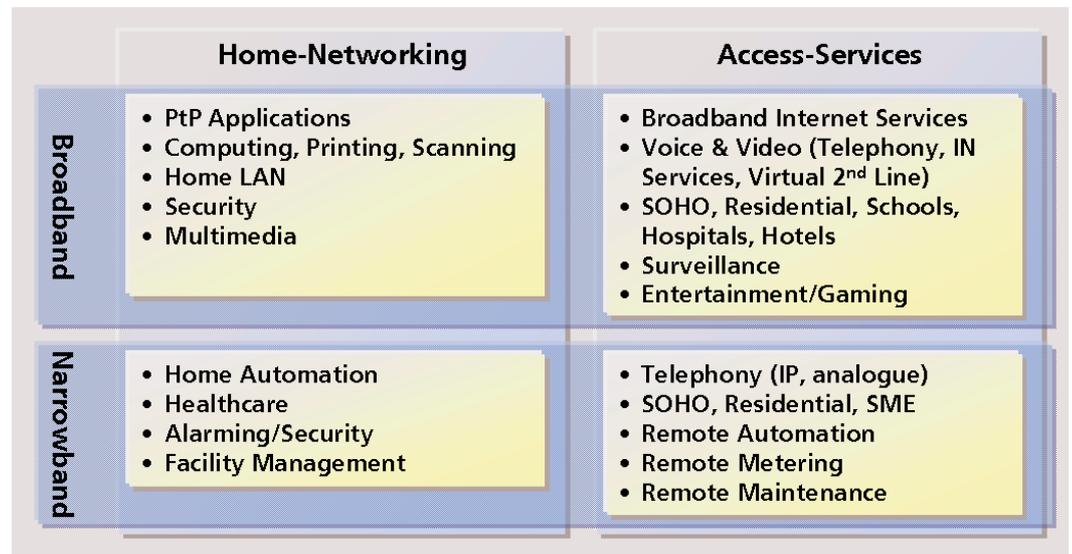


Figure 1: Ascom PLC enables a wide range of applications

The Ascom PLC system is easy to use:

- 90% of households connected - every mains socket is an interface
- No new wiring required - lead over competitor technologies
- Low investment - grow with your business
- A real alternative for the Last Mile
- Grab business opportunity in deregulated markets - leverage customer value
- 327 Mio persons online - growing bandwidth demands for broadband access
- Growing demand for inhouse-networking

Operating an Ascom PLC Communications System opens new business opportunities - not only in the access area, but also services around and including Ascom PLC.

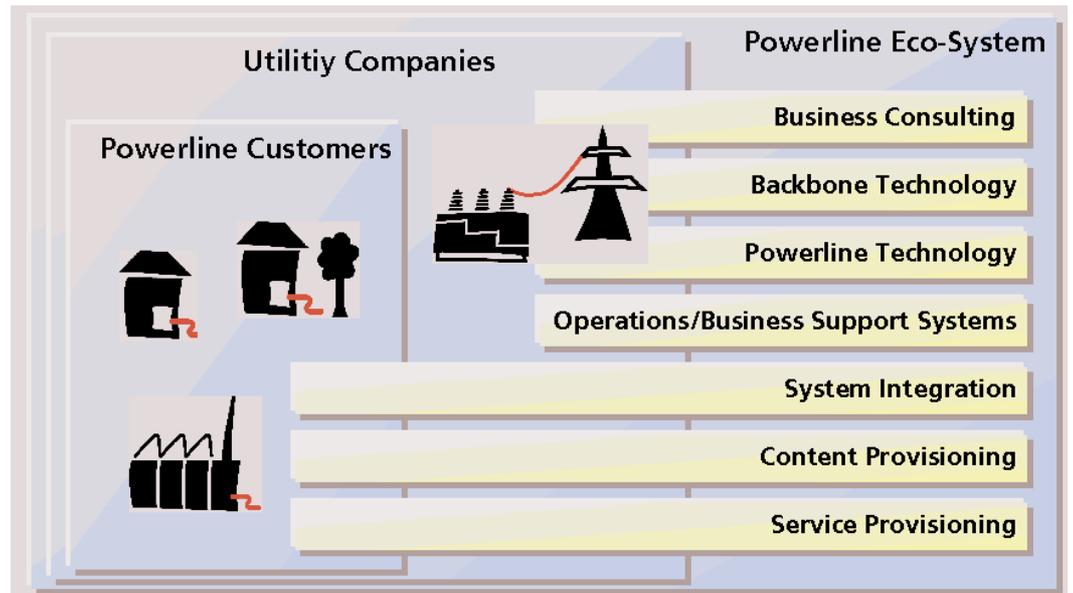


Figure 2: Ascom PLC opens new business opportunities

### Independent Outdoor and Indoor Systems

The Ascom PLC system consists of simultaneously operating Outdoor and Indoor Systems. The Outdoor System covers the public part of the low voltage power distribution from the transformer to the house access point. The Outdoor System is connected to the communication backbone at the transformer station.

