STRATEGIC ANALYSIS OF NOR.WEB CLOSURE

REPORT
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NORWEB's BREAKTHROUGH IN POWERLINE TELECOMMUNICATIONS

Powerline Telecommunications (PLT) describes the new generation of technologies which can distribute high frequency communications signals over operational power distribution/transmission networks.

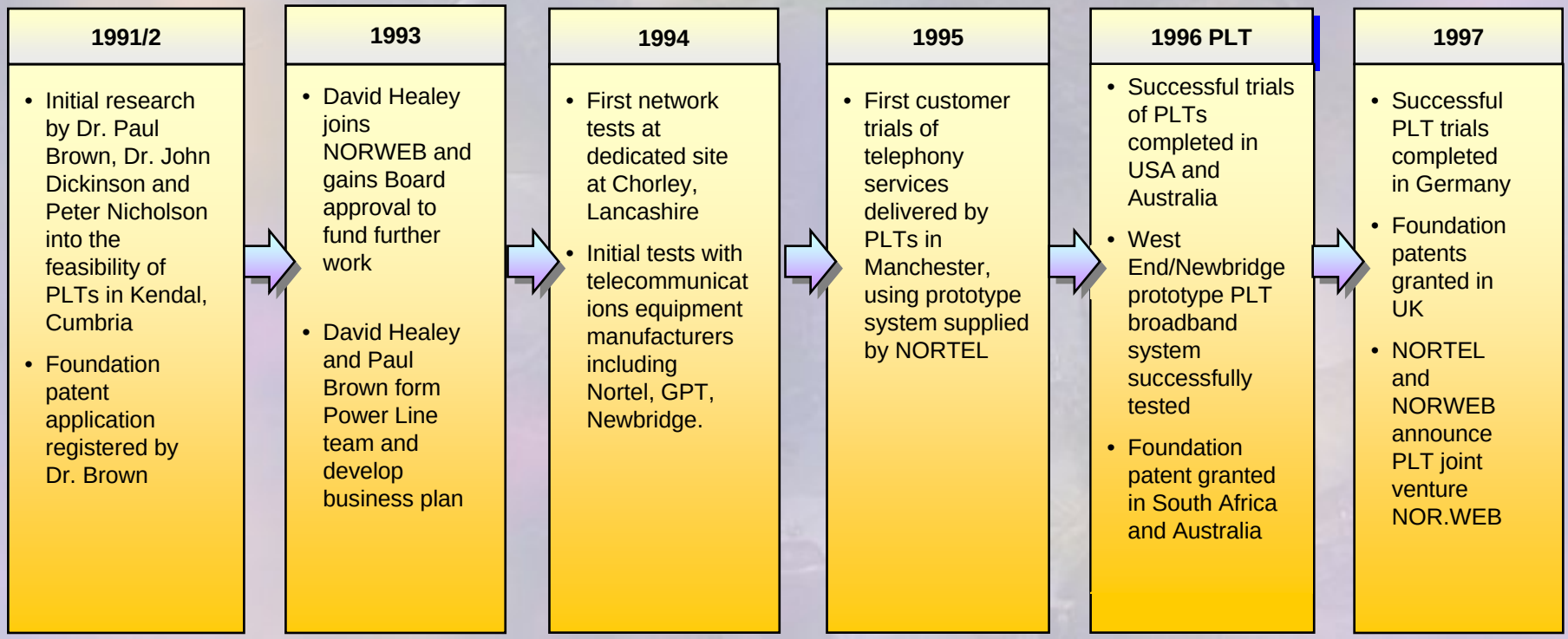
- PLT systems using “low” frequency signals have been operated by power companies for many years for simple telemetry and monitoring applications.
- In 1992 NORWEB carried out research which identified that high frequency (above 1MHz) signals could be successfully propagated. (A patent covering all such applications was granted to NORWEB in 1996).
- Although initial applications focused upon low voltage “access” networks systems are now in development which also employ in building and medium voltage “transmission” systems.

Research by NORWEB of the UK confirmed that communications at much higher frequencies than the present CENELEC standard can be successfully propagated over power distribution networks.

- Systems based upon operating frequencies above 1MHz.
- Focus was originally upon UK underground distribution networks utilising sheathed cables.
- NORWEB's research suggested that to maximise the potential communications capability of power systems, conditioning units or filters should be installed at strategic network termination points.
- By optimising the propagation performance of the underlying radio system the level of network filtering could be reduced dramatically.

The original technology was developed during the early 1990s by NORWEB, the Manchester-based British regional electricity company.

