Powerline an alternative technology in the local loop

- Presentation to IEEE -

March, 2004
Agenda

1. PLC Utilities Alliance
2. Power Line Communications
3. Access PLC competitive solutions
4. Endesa’s PLC project
The “PLC Utilities Alliance” (PUA) is an organization supporting Power Line Communications (PLC) development in Europe.

**Members**

- EDE
- EDF
- EnBW
- EDP
- IBERDROLA
- Enel
- UNION Fenosa

More than 100 Million electrical customers in 23 countries

**Objectives**

- Develop a common position among PUA members
- Work with national and EU bodies to obtain a favourable environment for PLC development
- Raise Awareness about the PLC opportunity
- Technical reference point
- Help standardisation process
- Support PLC equipment Research and Development

**Achievements**

**Awareness & Promotion**

- White Paper on PLC and its Impact on the Development of Broadband in Europe
- Communication with EU bodies, NAs, and other stakeholders

**Standardization & Regulation**

- Measurement campaign in five European countries
- Work in different standardisation bodies: ETSI, CENELEC, CISPR, JWG

**International Cooperation**

- UPLC
- plcforum
PLC Utilities Alliance – PUA Objectives for 2004

In 2004, the Awareness and Promotion Task Force of the PUA will have a special focus to boost the PLC market and to obtain a progress in key markets and utilities.

**2003 tasks follow-up**
- Maintain relationship with European Commission and National Authorities
- Consolidate as industry reference point
- Keep collaborating with standardization and regulatory organizations

**New developments for 2004**
- Focus on utilities (help in the commercial launch processes)
- Focus on relevant stakeholders (operators, media, financial market)
- Increase and structure exchange of information between PUA members
## Agenda

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<td>Endesa’s PLC project</td>
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## As an access technology, PLC is well positioned to compete with other access technologies in the mass market

<table>
<thead>
<tr>
<th></th>
<th>HFC</th>
<th>ADSL</th>
<th>PLC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Infrastructure</strong></td>
<td>• Fiber+Coaxial cable and copper pair (^1) (New deployment)</td>
<td>• Copper pair (existing telephone lines)</td>
<td>• Electric wires (existing power grid)</td>
</tr>
<tr>
<td><strong>Shared Medium</strong></td>
<td>Yes (Tipically 1000 users(^2))</td>
<td>No (Dedicated line per user)</td>
<td>Yes (Approx. 200 – 250 users)</td>
</tr>
<tr>
<td><strong>Services</strong></td>
<td>• Triple play: TV+Telephony+Broadband</td>
<td>• Broadband - Pre-launching: TV, VoD - Testing: Telephony (VoDSL)</td>
<td>• Broadband - Telephony (VoPLC) - Testing: VoD, energy services, PLC in-home services</td>
</tr>
<tr>
<td><strong>Data transmission rate</strong></td>
<td>• 45 Mbps(down)/10Mbps (up) - Commercial offers usually up to 2 Mbps</td>
<td>• 4 - 6 Mbps (ADSL) - Typically Asymmetric</td>
<td>• 45 Mbps (up + down) - New generation: 200 Mbps - Symmetric</td>
</tr>
<tr>
<td><strong>CAPEX per client(^3)</strong></td>
<td>HIGH</td>
<td>MID-LOW</td>
<td>MID-LOW</td>
</tr>
</tbody>
</table>

1 Copper wire necessary for voice service in non-integrated HFC networks
2 Strongly dependant on network design
3 Details subject to NDA
**Powerline Communications – PLC as alternative access infrastructure**

- PLC technology is able to compete with ADSL in the residential segment

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**Comparison of Access Technology CAPEX**

**Powerline Communications – PLC as alternative access infrastructure**

**In terms of roll out and provisioning, PLC is very well positioned to compete with other access technologies in the mass market**