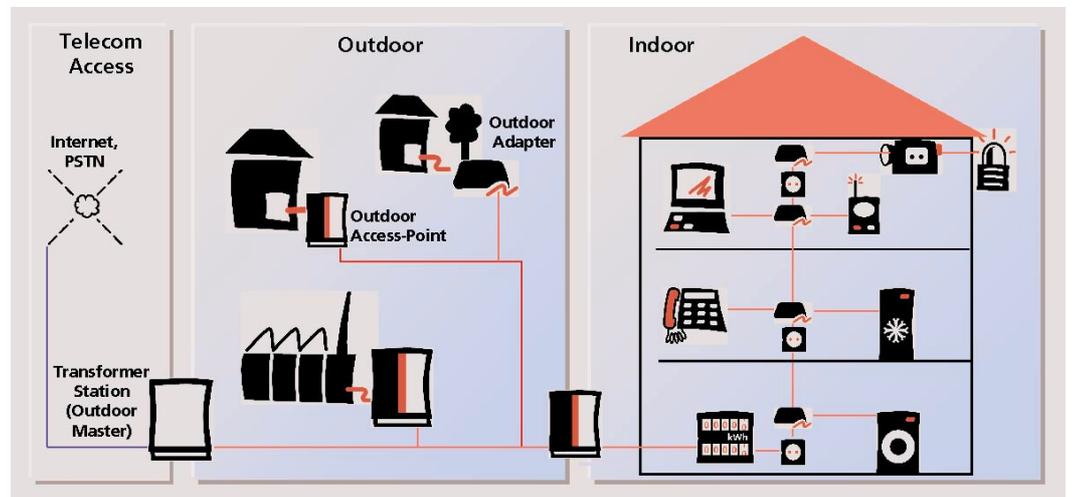


Figure 3: Complementing Outdoor and Indoor Systems for maximum coverage

The Indoor System extends the communication from the house access point to every socket in the private area of a building. It covers the private area of the power distribution. The Outdoor Adapter connects the Outdoor with the Indoor System. An Outdoor System with all its connected Indoor Systems is called a Power Cell.

Splitting the PLC network into two cascaded, but independent, Outdoor and Indoor Systems has technical and contractual advantages. On a technical level it yields a higher throughput, since pure indoor traffic, say between a PC and a printer, does not load the Outdoor System. Additionally the two systems can be trimmed optimally to the different transmission characteristics and requirements.

On a contractual level the splitting reflects the responsibility for the electrical distribution. The distribution from the transformer station to the house access point is owned and operated by the power utility, the network inside the home is in the responsibility of the home owner. The splitting of the communication system along the same borders results in clear responsibilities and easy problem prevention in case of interference.

### Extendable Solution

The Ascom PLC System is at the beginning of its life cycle. The technology is still in continuous development, adding even more powerful features to the coming generations.

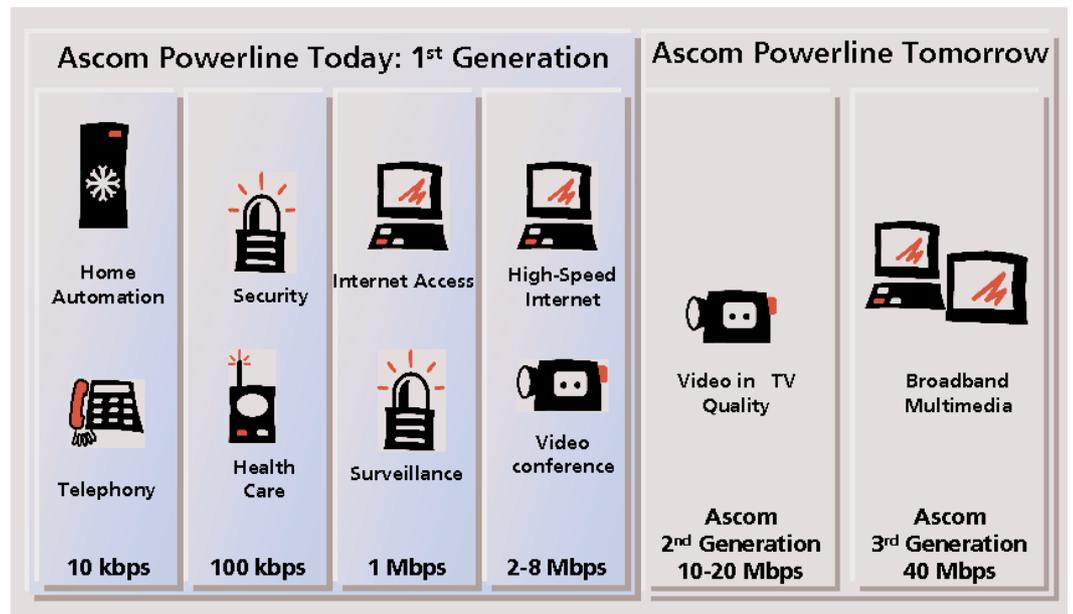
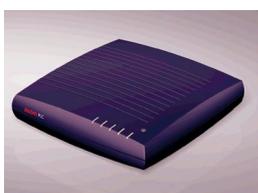