POWERLINE - CALENDER OF KEY EVENTS



The successful operation of high-speed PLT systems had to overcome a number of problems.

• Most electric appliances and applications generate high frequency noise which propagates across the power distribution system. This noise can make certain frequencies no go areas for communication systems.

• Even on underground sheathed cables high frequency radio signals tend to irradiate and can conflict with other users of the radio spectrum.

• The propagation characteristics of power distribution networks can differ dramatically, dependent upon cable types, number of service connections, joints etc.

The world's first commercial trials of a high speed PLT system were implemented in 1995 by NORWEB.

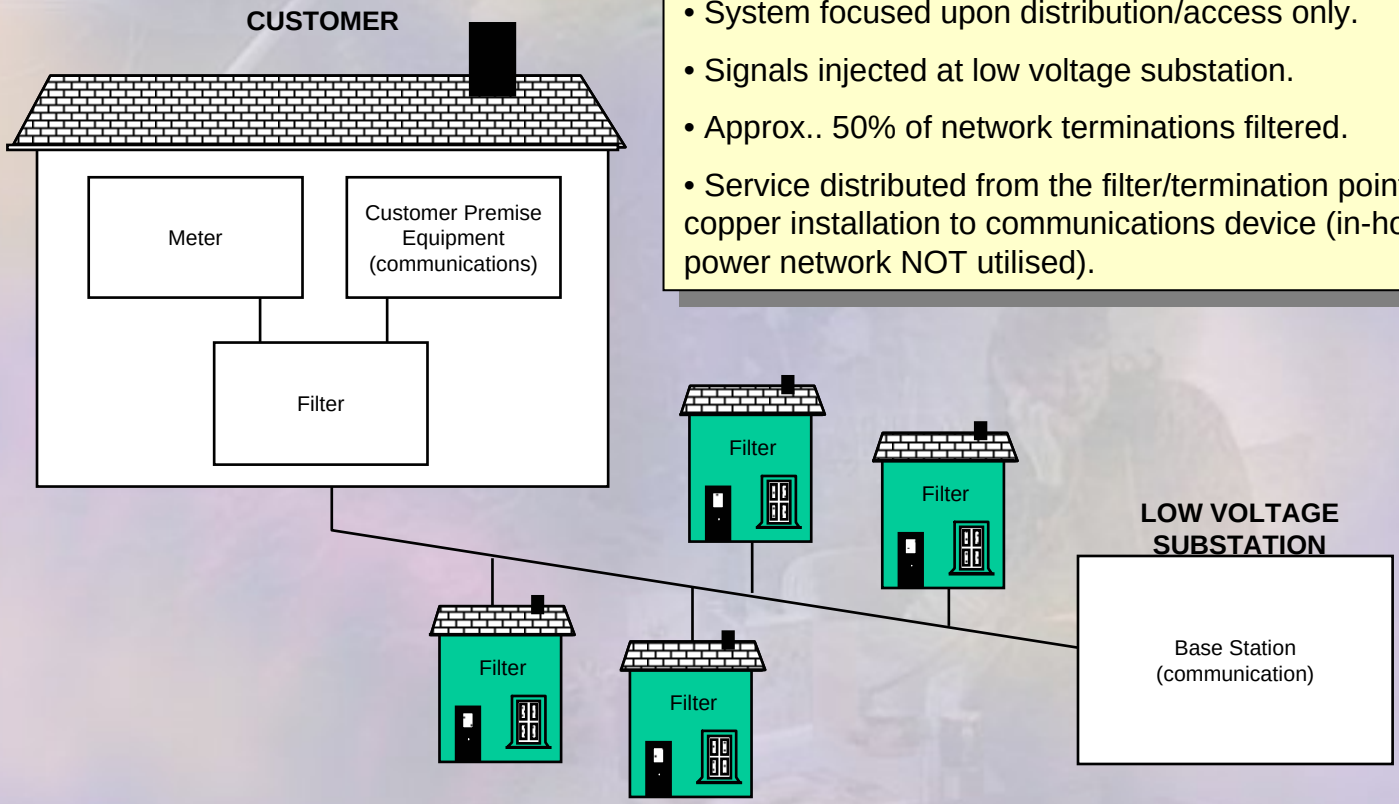
• The application employed was an adapted CT2 mobile radio systems supplied by NORTEL.

• Around 25 residential customers were given 32kbit digital voice service. A number of these customers also used the service for internet access.

