



Outline



- Context
- Broadband over Power line (BPL) applications
 - Access BPL
 - In House BPL
- Technical issues
 - Installation
 - EMC
- Regulatory and Standardisation issues
- Conclusion

Context



- ☞ The Communication Technologies over Power lines has a long development history
- ☞ The rapid and important growth of the Internet has resulted in the requirement for a new range of broadband access technologies to residential premises:
 - ◆ **Fibre Optic**
 - ◆ **Radio (LLR, Wifi, Wimax...)**
 - ◆ **Broadband communication over Power Line**
- ☞ Low Voltage Electricity Distribution Networks have become potential fruitful media in order to offer Broadband communication over Power Line

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Context



➡ History : Carrier current systems have been around for many years

- First patents at the beginning of the radio
- Some experiences with PLT offering audio HiFi in house
- In the sixteen's: electricity meter control by transmitting signal
- In the nineteen's: Automatic meter reading & domotique

In these applications, the transmission rate is of few kbit/s and the used maximum frequency is limited to 148,5 KHz

➡ In 1997:

- Norweb announced a new transmission technique able to offer an Internet connexion to customers through power line with a rate of 1 Mbit/s

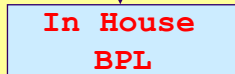
Beginning of the « Broadband over Power Line » era !
Vocabulary: PLT, PLC, BPL

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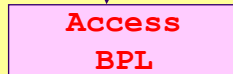
Context



BPL Systems



- Telephone Services
- Internet Services
- Video-on-Demand
- ...



Carrier Current Systems



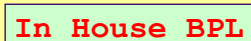
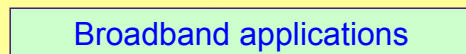
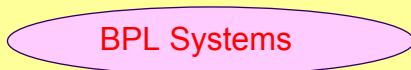
Narrowband applications



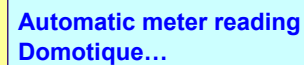
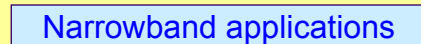
- Automatic meter reading (electricity, water, gas, heat)
- Lighting street control
- Device monitoring
- ...

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BPL Techniques :