Figure 4: Power for the future



APM-45o resp. APM-45ap



APA-45o resp. APA-45i

### PLC Products

The Ascom PLC System consists of a small number of plug-and-play products to build up powerful system solutions. The Ascom PLC devices are equipped with industry standard interfaces for easy integration into the communications world, be it towards the customer or the backbone. Presently the Ascom PLC System consists of the following devices:

- Outdoor Master APM-45o, controlling the Outdoor System and interconnecting a Power Cell to the backbone network.
- Outdoor Adapter APA-45o, providing a direct user access to the Outdoor System. This unit is used for a simple Internet access of a single family home where no indoor PLC networking is required.
- Outdoor Access Point APM-45ap, is the bridge between the Outdoor System and a single Indoor System.
- Indoor Adapter APA-45i, is the user modem to connect to an Indoor System.

In addition there are a number of support devices to optimise the systems. All devices couple the signal into the power mains via their power cable.

## **Standard Interfaces**

Die Ascom PLC devices contain standard Ethernet and USB interfaces to communicate with the users, providing easy interconnection with end user and backbone equipment.

## **Privacy Through V-LAN**

PLC is a shared medium. Many users are accessing it at the same time, hence it is necessary to protect the privacy of the individual traffic. The Ascom Powerline System is employing the standardised VLAN technology based on IEEE 802.1Q for this purpose. This enables a user-specific separation of the data streams, resulting in the protection of the user data. For this purpose the network administration assigns each user to a unique, private VLAN.

## **Encryption Preventing Eavesdropping**

Powerline systems can be accessed legally from any mains socket. The Ascom PLC System protects the user data on the power mains against unauthorised eavesdropping through encryption. The RC4 (Rivest's cipher number 4) encryption algorithm combined with the Diffie-Hellman key exchange guarantees very high security against eavesdropping.

## **System Management Included**

The Ascom PLC System contains all necessary features to facilitate the integration into an automated management and supervision system.

All Ascom PLC devices are manageable via DHCP (Dynamic Host Configuration Protocol) and SNMP (Simple Network Management Protocol). This allows the integration into standard network management systems, providing an effective system and traffic monitoring and fast error location with established tools.

## 2 Powerline Communication

The Ascom Powerline Communications System is optimised for the data transmission over existing power distribution networks, providing maximum throughput at a minimal power level. The modulation design and the frequency assignments avoid interference from and to amateur radio and broadcast services. Advanced technologies guarantee the privacy of the transmitted data.

### Powerline Frequency Bands

The Ascom PLC System is operating in the frequency range of 1.6 to 30 MHz. To achieve the highest throughput the carriers are managed dynamically and operated simultaneously. The carrier frequencies have been specially chosen to avoid interference from and to important radio amateur and broadcast services.