<table>
<thead>
<tr>
<th>Roll-out</th>
<th>HFC</th>
<th>ADSL</th>
<th>PLC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requires lengthy construction of new network</td>
<td>Possibility of rapid deployment, but CLECs are <strong>highly dependent on incumbent</strong></td>
<td>Rapid deployment over existing electric infrastructure (LV + MV substations, property of the utility and easily conditioned for PLC)</td>
<td></td>
</tr>
<tr>
<td>Civil works require public permissions (street digging, buildings)</td>
<td>In practice, deployment is being challenged by a slow ULL process</td>
<td><strong>Selectivity</strong> at substation and meter room level</td>
<td></td>
</tr>
<tr>
<td>Once an area is chosen for deployment, roll-out is not selective</td>
<td>Requires availability of collocation space in incumbent’s Central Offices and logistics</td>
<td><strong>Minimum need of civil works</strong> (linking of LV substations through MV PLC)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Provisioning</th>
<th>HFC</th>
<th>ADSL</th>
<th>PLC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reasonable provisioning process time</td>
<td>Short to medium provisioning process time for ILEC, longer delays for CLECs (shortening)</td>
<td><strong>Short provisioning time</strong> (just a CPE in user's domicile)</td>
<td></td>
</tr>
<tr>
<td>Requires installation from the street curb to client house of coax drop</td>
<td>Service availability varies from region to region (from as low as 50% to 95%)</td>
<td><strong>No permissions required</strong></td>
<td></td>
</tr>
<tr>
<td>Requires installation of CPE at the client’s household</td>
<td>Auto-installation DSL reduces provisioning time for basic services</td>
<td><strong>No works at customers premises</strong> (high acceptance)</td>
<td></td>
</tr>
<tr>
<td>For blocks of flats / apartments wiring permission from neighbors is required</td>
<td>CLEC <strong>dependency on incumbent</strong> to test and approve line</td>
<td><strong>Ubiquity</strong>: Any conventional electrical plug becomes part of the telecommunication network</td>
<td></td>
</tr>
</tbody>
</table>
Leading manufacturers ensure the availability and development of PLC equipment. 2\textsuperscript{nd} generation chipset will increase performance and competitiveness.

<table>
<thead>
<tr>
<th>PLC Technology</th>
<th>PLC Medium Voltage</th>
<th>PLC Low Voltage</th>
<th>In-house</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chip designers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLC equipment manufacturers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DS2</td>
<td>UAT Inc.</td>
<td>POWER8WAN</td>
<td></td>
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<tr>
<td></td>
<td>TOYOCOM</td>
<td>Schneider Electric</td>
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<td></td>
<td></td>
<td>ascom</td>
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<tr>
<td></td>
<td></td>
<td>POWER8WAN</td>
<td></td>
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</table>

NOTE: DS2 has already tested a 2nd. Generation chip (200 Mbps), that will be available in the market in 2004.
More than 80 PLC initiatives in more than 40 countries show a high interest in PLC technology among worldwide utilities

Source: Arthur D. Little 2003

*Not exhaustive
Many companies already started controlled commercial initiatives, and some of them have already launched PLC services

<table>
<thead>
<tr>
<th>Technology trials</th>
<th>Massive (&gt;100 users) technology trials</th>
<th>Pre-commercial and commercial initiatives</th>
</tr>
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<tbody>
<tr>
<td>Energieversorgung Offenbach</td>
<td>Energi</td>
<td>Pattern Com</td>
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<tr>
<td>Cogele Companhia</td>
<td>Enel</td>
<td>EDF energia portuguesa</td>
</tr>
<tr>
<td>GRANINGE</td>
<td>STOEN</td>
<td>Endesa</td>
</tr>
<tr>
<td>EDF energia portuguesa</td>
<td>ELFORSK</td>
<td>EEF FEW</td>
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<tr>
<td>CCE</td>
<td>VATTENFALL</td>
<td>IBERDROLA</td>
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<tr>
<td>IPRE</td>
<td>Light</td>
<td>PowerCom</td>
</tr>
<tr>
<td>Strom</td>
<td>Elforsk</td>
<td>Lyse</td>
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<tr>
<td>Ameren</td>
<td>NUKON</td>
<td>ppl</td>
</tr>
<tr>
<td>LUZ DEL SUR</td>
<td>RECH</td>
<td>Turku Energia</td>
</tr>
<tr>
<td>CHILECTRA</td>
<td>MVV Energie</td>
<td>Reykjavik Energy</td>
</tr>
<tr>
<td>SKANSKA</td>
<td>EDF</td>
<td>IDE</td>
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<tr>
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<td>PowerCom</td>
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<tr>
<td>UNIUN TENOSA</td>
<td>EDF</td>
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Worldwide Broadband market growth shows the classic “S-curve”, in which Europe and USA are still climbing up the Growing stage.