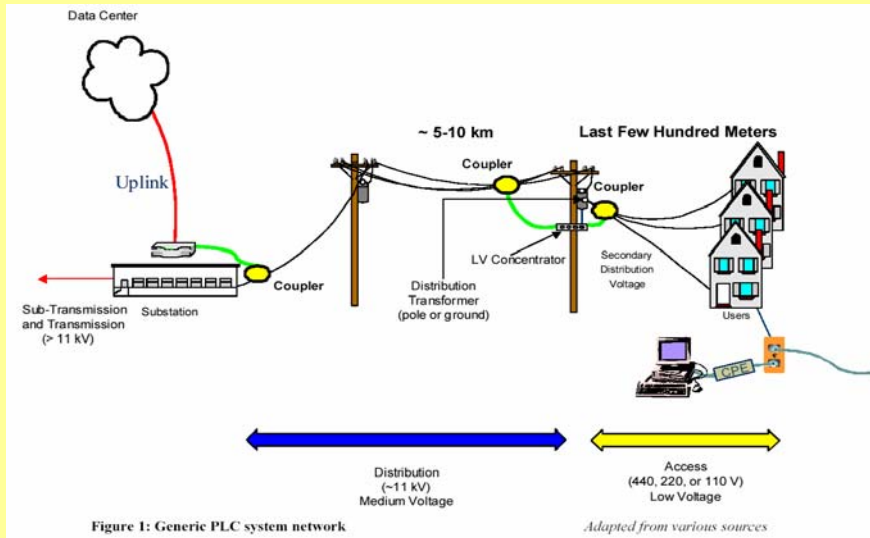


Carrier Current Systems



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Access BPL



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Access BPL



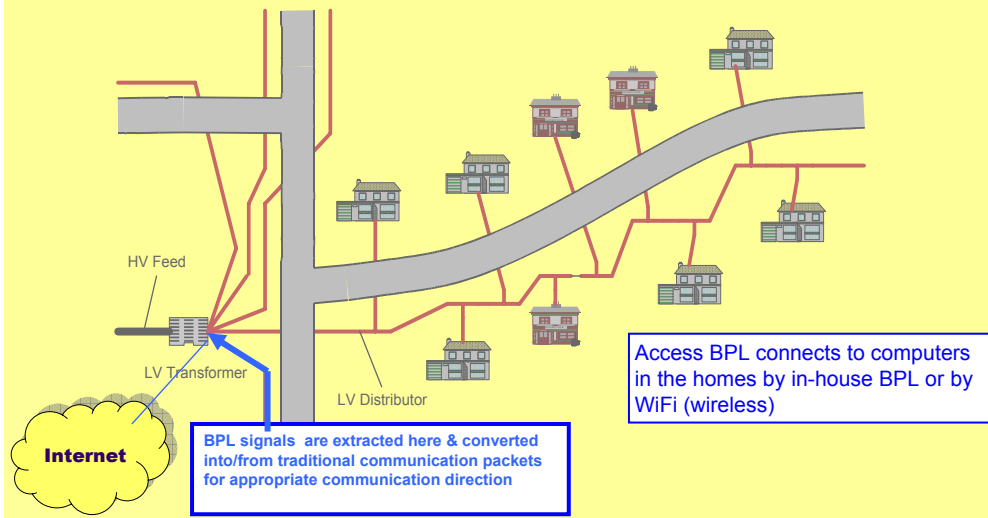
One system uses Orthogonal Frequency Division Multiplexing (OFDM) to distribute the BPL signal over a wide bandwidth using many narrow-band sub-carriers. At the BPL injector, data from the Internet backbone is converted into the OFDM signal format and then coupled onto one phase of the MV power line. An injector also converts BPL signals in the other direction from the MV power lines to the format used at the Internet backbone connection.



Amperion Power Line Coupler and Weatherproof Enclosure⁹

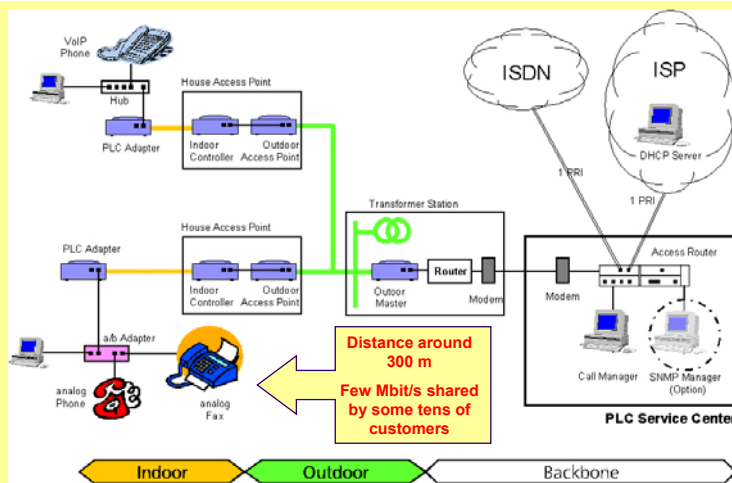
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Access BPL



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Access BPL : Ascom solution



➔ **Complete solution** « Services + Access BPL + In House BPL »

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Access PLT :



- In competition with xDSL, Satellite, Radio, CATV
- For energy suppliers, an opportunity to penetrate new business area
- Need of important investments (Optical Fibre to the LV transformer)
- A way to bring telephone service in the developing countries

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In-House PLT : Major stakes



- In competition with :

No new wire :