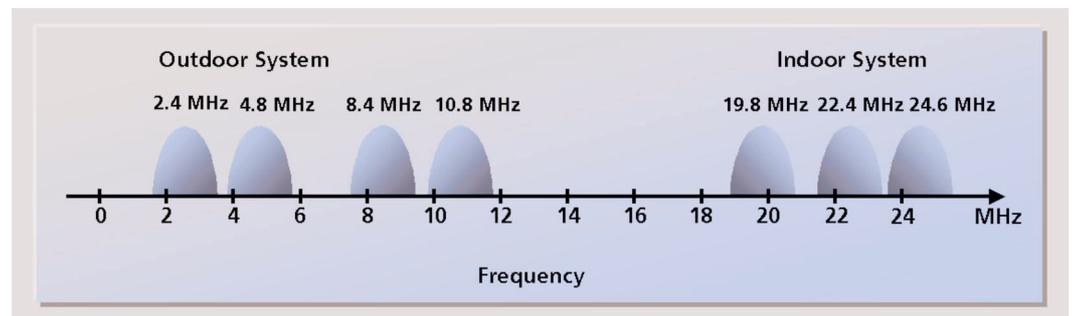


Figure 5: Typical Ascom PLC frequencies

The choice of the carrier frequencies is based on extensive measurements and frequency planning within the short wave radio band and is in line with the work in progress in CENELEC and with NB30 (Nutzungsbestimmung 30) of the German Regulator. Additionally the system satisfies the important European norm CISPR 55022.

Each Ascom PLC System is simultaneously operating on three carriers. Each providing a user data rate between 750 and 1'500 kbits/sec, resulting in a capacity of 2.25 to 4.5 Mbps for each PLC System (Indoor as well as Outdoor).

### Radiated Emissions

The Ascom PLC system automatically minimises the radiation. All PLC slaves (APA-45o, APA-45i, APM-45ap) use a variable transmit power up to a parameterised maximum value. Slaves close to their master can maintain an excellent connection with very low transmit levels. The Ascom PLC slaves automatically adjust their transmit power to the minimum required transmit level to maintain a high quality link. This feature minimises the overall system radiation.

### Dynamically Allocated Capacity

A PLC System is a shared medium. It carries the traffic of all the connected users. The access to the channel is managed by the PLC Master (APM, resp. APM-ap). It dynamically allocates channel capacity to the users based on their instantaneous demand, thus providing the maximum possible system throughput. This is made possible through the packet oriented data transmission.

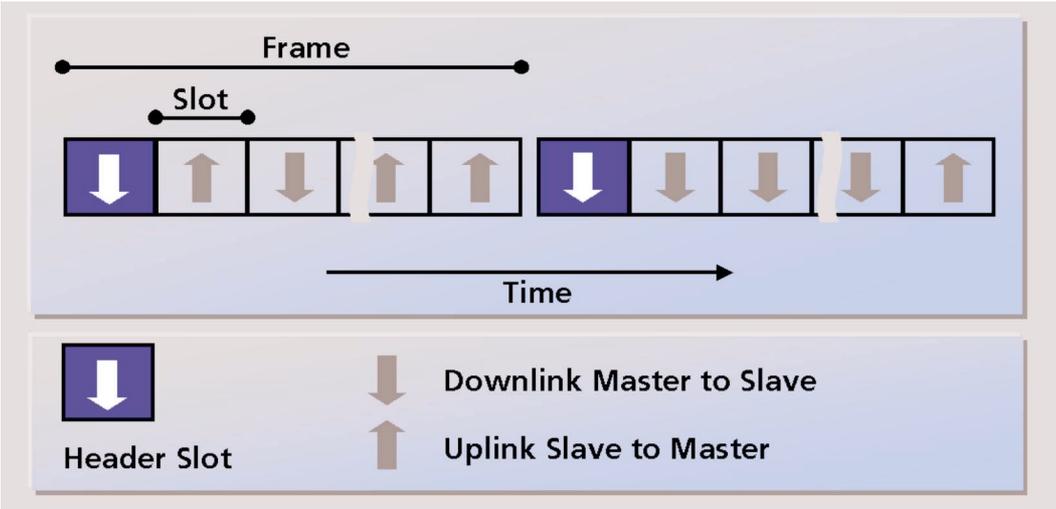


Figure 6: Dynamic allocation of capacity based on present requirements

### Priority for Real-Time Data

Die Ascom PLC devices give priority to real-time data, thus ensuring good voice and video quality across the PLC channel.

