

**Technical Trial  
of  
Broadband IP/Internet  
over  
ESB Power Networks  
  
Engineers Ireland**

October 2006



# Outline of Presentation

1. Introduction to Broadband Power Line Carrier
2. Trial start up
  1. Objectives
  2. Location
  3. Selection of vendors
3. Implementation
4. Key Implementation Issues
5. Stakeholder Involvement
6. Conclusions and Bottom Line



# Power Line Communication

Power line communication (PLC), also called mains communication, power line telecoms (PLT), is a term describing several different systems for using power distribution wires for simultaneous distribution of data.

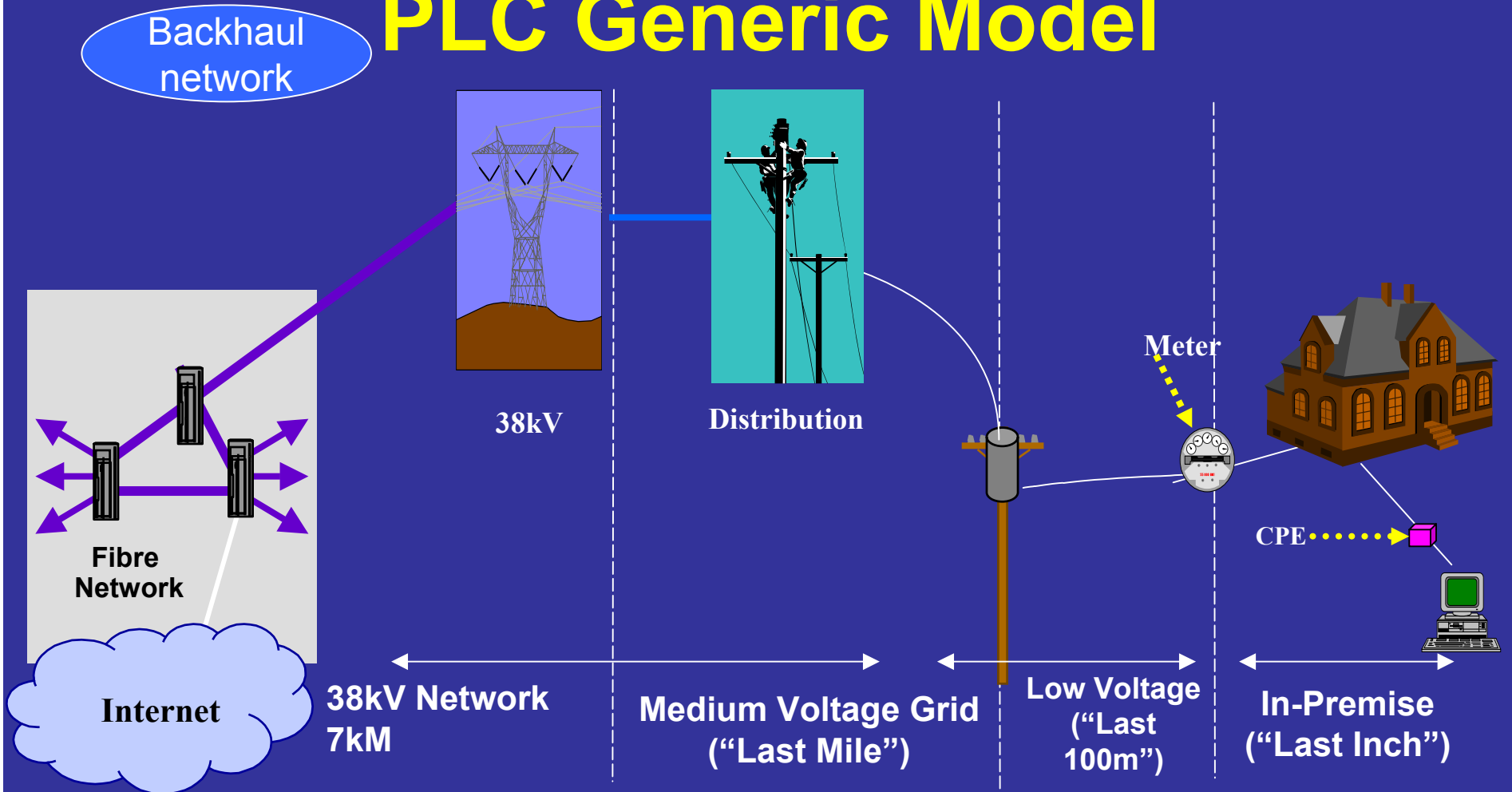
Traditionally electrical utilities used low-speed power-line carrier circuits for control of substations, voice communication, and protection of high-voltage transmission lines.