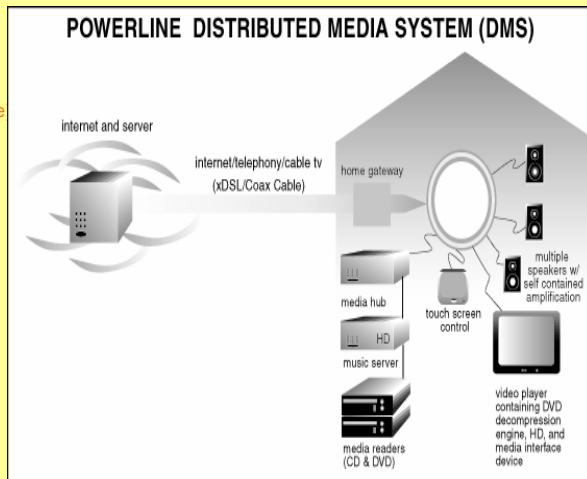
- * Radio
- * Home PNA (Home Phone Network Alliance)
- * Infra Red (blocked by walls)

New wire :

- * Ethernet
- * UTP 5
- * Fibres (MMF, FOP)

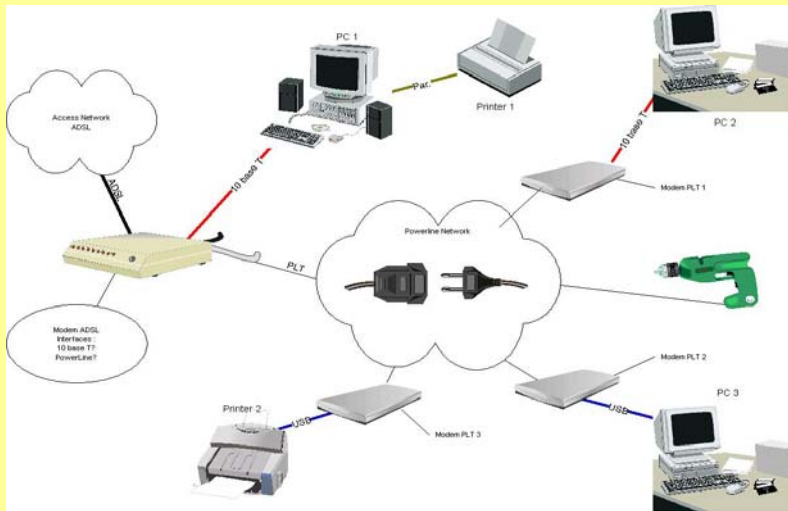
→ Services :

- ▶ PC, Internet
- ▶ Others...



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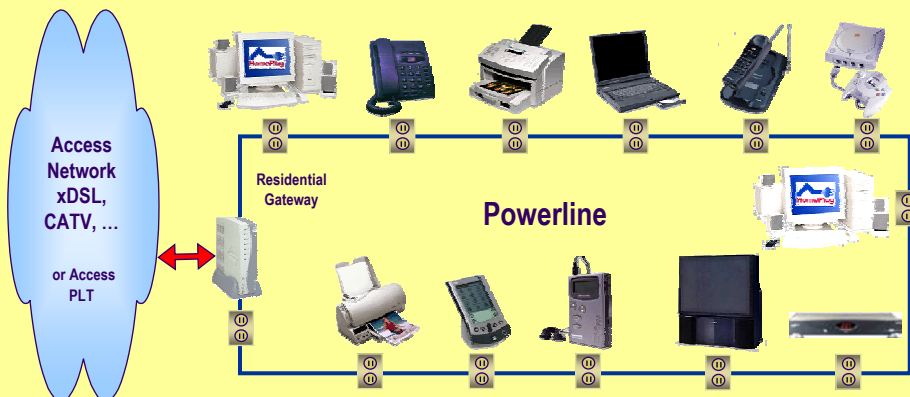
In-house PLT : LAN-Concept



- Internet connexion shared between some users or creation of a LAN

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In-House PLT: HomePlug Powerline Alliance scheme



- ➔ In House PLT is more suitable for public applications

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In-House PLT : Examples of modems



(Source : Elcon)



(Source : Enikia)



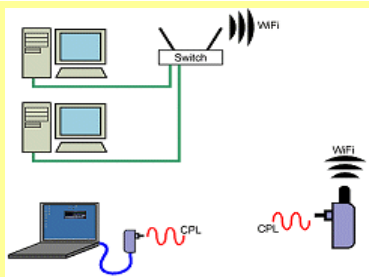
(Source : Ascom)



(Source : Sagem)

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In-House PLT : Examples of modems



(Source : Develo)

In the future the modem will be integrated in the plug



(Source : Lea / Legrand)

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Technical issues for BPL Systems



➤ Frequency allocation for Access & In-House BPL

Network traffic inside the household does not affect the outdoor zone

➤ High attenuation effects

Optimum distances is depending on power output, loss during power distribution, and the noise level at the receiving end.