Source: Arthur D. Little Global Broadband Report, 2003
Significant increases in Broadband penetration are forecasted for the next years, with many European and USA markets approaching 50% by 2008.
There are many EU member states without alternative access infrastructure and the investments in new fixed access infrastructure have been delayed or cancelled.

Digital subscriber line (xDSL), using copper telephone lines, currently is the prevalent technology for delivering Broadband access in most European markets.

In spite of its more innovative offer (triple play service bundling), cable has been outpaced by DSL (almost ubiquitous availability).

70% of all broadband connections in the EU are based on incumbent DSL networks.

Alternative technologies such as fibre or WLL play a minor role for delivering broadband.

Source: Jupiter 03, Yankee Group 03, JP Morgan Dec 02, e-marketer March 03, Nielsen, Arthur D. Little analysis, 2003, DG Information Society
Incumbents dominate not only the physical provision of DSL broadband, but also the retail market

- 81% of all connections provided over the incumbent DSL networks are directly retailed to users by the incumbent.
- Local loop unbundling constitutes only 5% of the market.
- Independent ISPs retail the remaining 14%.

Source: DG ITU World Telecommunication Regulatory Database, ECTA, September 2003
PLC is being launched and represents a great opportunity for utilities and telecom operators

Conclusions

- Broadband is growing at a high rate and there is a great market opportunity
- Development of new access infrastructures is expensive and the unbundling process has enjoyed only limited success
- PLC is confirming itself as the access technology that could compete with ADSL in the residential and SOHO segment
- PLC is commercially available:
  - High coverage and ubiquity of the electrical network
  - Broadband Internet (symmetric transmission) and VoIP services
  - Fast modular and selective deployment
  - In-house installation fast and simple
  - First tier manufacturers are commercializing products
- Utilities are solid partners and PLC business is within their core competences
- The wholesale carrier access business model could be appropriate for utilities and telecom operators
1. PLC Utilities Alliance
2. Power Line Communications
3. Access PLC competitive solutions
4. Endesa’s PLC project
After more than three years developing the PLC project, Endesa is now ready to undertake massive commercial deployments.
Powerline Communications – PLC Technology and Access Network

PLC is a broadband technology using low and medium voltage power lines for digital transmission of voice and data

PLC Access Technology

- Uses existing infrastructure to provide an access broadband network with a higher potential coverage than any other access technology.
- PLC transforms a conventional electrical plug in a connection point (ubiquity) for advanced telecom services (Broadband Internet access, IP telephony, domotics, VoD, etc.).
- PLC allows for a fast modular and selective deployment.
- In-house installation fast and simple.
- Capacity and costs are similar to incumbent operators’ ADSL.
- **PLC can offer** broadband services at transmission rates equivalent or better than ADSL (up to 20 Mbps).
Endesa's PLC Project

During the MTT in Zaragoza, 330 buildings, 140 low voltage transformers, 20,000 homes and 2,103 users where deployed and placed in service in only five months (25 people team)

CPE and Transformer deployment

Users = CPEs

Deployment Data

- 20,000 homes deployed in five months
- More than 70% of users installed in two months
- Connection of 140 L/V transformers:
  - 56 L/V transformers with optical fibre
  - 84 L/V transformers with PLC M/V

Source: Key Performance Indicators of the MTT, ENF
Endesa’s PLC Project

Different concentration levels per L/V transformers and Meter Rooms were tested and it was proven that there are no significant impacts on the QoS due to high concentration levels.

Concentration in L/V transformers is between 1 and 133 users
Maximum number of users per Meter Room is 24
20% of Heavy Users are in the 5 more concentrated L/V transformers

Source: Key Performance Indicators of the MTT, ENF
Internet users showed an intense and symmetric usage of PLC services during the Massive Trial.