• Service quality improved dramatically after the first six months. The majority of service faults resulted from faults within the customer premise equipment. After twelve months, acceptable service was approximately 98% of all connections.

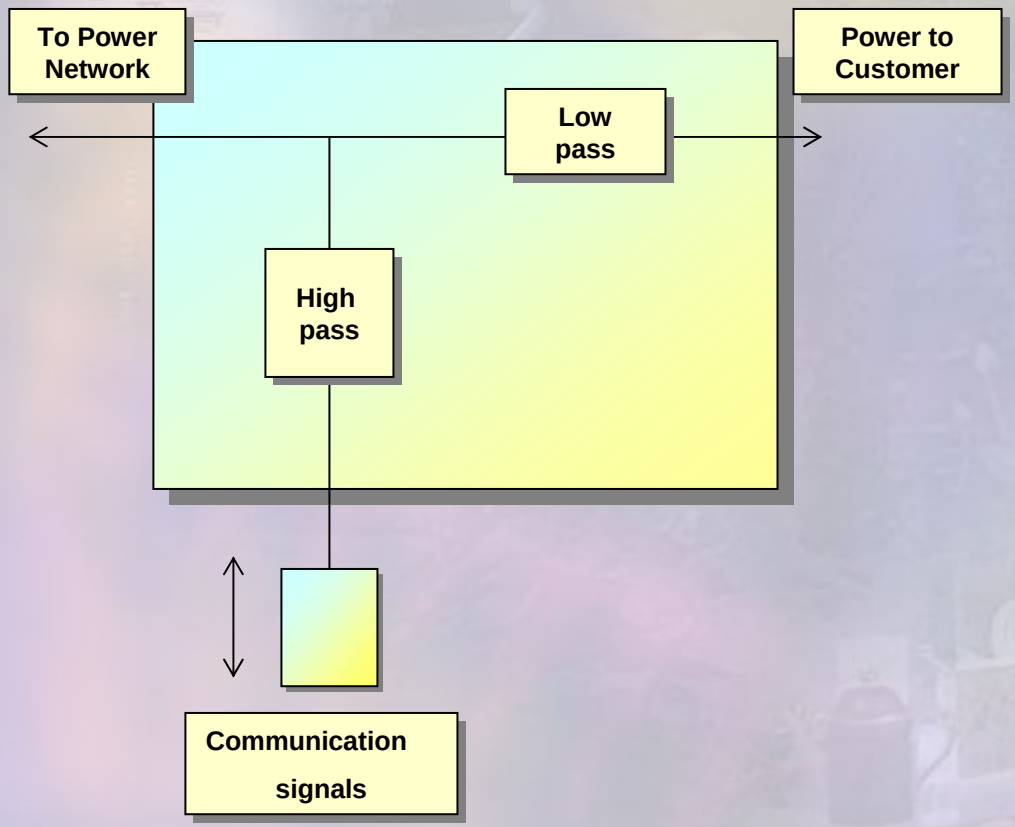
• The equipment operated at frequencies between 8MHz and 12MHz. (In normal mobile operation it would have operated around 900MHz).

NORWEB's trials clearly demonstrated the successful operation of high speed PLT systems.



- System focused upon distribution/access only.
- Signals injected at low voltage substation.
- Approx.. 50% of network terminations filtered.
- Service distributed from the filter/termination point by copper installation to communications device (in-home power network NOT utilised).

The filter (Conditioning Unit) was a key of NORWEB's initial PLT network development.