➤ Electromagnetic Compatibility :

EMC standards which set limits for immunity and emission



Regulation and standardisation issues

Complex work is to be done in order to establish accepted rules by which BPL can be operated in a safety way and without interference

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Installation aspects of BPL Systems



Signal attenuation as a function of distance



(Source : Ascom)

Average distance

Access BPL : between 200 and 300 m

In House BPL : less than 100m (different interference sources)

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EMC issue



→ One of the main issues : **Potential radio interference**

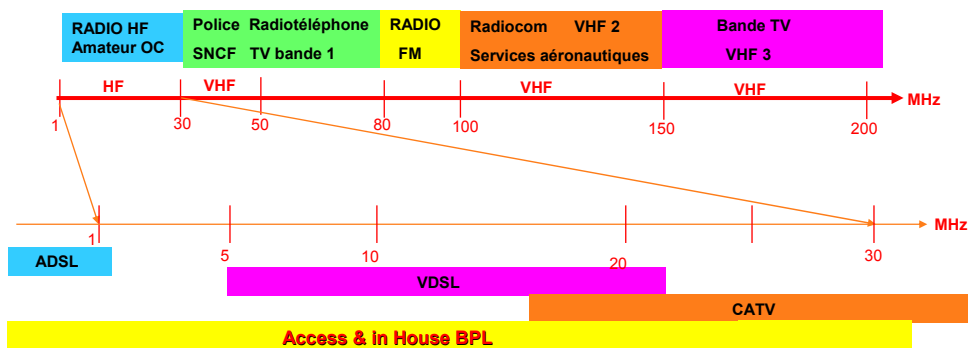
BPL systems use frequencies that radiate into the air from the open wire power conductors, causing possible interference to licensed services, including emergency services and amateur radio operators.

→ Unlike other broadband conductors, open-air power lines are excellent radiators of the frequencies used in BPL systems, so they behave as transmitting (and receiving) antennas.

This issue has not arisen in connection with other broadband distribution technologies BPL because copper twisted-pair wiring (used for xDSL), coaxial cable, and fiber are all effectively non radiating mediums

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Examples of licensed services

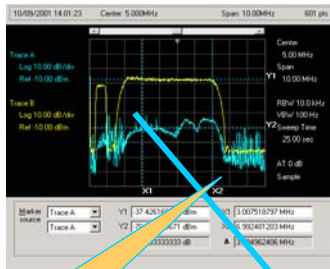


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Comparison of conducted and radiated emission between a VDSL signal transmitted both on telecommunication cable and electrical cable of 220 V



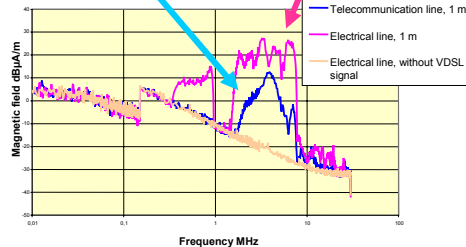
Telecommunication line



Electrical line



Telecom cable (worst cable which is not used for high bit rate transmission)
Common mode voltage and resulting radiated field



Electrical cable (new cable)
Common mode voltage and resulting radiated field

EMC issue



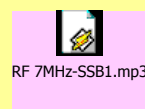
- ➔ Radio waves at these frequencies can “bounce” off the ionosphere to travel very long distances.