The carrier can communicate voice and data by superimposing an analogue signal over the standard 50 or 60 Hz alternating current (AC) system.

This trial covers Broadband over Power Lines (BPL) with data rates above 1Mbps to the home.



# PLC Generic Model



\* CPE - Customer Premise Equipment

# ***Trial Objectives***

- **To evaluate current developments in PLC for high speed Internet access**
- **To ascertain if there are potential commercial applications for PLC in ESB's Medium (MV) and Low Voltage (LV) Networks.**
- **To test the Medium Voltage Network as a carrier to bridge “The Backhaul Gap”**



# ***Pilot Location – Tuam Co. Galway***

- **Adjacent to National Fibre Network (7kM)**
- **38kV to Medium Voltage (MV) Station close to town (1kM)**
- **Short Medium Voltage ring network from 38kV station around town. (5kM)**
- **Electricity network typical of most rural towns**
  - Mixture of overhead line and underground cable at both MV and Low Voltage
  - Alternative means of supply for many customers at MV and/or Low Voltage



# Selection Process

- Select Advisor
- Develop RFP
- Develop Evaluation Criteria
- Evaluate Responses
- Shortlist
- Select Vendor(s)

# Backhaul from Fibre POP to 38kV Station

- **Existing PLC technology alone does not support this.**
- **When technology available – serious provisioning issues and costs arise**

# Successful Bidders

## •Vendor A

Why ? Price  
Market Leader  
Proven Implementation Capability  
Ease of Operation  
Reference List

## •Vendor B(DS2 chipset)

Why ? DS2 Chipset (Newer Technology)  
Capacity  
Indicated capability on Medium Voltage  
Reference List.



# Basic Description

	Vendor A	Vendor B
<i>Chip Set</i>	iTran	DS2
<i>Modulation</i>	DSSS	OFDM
<i>Capacity</i>	2Mbps	34Mbps
<i>Coupling</i>	Inductive & Capacitive	Inductive & capacitive
<i>Components</i>	MV & LV	MV & LV