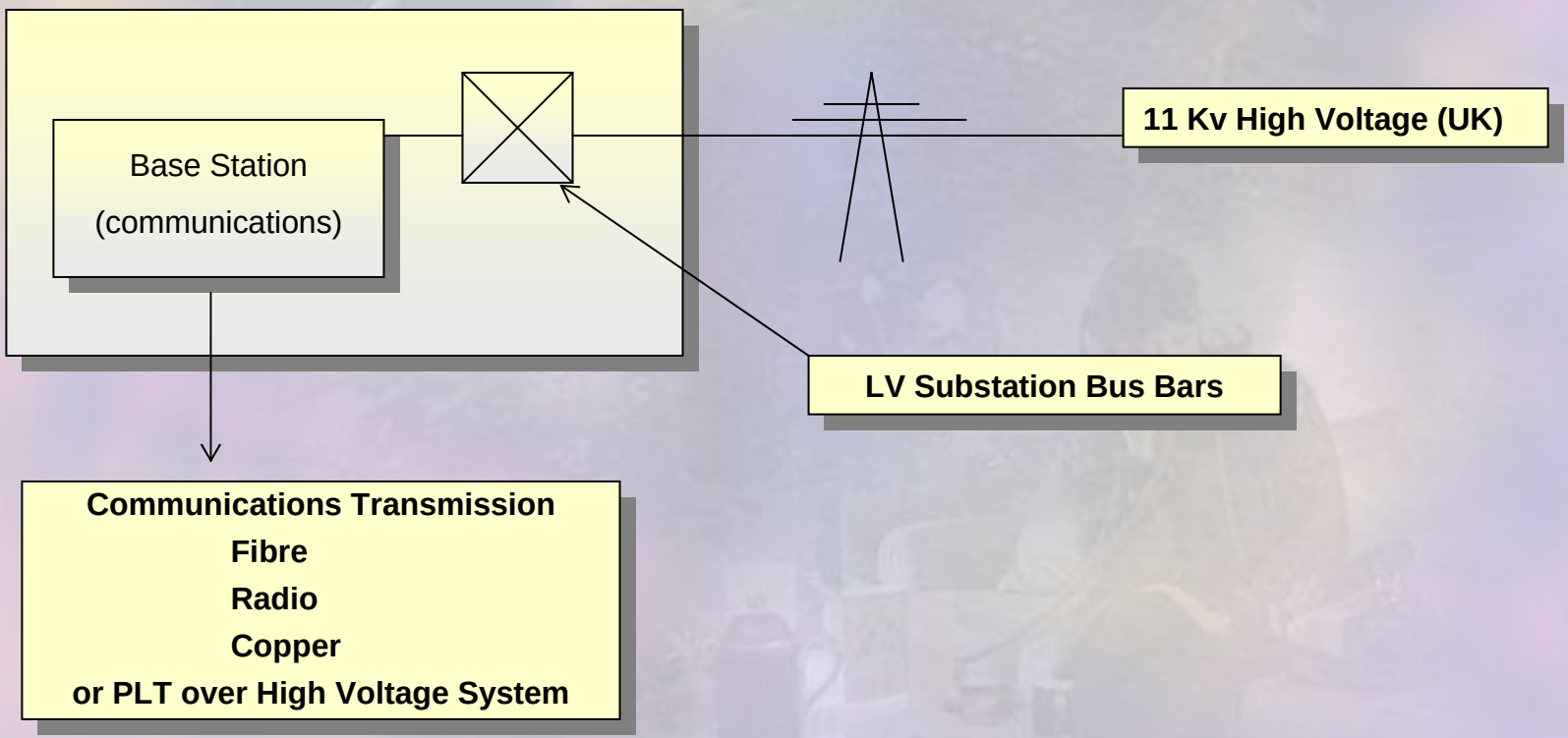


The filter was to be implemented at each network termination/supply point (homes and street lights).

The high pass filter matched cable impedences to allow effective delivery of communications signals

The low pass filter prevented high-frequency signals entering the domestic power system and stops high frequency noise entering the distribution network and compromising communications signals.

Under NORWEB's proposals the local area base station or network intelligence can interface to any appropriate communications transmission technology



NORWEB initially registered five principal Powerline patents.

- Communications apparatus (filter) (ref. GB2304013).
- Coupling of communications signals onto power distribution network - above 1MHz (ref. WO 9607245).
- Power communications utilising TDMA FDMA CUMA transmission protocols (ref. WO 9529537).
- Hybrid power communications networks also utilising fibre on co-axial cable (ref. WO 9529536).
- Signal input and removal device for frequencies above 1MHz (ref. GB 2272350).

These intellectual property rights were founded upon a "base" patent which may require any operators of power line services to obtain a licence from NORWEB.

- Patent granted in Australia, South Africa and USA.
- Patent pending in European Union and 12 other countries.
- Over 30 secondary patents have been registered on related developments with applications pending in 28 countries.

The success of the Manchester trials based upon a very preliminary adaptation of a mobile system led NORWEB to seek a technology partner to jointly develop a commercial volume system.

- NORWEB held discussions with a number of interested equipment vendors.

- In addition, two key questions were raised regarding a future PLT system development:
  - What propagation system would provide the most effective foundation for a broadband PLT system?
  - What would be the service capability and focus of such a system?

ULTIMATELY THE ANSWER TO THESE QUESTIONS WOULD DETERMINE A NUMBER OF ISSUES WHICH WOULD IMPACT THE VIABILITY OF THE NOR.WEB STRATEGY

NORWEB WERE CONFRONTED BY TWO OPTIONS REGARDING BOTH TECHNOLOGY AND MARKET FOCUS.