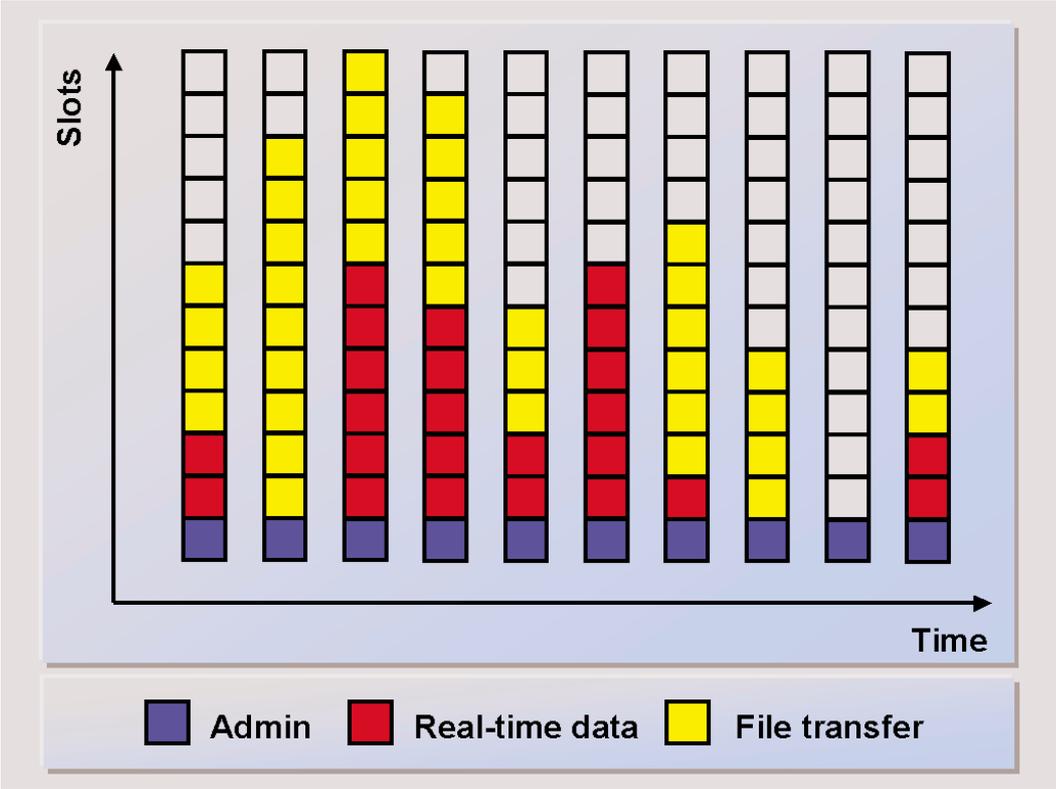


Figure 7: Highest priority is given to real-time data.

The Ascom PLC System automatically distinguishes between real-time and non-real-time data based on the protocols. Real-time traffic, such as voice or video, requires a transmission with minimal delay, whereas non-real-time data, e.g. file transfer, is not hampered by varying transmission delays.

### 3 System Integration

The Ascom PLC devices contain the required functionality and protocols for an easy integration into large, automated communications systems.

#### Scalable Solutions

Ascom PLC devices can automatically receive all operating parameters, such as IP addresses, VLAN-IDs, and phone numbers, from a DHCP (Dynamic Host Configuration Protocol) server. The devices require normally no on-site parameterisation.

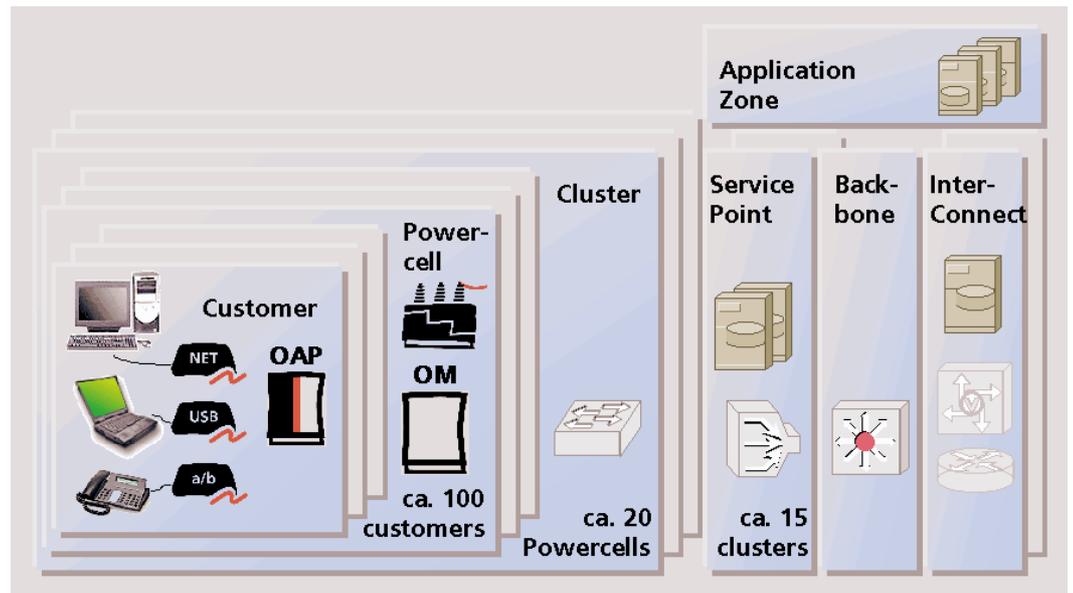


Figure 8: Simple structure of an Ascom PLC System

An Ascom PLC system can be extended seamlessly from small to large and augmented with added-value services.