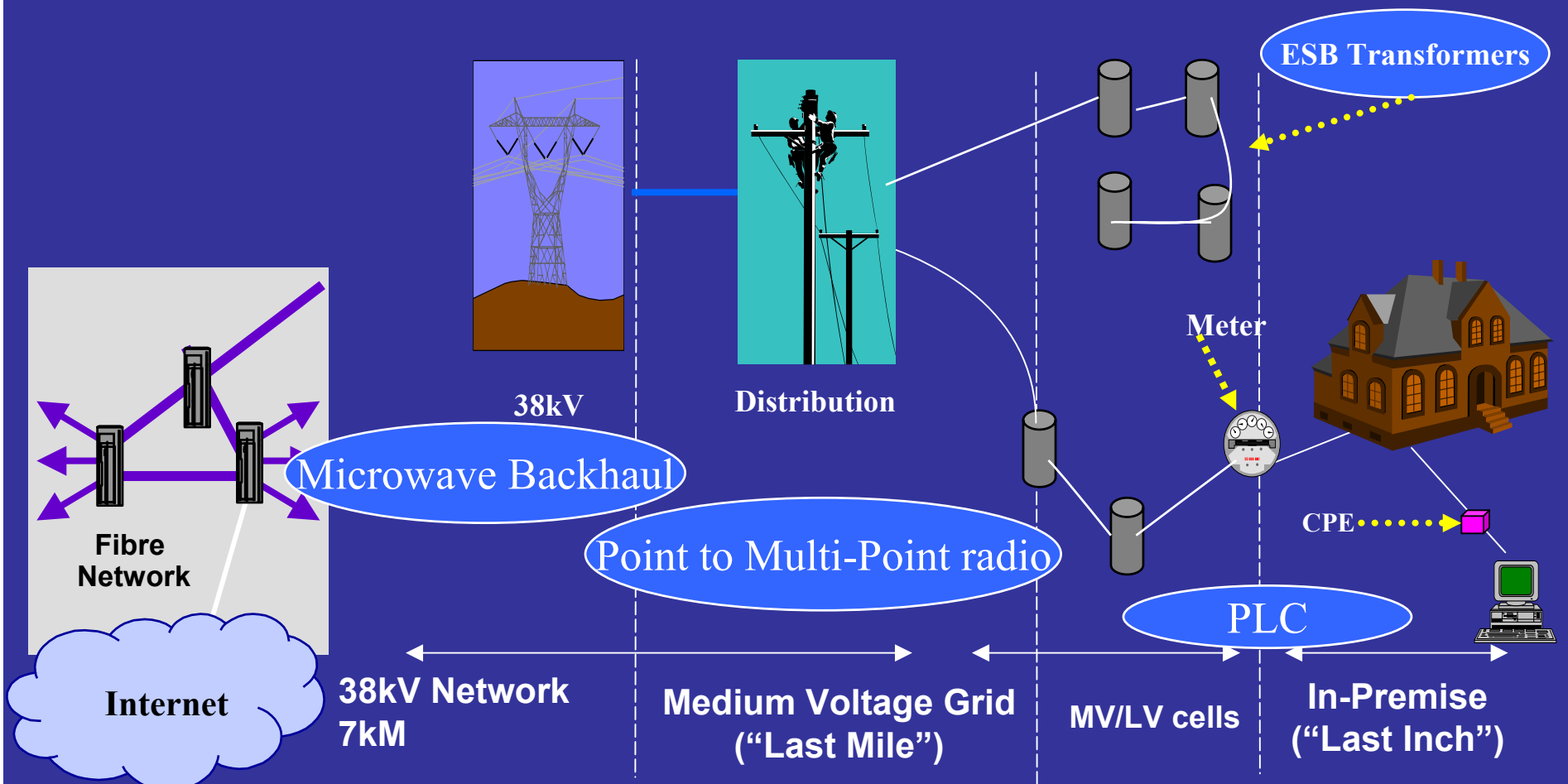
# Initial Issues

- **Limitation of Vendor A MV repeaters required development of BPL mini-pops with connection back to main PoP for town**
  - **Point to multipoint radio**
- **Difficulties with overhead lines for Vendor B**
  - **Radio backhaul from town centre to first MV repeater**

# Backhaul from MV Substations to 38kV Station

- MV transformers generally on a ring circuit with alternative electrical paths back to 38kV Station
  - Existing PLC technology alone does not support this option

# Actual trial



\* CPE - Customer Premise Equipment





# PLC Trial Backhaul Schematic



PLC network with 10BaseT interface to backhaul. Proposed router connection at Tuam South to interface with radio element of backhaul.

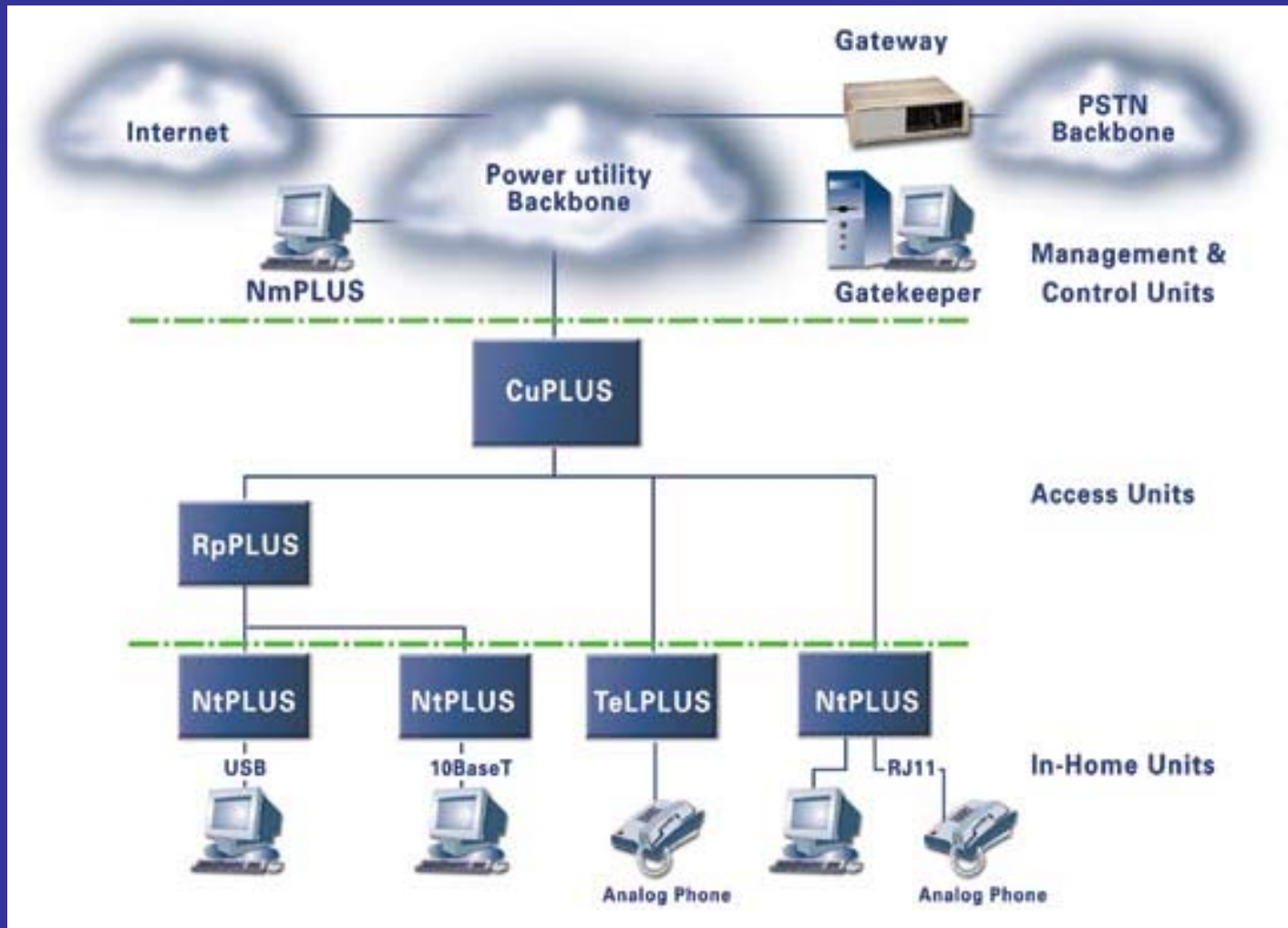
Requirement to backhaul info using NTFON facilities to bring data back to ISP Hosting Centre. Estimated bandwidth uplink capacity required 4-6Mbps.