- Certain vendors were suggesting that a PLT system would be best targeted at a data-centric delivery for the following reasons;
  - Questions were raised over the capability to support real time voice service without incurring considerable costs in extensive filtering or “conditioning” of the network.
  - The future of residential/small business services was seen as based upon data. The growth of internet access seemed to support this position that voice would eventually be delivered over “packet” based networks.

- Other vendors believed if PLT was to deliver service to a large proportion of the residential market, real time voice had to be available.
  - Utilities would not be interested in delivering initially a niche data service.
  - Voice was seen as the only “universal” commercial communications service in the residential sector.
  - Certain radio propagation systems designed for other networks (e.g. XDSL) were capable of supporting real time voice within onerous environments.

In 1997 NORWEB completed a partnership (50:50 JV) with NORTEL to form NOR.WEB. The business would develop a high speed data PLT access technology, focused upon the residential and small business sectors.

The key market for NOR.WEB was those power utilities who would be interested in diversifying into provision of telecoms/data services.

• Initial focus was upon the European market, particularly those countries who had densely textured underground power distribution networks.

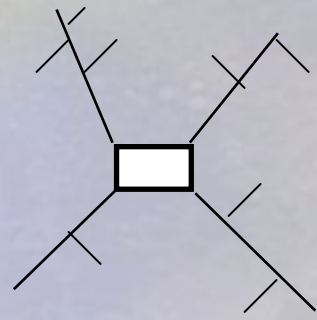
• In most countries which had or were looking to implement telecoms liberalisation, the power utility was seen to be involved in offering competitive services as directly or indirectly.

• NOR.WEB's early approaches to utilities in 1997/8 were at a stage however where the product was yet to fully proven in the field.

• Also the UK government body responsible for frequency management began at this time to raise issues regarding eradication of high frequency signals from the Manchester network trials.

WHY IS PLT ATTRACTIVE TO UTILITIES?

The traditional utility market is structured across four separate functions and de-regulation is also based upon this format.



Generation Transmission Distribution Supply

SOME COUNTRIES ARE ALSO REGULATING TO INTRODUCE SEPARATE FUNCTIONAL AND ACCOUNTING STRUCTURES FOR METERING (*eg. California is to require the meter provision, metering services, meter reading and billing to be offered as individual contracted and competitive services*)

Utilities around the world are having to deal with increasing pressures upon their core activities.

• Power distribution exhibits between 1% and 2% CAGR in developed countries (average CAGR in USA 1.1% Frost and Sullivan.

• Power supply (service) business often generates gross margins of less than 2% due to electricity price controls.

• Conversation/increase of energy efficient systems reduces growth of generation sector.

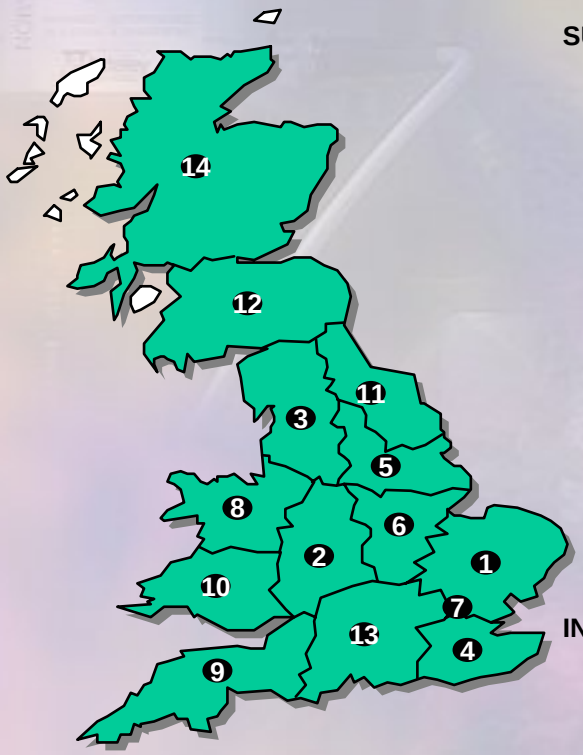
• Privatisation de-regulation results in regulatory pressures to reduce retail prices.

• Introduction of service competition result in reduced market share, increases downward pressure on prices and increases service costs.

Utilities therefore actively seek revenue growth and capabilities to differentiate/add value to their core utility service.