### INTERNET ACCESS: Daily total traffic (MB)

<table>
<thead>
<tr>
<th>Date</th>
<th>Daily traffic Total MB (In + Out)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ip In MBytes</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Sep 02</td>
<td>631</td>
</tr>
<tr>
<td>Oct 03</td>
<td>10%</td>
</tr>
</tbody>
</table>

### INTERNET ACCESS: Users’ distribution per average daily usage

- **54% of users** use the Internet service daily
- **94%** of users use it weekly
- **The Spanish average Internet usage is 5.3(*) MB daily**
- **20% of users manage more than 100 MB daily (Heavy users)**

Source: Key Performance Indicators of the MTT, ENF

(*): Source: NetValue, Internet Overview, Junio 2002
Telephony usage pattern was above the Spanish average during the MTT

Telephony usage pattern was above the Spanish average during the MTT

**Stages**
- First stage: Only local calls for all telephony users
- Second stage: Opening up of national calls communicated to a group of 500 users
- Third stage: Opening up of national calls communicated to a group of 500 users

**Usage**
- 65% of the clients use the service daily and 84% weekly
- 5.27 Calls per day and user
- In Spain the average number of calls per day of the residential segment is 4.2

Source: Key Performance Indicators of the MTT, ENF
Customer satisfaction measurements that revealed a high acceptance level of the global service offering and users’ interest in continuing to use PLC services

The users have shown **very satisfied** with the **service quality of PLC Internet Access**

- **PLC has been evaluated better than ADSL (4.32 PLC vs. 3.65 ADSL)**

The users have shown **satisfied** with the service **quality of PLC telephony**

- **The general satisfaction with PLC telephony was 3.65 compared with 3.99 obtained by incumbent Telefónica**

85% of the users explicitly allowed Endesa to share their contact data with AUNA, in order to receive detailed information on the commercial terms of the PLC service

Source: User Satisfaction Study, Endesa Net Factory, November 2002
The Massive Technology Trial has confirmed that PLC is a suitable technology for offering Broadband Access to the massive residential market.

**MTT conclusions**

- PLC can be applied to both low and medium voltage power grid
- Network solution adopted can be used for any kind of electrical topology
- Interconnection with Public Internet and Telephone Networks has proven viable
- PLC related works over electric infrastructure do not affect electric service
- **PLC network can be deployed quickly and selectively**
- A high degree of standardization can be achieved for transformations centres and meter-rooms.
- Technical coverage ratios are higher than those achieved by ADSL
- **PLC can offer Broadband Internet Access (> 2 Mbps) and VoIP services**
- Leading manufacturers ensure PLC equipment commercial availability
- No complaints about electromagnetic interferences have been registered (Spanish Authorities have developed a specific measurement campaign)
The first Commercial Trial was launched in Zaragoza in October 2003, providing the customers with Telephony and Internet Access services through PLC.

**Characteristics of the Commercial Trial**

- A specific *License* was obtained by Endesa, in order to conduct the Carrier Services (October 2003)
- Telecom Operator: *Auna TLC*
- Date of launch: **27th October 2003**
- Dimension: Up to **5,000 households** covered in *Zaragoza*
- Potential market:
  - existing deployment
  - new market in the same areas
- *Services* provided with PLC:
  - Telephony: Voice over PLC (VoPLC)
  - High speed Internet access: **128, 300 or 600 kbps** (up to 45 Mbps)
- The **Commercial Offer** was designed combining the services and different bandwidths, with competitive prices regarding those of ADSL in Spain
- Endesa has reached a **penetration of around 19%** in the PLC areas in Zaragoza

**Description of the Commercial Offer**

- **Internet Banda Ancha**
  - Tarifa plana (flat rate)
  - Internet y Telefonia simultaneamente
  - **8 Mbps para tu web personal**
  - Tarifa plana de 50 euros (all-inclusive)
- **Telefonia**
  - De portillo
  - Tarifa para empresas
  - Servicio de atención al cliente 24/7

**Oferta 1**

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**Contrata ya cualquier Pack de AUNA y paga sólo Internet**

Contratando ahora tu Pack Net PLC 128 ó Pack Net PLC 300 te regalamos el doble de velocidad hasta el 31 de mayo de 2004.