# Radio Backhauls.

- “Line of sight” required back to 38kV Station
- Use existing mast/pole in 38kV station to accommodate antenna for backhaul
- Require erection of pole/steel column to accommodate antennae in pilot areas –planning permission, wayleave issues.
- Ground enclosures for communication equipment in pilot areas may require planning permission and/or wayleave clearance



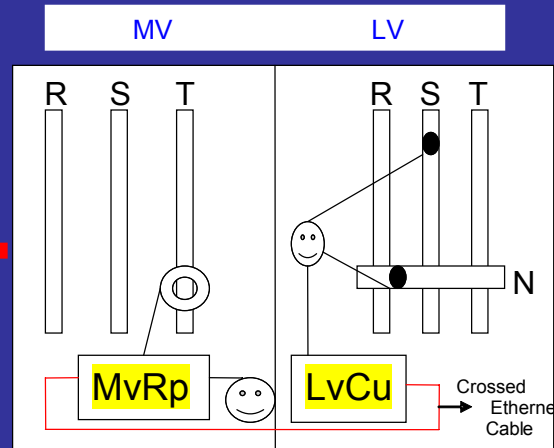
# Basic Architecture



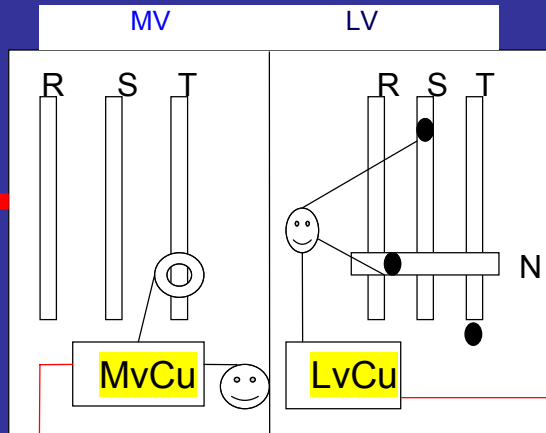
# Vendor A Cell 1 PLC Schematic

Lissadyra transformer

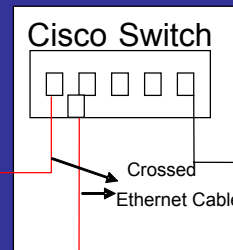
200m UG  
MV Cable



Belair Transformer



Radio Link



NMPlus 3.2 - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address http://217.114.174.133:8080/client/main.jsp

View Tools Help Logout Search: go

Undefined > Undefined > 00036A030810...

★ 00036A030810 Lissadyra LvCu Last Polled: Oct.17, 12:01:54

General Manager Services Security

Component ID

Ethernet MAC 00036A030810

Name 00036A030810 Lissadyra

IP Address 10.2.0.51

Subnet Mask 255.255.0.0

Type CuPLUS

Parent Unit:

Additional Information

Description Lissadyra Lv CuPlus

Comments

Reboot Unit Poll Unit Now Refresh Save

Alarms & Events No Filter Multiple Close Total Alarms 1001 Open 985 Prev. 1 Next

ID	Sev.	Time	Alarm Name	Source Name	Status	CuPLUS MAC
8813	✖	Oct.18, 15:52:12	CuPLUS Lost	★ : 00036A030810 Lissadyra LvCu	Open	
8799	⚠	Oct.18, 15:04:35	CuPLUS Reset	★ : 00036A02D224 Belair MvCu	Open	
8787	✖	Oct.18, 14:27:37	CuPLUS Lost	★ : 00036A030810 Lissadyra LvCu	Open	
8782	✖	Oct.18, 14:22:12	CuPLUS Lost	★ : 00036A030810 Lissadyra LvCu	Open	
8776	✖	Oct.18, 13:52:12	CuPLUS is not SNMP Manageable	★ : 00036A030810 Lissadyra LvCu	Open	
8768	✖	Oct.18, 12:57:12	CuPLUS Lost	★ : 00036A030810 Lissadyra LvCu	Open	
8720	⚠	Oct.18, 09:03:28	CuPLUS Reset	★ : 00036A02D224 Belair MvCu	Open	
8715	⚠	Oct.18, 08:53:14	CuPLUS Reset	★ : 00036A02D224 Belair MvCu	Open	

Loading Alarms... Internet

Start Ping Plotter Window... 3 Intern... 11 Micros... Microsoft P... 4 Micros... beverage ... Acrobat Re... 16:08



# ESB Networks Considerations

- **Safety**
- **Access to Network to install/maintain PLC equipment**
- **Protection of PLC equipment**
- **Operational issues**
- **Regulatory - CER**



# ***Implementation Findings - Vendor A***

- Repeater installed in each ESB minipillar throughout estate.
- Management System can be used to identify redundant repeaters.
- Individual customers simply plug in modem to electrical socket.
- Distance from transformer and electrical wiring within customers premises will effect performance



## *Low Voltage Repeater in ESB Minipillar*



# *MV Coupling at ESB Switchgear*



# ***Implementation Issue 1 - Vendor A***

- **Initial installation in August 2004 with 1 customer**
- **Customer experienced loss of connection at night**
- **Over following two/three months loss of connection occurred earlier in evening**
- **Vendor A attempted to re program MV modems remotely without success**
- **In December 2004 MV modems replaced**
- **15 Customers used successfully for nine months**



# ***Implementation Issue 2 - Vendor A***

- **Observations on interference by PLC to a range of HF frequencies used by amateur radio transmitters.**
  - Mobile transmitter with RF power of 40W (16dBw)
  - Frequencies 3.680/7.060/10.122/14.205 MHz
- **PLC interference on HF signals observed but only a problem with weak signals.**
- **Problem with HF signals interfering with PLC.**
  - PLC Management system attempts to compensate

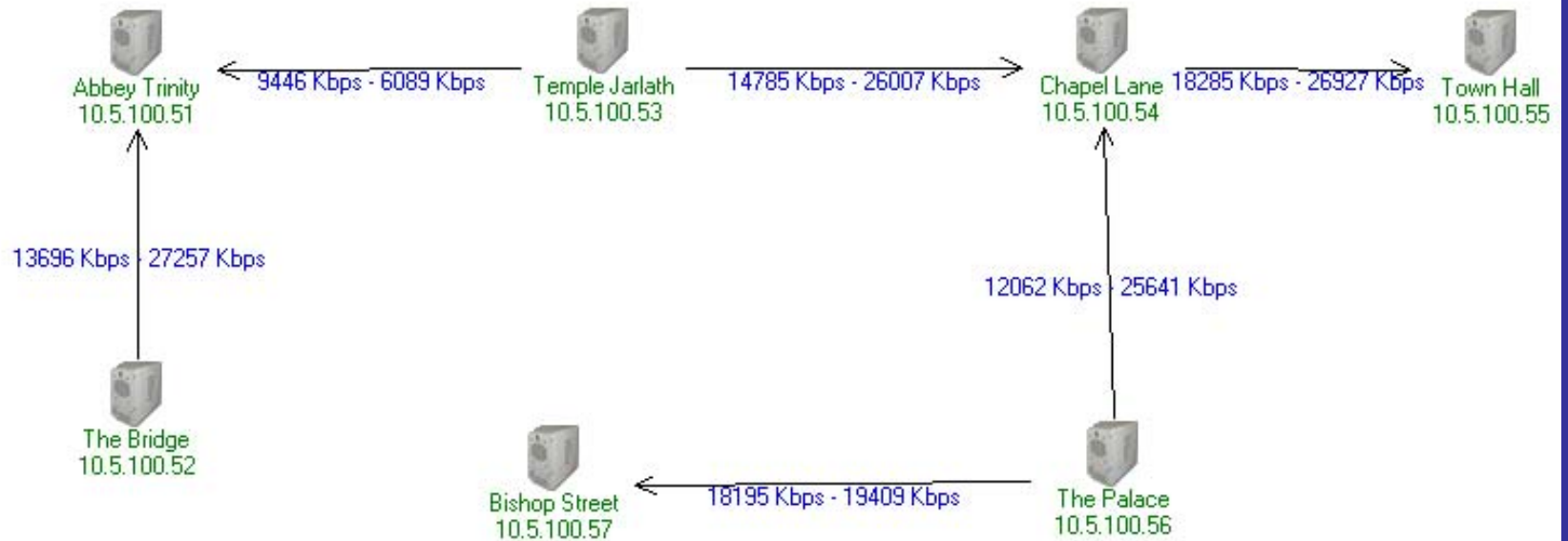
## ***Vendor B – Initial Provisioning***