#### Backbone Connection

The standard interfaces and the transparent data services result in an easy interconnection with and integration into a backbone communication system.

The integration of an Ascom PLC System into an overall communications system requires application specific resources outside the proper PLC System. These deal with an efficient network management and data routing, data and system security, as well as the billing of the services. The figures below highlight the most important resources for Internet access and telephony services.

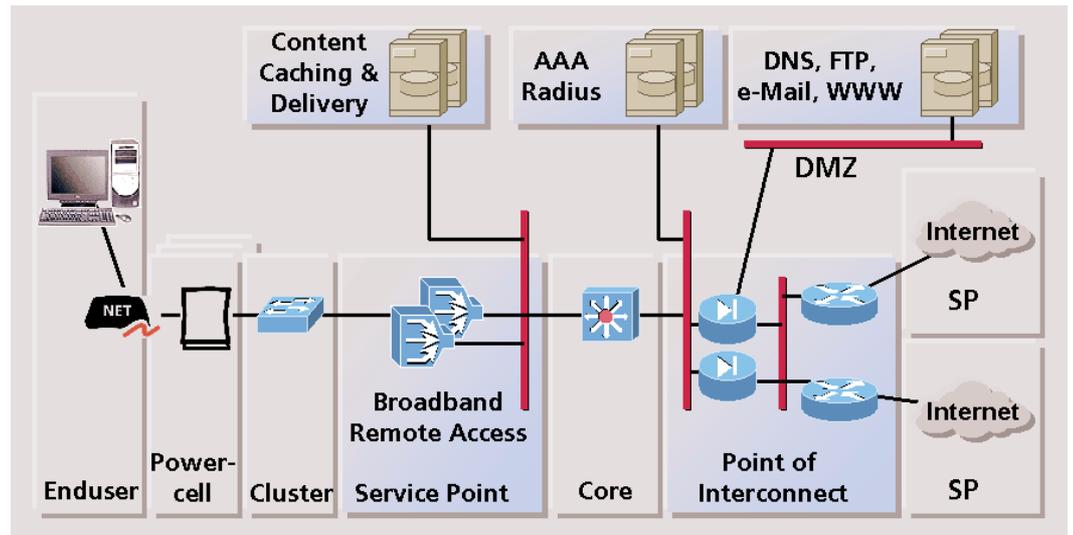


Figure 9: Internet access

Voice integration requires specific support for call establishment, billing, and possibly specialised services like VoiceMail.