Certain frequency bands are used by amateur radio operators to communicate around the world using very low transmitted power levels. Harmful interference can occur if a BPL system operates in the vicinity of a licensed operator using the same frequency

- ➔ Radio broadcasters have also expressed concern about the potential of BPL to prevent their signals from reaching listeners.

Impact on Digital Radio Mondiale (DRM)

Example of interference at 7.0 MHz



Regulatory & standardisation issues



→ Radiation limits below 30 MHz ?

EUROPE

- ▶ NB30 : adopted by German regulation in may 2001
- ▶ MPT 1570 : UK standard adopted in August 2001
- ▶ Limit proposed by BBC in CEPT SE35
- ▶ Limit proposed by Norway in CEPT SE35

☞ **Mandate M313 issued by European Commission : Elaboration of standard for extended networks (xDSL, BPL, CATV)**

Not yet available

USA

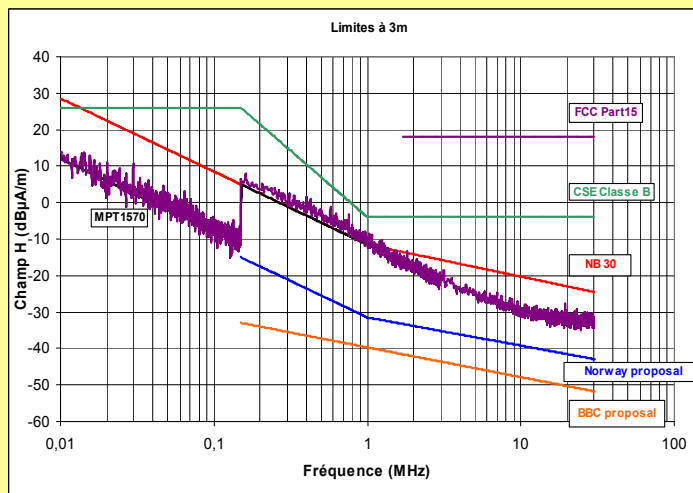
In the United States, the FCC has been the primary forum for resolving radio interference claims. Throughout most of 2004, the FCC conducted a rulemaking to consider BPL-specific changes to its **Part 15** rules that govern radio frequency interference

→ For example, the FCC rules:

- ▶ Clarify that the existing Part 15 radio frequency emissions standards apply to BPL;
- ▶ Impose operational requirements for BPL systems to promote avoidance and resolution of harmful interference, including technical mitigation capabilities like "notching;"
- ▶ Prohibit BPL in specified frequencies and geographical areas designated for licensed uses for aeronautical and maritime functions

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Comparison of different proposals for limits at 1 meter above 30Mhz



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Conclusion :



BENEFITS OF BPL

- **“Last Mile” solution** : potential 3rd solution (+ DSL & Cable) to bring broadband services to the home
- Internet and high speed broadband access to wider areas of the country : Telephone for developing countries
- Promote redundancy of communications systems
- Resource sharing (home networking)

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Conclusion



Deployment of BPL

- **In house BPL**
 - No interference problem
 - Products on the market
 - In competition with WIFI (security)
- **Access BPL**
 - Still waiting for an EMC standard in EUROPE
 - Some trials in USA, AUSTRALIA, South AFRICA....
 - Could be an option needed to facilitate vigorous competition

Cost of access: BPL = 226 Euros ADSL = 150 euros
(From trial at Manassas, USA)

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Conclusion



→ Three issues for BPL :

- ☞ The first is competition from existing and emerging network technologies. **BPL is technically mature** but is being **beaten by wireless alternatives** and old-fashioned twisted-pair. There is little sign of strong consumer demand.
- ☞ **QoS of BPL is affected by interference** from non-communication devices that are on the same network and **BPL may produce interference on Radio services**
- ☞ A third issue is indifferent industry support and **the absence of major commercial and regulatory champions**. There is no consensus about standards; there is disagreement about both technical and commercial feasibility.

By considering the Regulatory and standardisation aspects : **“2005 is shaping up to be a pivotal year for BPL”**.

It will ultimately be the marketplace that will determine the success or failure of this technology