- Based on site survey and desktop design
- Unable to implement PLC backhaul on 1kM section of overhead MV overhead networks due to noise levels.
- Fundamental redesign undertaken compounded by major changes in ESB topology in Tuam town.
- Installation of PLC on ESB MV network is extremely difficult and time consuming



# Vendor B MV Schematic

Short runs of UG cable between transformer locations (<200m)



# *Vendor B Equipment in Enclosure*



# Vendor B Enclosure



# *Vendor B Pole Mounted Enclosure*



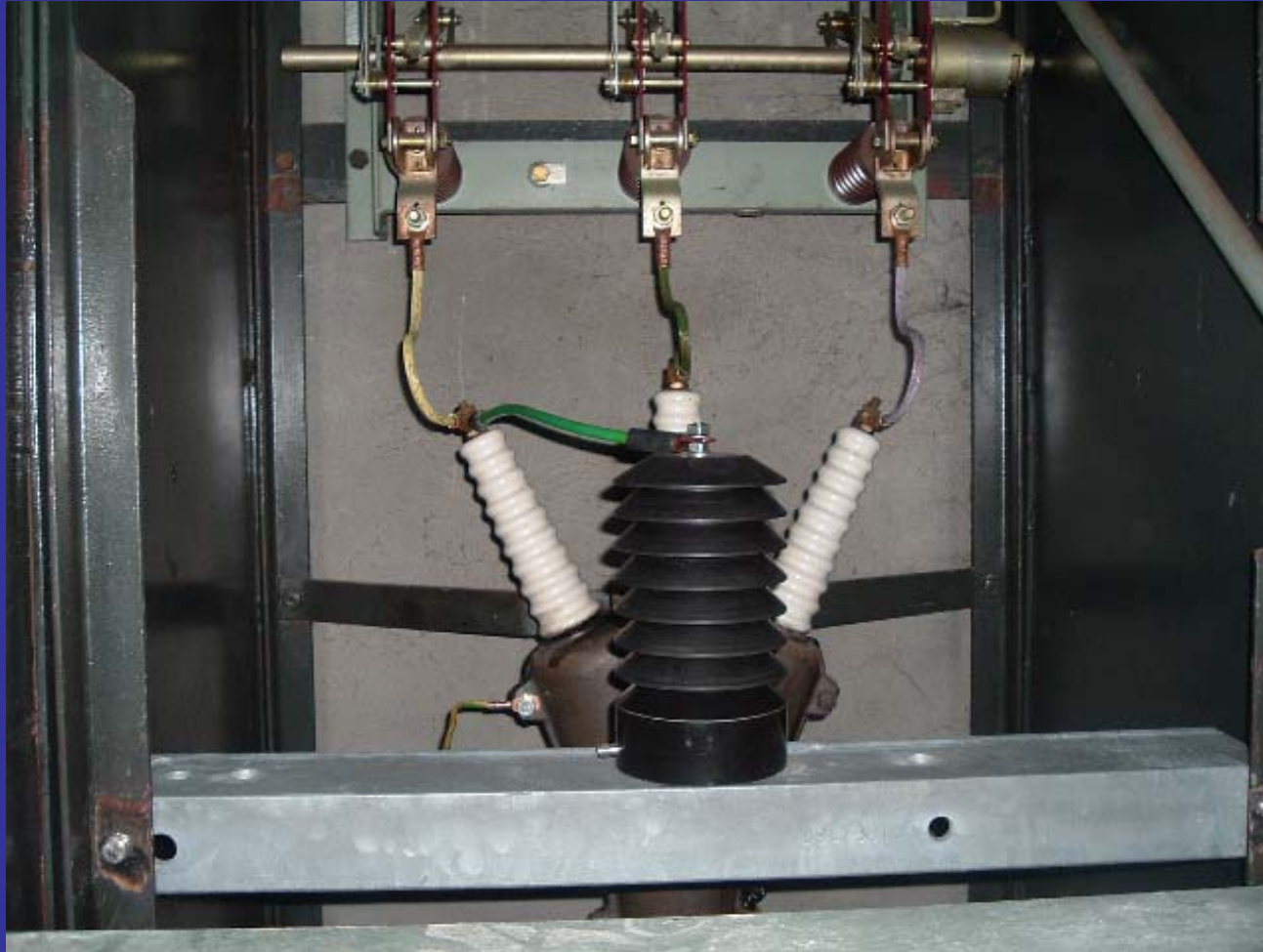
# Indoor MV Inductive Coupler



# Outdoor MV Capacitive Coupler



# Indoor MV Capacitive Coupler



# ***Implementation Issues at MV Vendor B***

- **Design of equipment major issue**
  - **Size**
  - **IP rating**
  - **Requirement for power supply**
- **Change in Electrical Topology requires redesign and possible change in equipment**
- **Unable to overcome noise on Overhead Networks**

# ***Implementation Issues at LV Vendor B***

- **Similar rollout problems as with MV PLC**
- **Inductive coupling of PLC signal only effective on power cables with low currents (< 30 amps)**
- **Capacitive coupling on ESB mains cables raise issues of safety and protection.**
- **Capacitive coupling on customers equipment also raises the issue of Public Liability**

# ***Implementation Issues at LV Vendor B***

- **Indoor ESB MV substation feeding apartment block(s) with centralised metering**
  - Connection from modem to “signal multiblock” in metering room.
  - Connection to coupler on customer side of meter
- **Tests identified the following:**