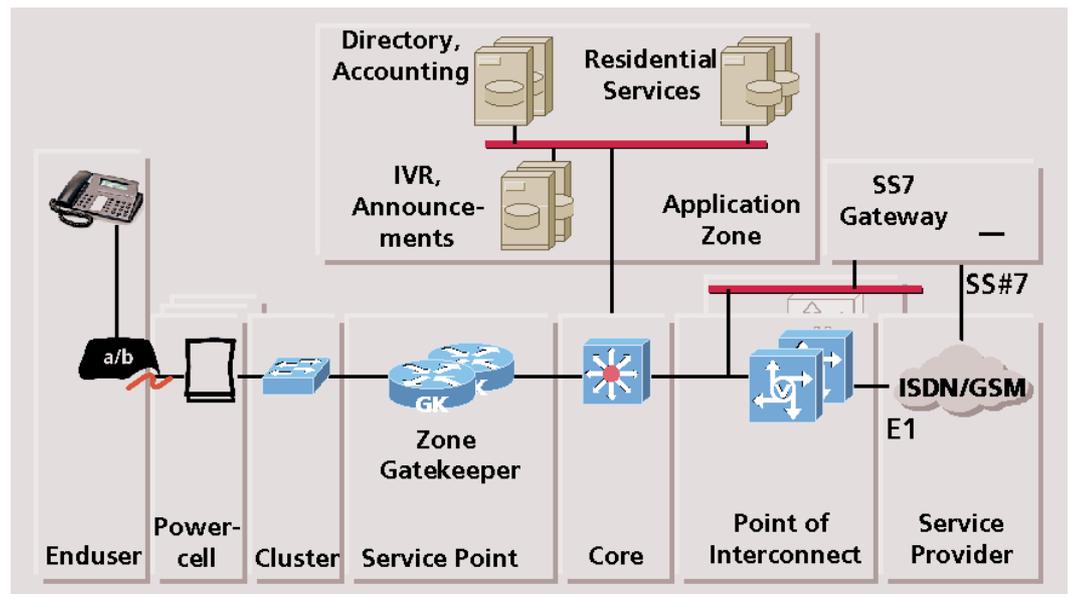


Figure 10: Voice access

### SNMP Network Management

The Ascom PLC devices contain SNMP agents with the required characteristics to be monitored and controlled remotely. SNMP is the de facto industry standard to manage network devices including, e.g., routers, printers, and now also Ascom PLC devices. The Ascom PLC device include the SNMP functional areas configuration, fault, and security management.

## 4 System Planning and Installation

System planning is the basis for an efficiently operating PLC system. This entails determining the best installation points, planning the usage of the available PLC carrier frequencies, assigning IP addresses and VLAN-IDs, and all the aspects regarding the connection to the communication backbone.

### Flexible Installation Points

Under normal circumstances the installation points are given, e.g. the Outdoor Master in the transformer station, Outdoor Access Point beside the electricity meter, etc. However, there is no functional requirement to install these units there, they can be installed in any convenient point satisfying the following requirements:

- Easy access for service personnel
- Protection from vandalism and environmental impacts like heat and rain,
- Access to the backbone (in case of the Outdoor Master), or access to the customer (Outdoor or Indoor Adapter),
- Achievable coverage area for Outdoor Master and Outdoor Access Point,
- Available signal strength for the Outdoor Adapters, Outdoor Access Points and Indoor Adapters,
- Interference avoidance between neighbouring Indoor Systems.

### Coverage Area

The achievable distance of the PLC system depends primarily on the losses along the power distribution. Based on extensive Ascom measurements it is possible to predict the average distance that can be achieved in a real situation. Based on physical reasons the signal attenuation is increasing with frequency, as shown below.

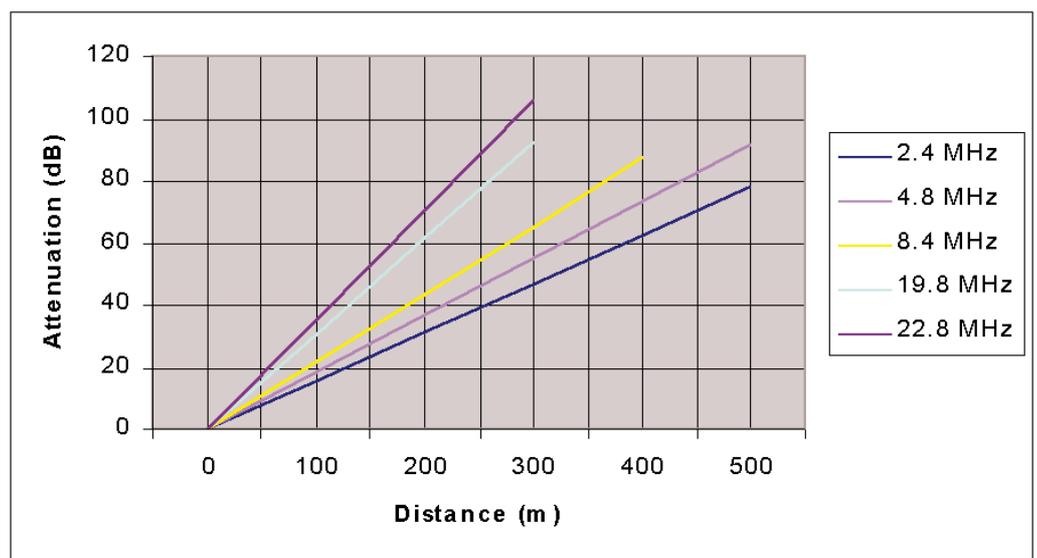


Figure 11: Signal attenuation increases with frequency and distance

Correspondingly the coverage distances of the various carrier frequencies differ.