- **Cuota mensual GRATIS**
  - Internet + Telefonia
  - Terminal telefónico GRATIS
  - Llamadas entre clientes de AUNA GRATIS (cuando el cliente está conectado)
  - Llamadas ilimitadas (2h diarias)

**Oferta 2**

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**Cuota mensual GRATIS al contratar la Tarifa Individual 6 de Telefonia**

Por tan sólo 6 €/mes tus llamadas locales, provinciales e interprovinciales te costarán únicamente 0,6 cent/min. Además tienes un descuento del 15% en llamadas de fijo a móvil nacional.

Si prefieres acogerte únicamente al servicio de Telefonia, te ahorrarás el 50% de la cuota mensual, y pagarás tan sólo 7 €/mes.

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**Prime cuota mensual GRATIS**

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During the last months Endesa realized the rollout of PLC in two areas of Barcelona and just started its commercialization.

Characteristics of the Commercial Trial

- Telecom Operator: Auna TLC
- Date of launch: February 2004
- Dimension: 5,000 households covered in Gràcia and Sarriá Sant-Gervasi, Barcelona
- Services provided with PLC:
  - Telephony: Voice over PLC (VoPLC)
  - High speed Internet access: 128, 300 or 600 kbps (up to 45 Mbps)
- Network Deployment
  - 90 Transformer Stations in 9 rings
  - More than 90% of transformer stations are connected via Medium Voltage PLC

Description of the Commercial Offer

Internet Banda Ancha
- Tarifa plana las 24h
- Internet y teléfono simultáneamente
- Tres velocidades: 128, 300 y 600 kbps

Telefonía
- 15€ por mes
- Tarifas muy competitivas
- Servicio de atención al cliente 24h

Oferta 1. Internet+Telefonía

Todas las ventajas contratando cualquier Pack Net PLC

- Cuota mensual de teléfono GRATIS
- 300 kbps al precio de 128 kbps
- Todas tus llamadas locales a 0€/min.

Oferta 2. Telefonía

Paga sólo la mitad de la cuota y haz todas tus llamadas locales por 0€/min

- 50% de descuento en la cuota mensual hasta el 31 de mayo
- Llamadas locales a 0€/min.

Oferta 3. Internet

Navega el doble de velocidad a precio de 128 kbps

- Contrata 300 kbps a precio de 128 kbps
- Teléfono en la ciudad 0€/min. (hasta el 31 de mayo)
The majority of the users of the Massive Technological Trial accepted to be contacted by the Telecom Operator and finally become “PLC customers”

- A network covering 20,000 homes was deployed in only 5 months (25 people team)
- Provision time similar or better to ADSL
- Heavy use of voice services (>1,5M calls in 10 months)
- Internet users make an intensive use of PLC services:
  - 20% users>100MB and 10% users>1 GB of daily traffic
- High QoS (good service even for 80% penetration in one building)
  - The users have shown very satisfied with the service quality of PLC Internet Access
  - The users have shown satisfied with the service quality of PLC telephony
- PLC 128, 300 and 600 kbps
- 60% of the MTT users signed a contract to be provided with the PLC services and started paying for them
- More than 25% of users are new customers, who had not enjoyed the PLC services for free during the MTT
- 2 months after the commercial launch over 20% user penetration was reached in the area covered
For all queries regarding the PLC Utilities Alliance and PLC opportunity please contact:

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*PLC Utilities Alliance President*

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Ribera del Loira, 60, 3ª pl.  
28042 Madrid, Spain

Telephone: +34 91 213 10 12  
Telefax: +34 91 213 48 06  
Mail: mlopez@endesa.es
The majority of the utilities have selected an Access Carrier business model to develop its PLC opportunity.

**PLC Access carrier operator**

- **Utility traditional business:**
  - Infrastructure business
  - Network deployment and operations
  - Over an utility core asset (electricity network)

- **The carrier model leverages on:**
  - Utility know-how on deployment and network operation
  - Retail operators’ marketing and commercial capabilities

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**Operations to be done by final operators**
- **End Client**
  - CPEs and other commercial costs
  - End Client revenues

**Operations to be done by the Utility as access carrier**
- **Access network**
  - Commercialization of wholesale and neutral local access services to operators
  - PLC network investments (except CPE)
  - PLC network Operation & Maintenance

- **Metropolitan distribution network**
  - Transport network, interconnection, Internet exit, etc.