  - Requirement for filter sockets in customer’s apartment
  - Possible interference from multi-socket boards on same circuit
  - Requirement for capacitive couplers on customer’s side of the meter
- **Due to complexity of installation of LV equipment outdoors along the street rollout abandoned.**

# ***Stakeholder Consultation***

- **Irish Radio Transmitters Society**
- **Communications to ComReg from Defence Forces**
- **Involvement of ComReg radio/spectrum experts**
- **Business Case template (Major workshop with BMP 17/06/04)**

# *Regulator Input*

- **Two surveys of operational equipment**
- **17<sup>th</sup> May 04 and 5<sup>th</sup> August 04**
- **Measurements Performed on both Vendors**
- **ComReg also investigated problems with performance of Vendor B equipment on overhead MV lines**
- **Comreg draft report on findings**

# ***Regulator Findings and Recommendations***

- **Both systems comply with German leakage Limits**
- **Vendor B equipment should exclude amateur bands**
- **Need to notch out HF “safety of life frequencies”**
- **Reduce injection power**
- **Irish leakage limits would then be complied with**

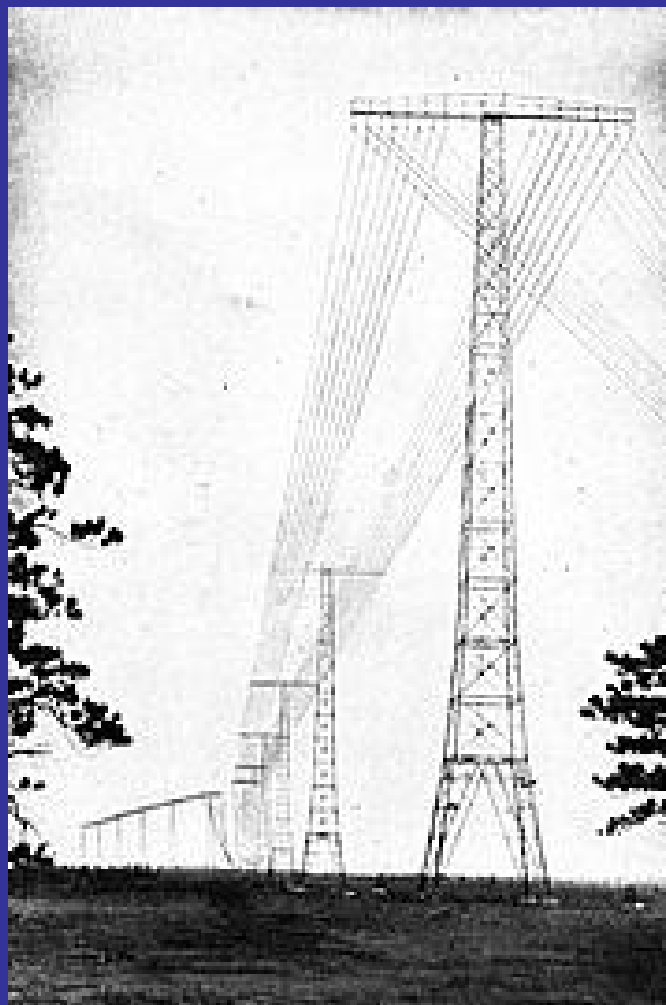
# ***Regulator RF Investigation***

- **Comreg investigated noise level on Overhead network**
- **All frequencies identified as legitimate transmissions,**
  - **continental European shortwave broadcasts**
- **Unique topology of Irish electricity distribution network**
- **Ireland's Geographical position means that shortwave signals are received at higher levels than in continental Europe**