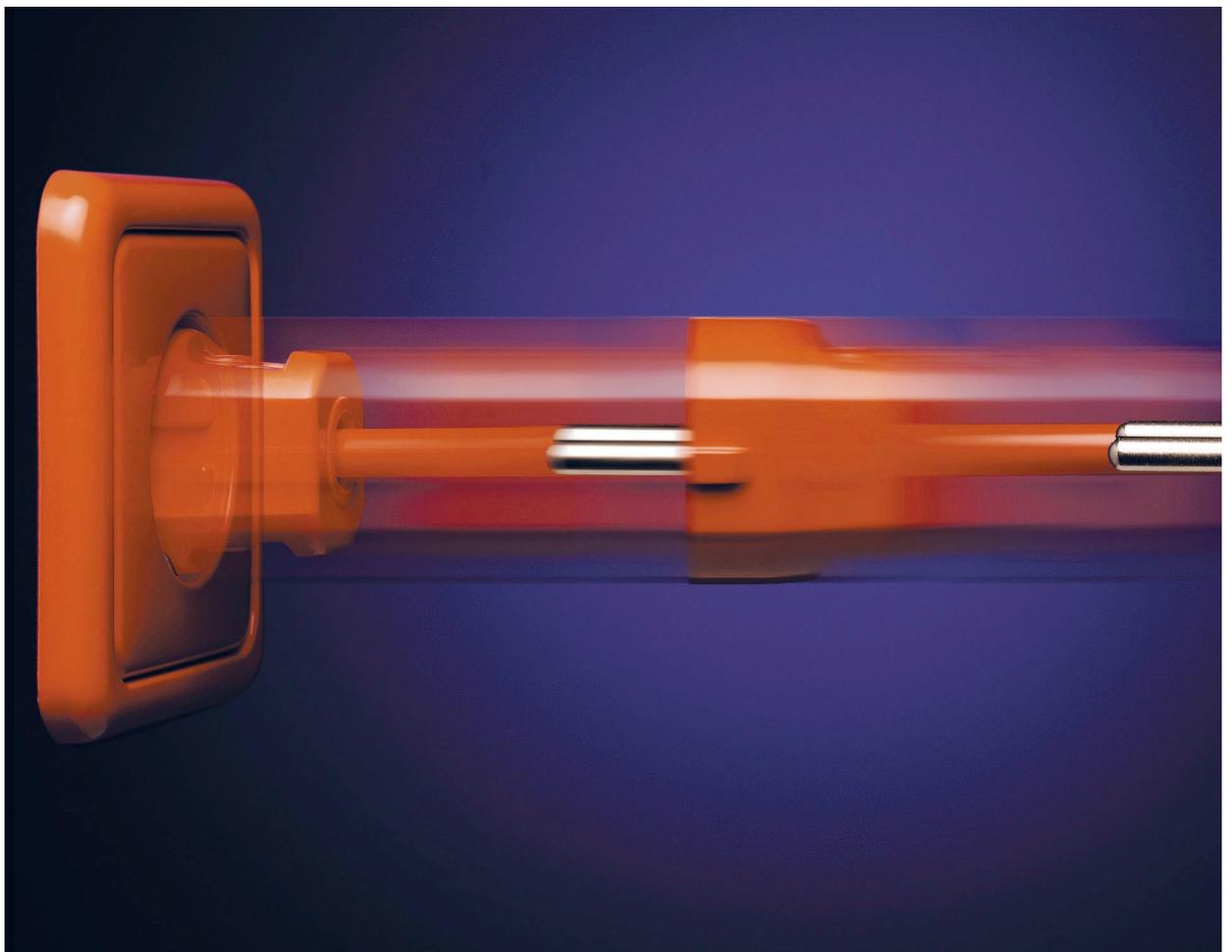
At 2.4 MHz a typical distance of 150 to 250 m can be achieved. At 8.4 MHz the typical distance is in the range of 100 to 200 m. The system coverage can be extended with Repeaters.

The Indoor frequencies around 20 MHz achieve a coverage of about 70 to 100 m within buildings. The distance depends largely on the cabling type. Also the coverage of Indoor Systems can be extended with Repeaters.

### **Interference Avoidance**

Installing two or more Outdoor Access Points in close proximity may lead to interference between the Indoor Systems. Such Interference leads to a loss of capacity due to collisions on the commonly used power lines. Even if such collisions do not lead to errors in the end-to-end data transmission, the interference should be avoided to achieve the desired system throughput.

Such interference can be avoided with proper frequency planning, or with the help of the special Indoor Foreman device. Foreman devices are subordinate Masters which share the available bandwidth with a main Master. The main Master co-ordinates the access to the frequencies and time slots, hereby avoiding interference between the co-ordinated systems. Foreman devices are available for Outdoor as well as Indoor Systems.



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