# *Regulator RF Investigation*

- **Currently at a minima in 11 year sunspot cycle**
  - **Relatively 'poor' propagation conditions for SW signals**
  - **During sunspot maxima signal propagation levels will increase further decreasing C/N levels**
- **Antenna Effect**
  - **Where long overhead lines with local earthing form a capacitively coupled 'Beverage Type' long wire antenna with the terminating end connected to ground. Particularly efficient for SW reception**

# Beverage Antenna



# *Service Definition and Setup*

- **ISP Setup**
  - **Access**
  - **Speed**
- **Client setup**
- **Micro Site**



# Web Site for Customer Support ESB 'Micro Site'

ESB Broadband Powerline Trial - Home - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Media

Address http://devesbnet/broadband/ Go

**ESB** broadband powerline

- Home >
- What is broadband? >
- What you need >
- FAQ's >
- Contact Us >
- Terms and Conditions >

**Welcome to the ESB Broadband Powerline Trial Background**

One of the key historical constraints to offering a high speed data service to businesses and individuals in Ireland is what is referred to as the 'last mile' or 'local loop' problem. Many telecomms operators had upgraded their backbone infrastructures with the advent of fibre technologies but the business case for fibre-to-the-home (FTTH) could not be made.

**Last Mile Alternatives**

In recent years strides have been made in solving this problem. Digital subscriber line (xDSL) driver technology has enabled very high speeds to be achieved over traditional copper pairs from the local exchange to the home or business. NTL and other cable operators have spent millions upgrading their cable networks to fully bi-directional hybrid fibre-coax networks and great strides have been made in WiFi wireless technology particularly with the acceptance of IEEE 802.11(a, b and g) both for in-building networking and last mile. Finally, the awarding of 3G UMTS mobile licences offers the potential of mobile broadband (or near broadband) services.

However, general roll out of these services have been slow due to regulatory unbundling issues and the general downturn in ICT in Ireland and world-wide, however, the major investments are in place and the technologies outlined above are proven and standardised.

**Power Line Carrier Technology**

Because utilities have physical infrastructure in the form of the LV network running into home and businesses, lateral thinking from about 1997 onwards, has suggested that there is a financial opportunity for

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Done Local intranet

Start ESBnet - Microsoft Inter... ESB Broadband Power... 10 Microsoft Outlook 16:15



# Technical Conclusion

- **Broadband Power Line has naturally attracted huge political and financial support, particularly in Europe and the US**
- **Enormous sums of money have been spent by very capable companies since approximately 1997 trying to perfect this technology**
- **Most of these companies have exited the market or no longer exist**
- **Despite the significant prize (if or when achieved) of enabling an alternative last mile infrastructure, Broadband Power Line Technology is nowhere near an appropriate state of development required for 'mass market' rollout**
- **Additional provisioning issues identified during trial push significant additional cost into an already marginal business case**



# Rationale for conclusions are supported by trial results

•Key general concerns over PLC Technology were all experienced during the trial process:-

- Spectrum & R/F Interference Issues
- Proprietary Technologies lack of any ITU or IEEE standards,
- Heterogeneous Networks – Lack of repeatable ‘Production’ Capability particularly in the case of emerging higher speed chipsets
- Lack of Sub-Station Backhaul Connectivity
- Cost and complexity of provisioning
- Stability of baseline service and Network Management Software

# Significant additional issues were uncovered during the Tuam Trial

- **Electrical Topology** – increased RF egress and ingress issues
- **Technology sensitive to loss of service due to noise ingress**
- **Severe limitations on use of MV network as backhaul**
- **Equipment size and IP65 protection issues with Vendor B**
- **Lack of transparency in relation to design and problem resolution**
- **High degree of design and experimentation**

# Bottom Line

- A limited number of potential 'sweet spots' exist for Broadband Power Line. These mainly relate to in-home networking and urban high-rise provisioning (where unfortunately many broadband alternatives already exist).
- However, despite significant hype and R&D spending by vendors and certain utilities, Broadband Power Line Technology is nowhere near an appropriate state of development required for commercial 'mass market' rollout
- ESB Group and the Irish Government (through the Department of Communications, Marine and Natural Resources) have verified the current status of the technology at a very low cost compared to many utilities and government authorities in Europe and the US



# Questions and Answers