The introduction of liberalisation and de-regulation of the power utility sector in the UK has led to a round of mergers and acquisition. Ultimately however these do not solve the underlying pressures within the businesses.

MERGER & ACQUISITION ACTIVITY IN THE UK ELECTRICITY DISTRIBUTION SECTOR



SUBSIDIARIES

INDEPENDENTS

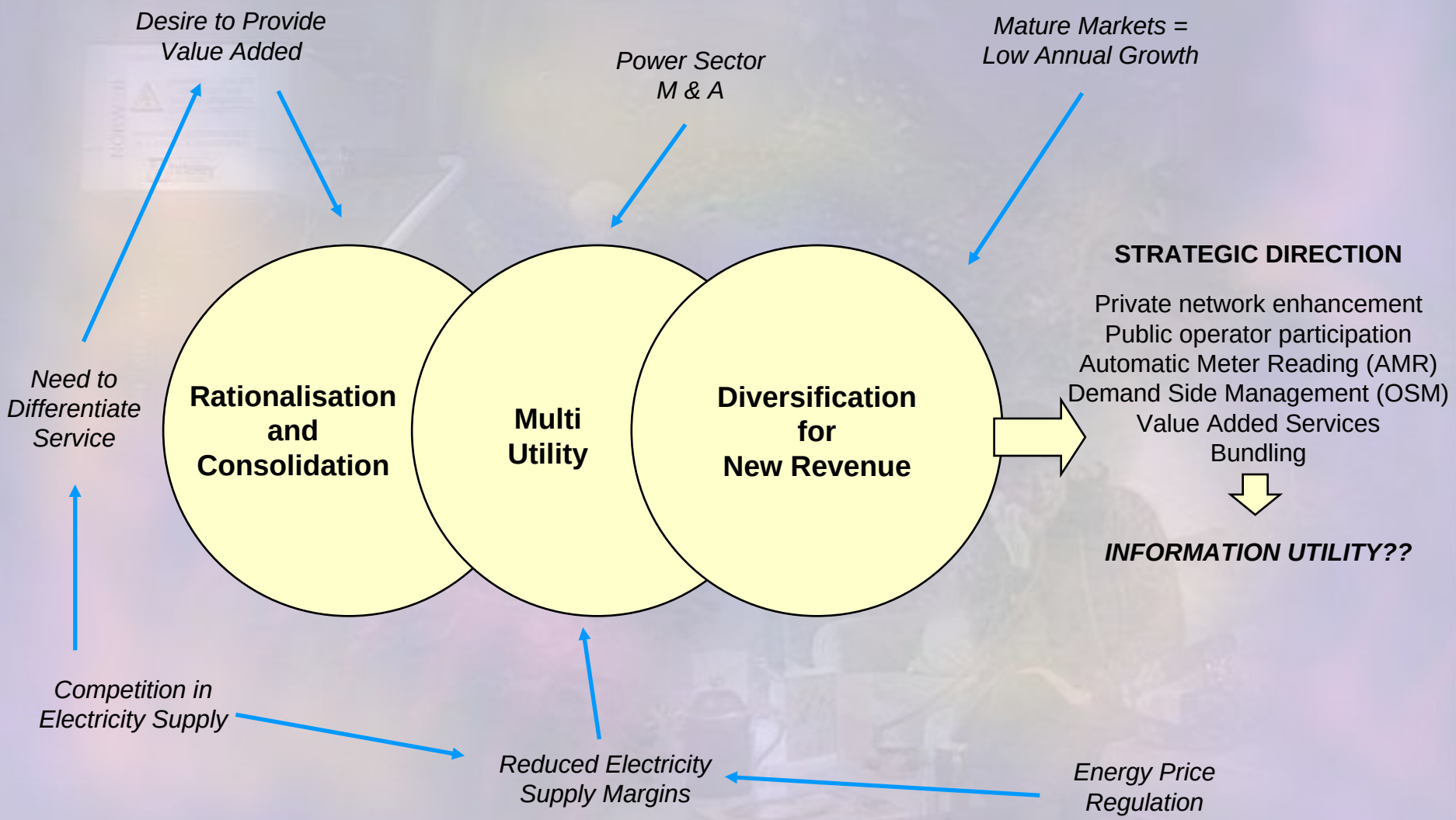
COMPANY	OWNERS	VALUE OF BID (£BN)	YEAR OF BID
1 Energy Group	Texas Utilities (US)	4.46	1998
2 Midlands Electricity	GPU/Cinergy (US)	1.73	1996
3 Norweb	North West Water (UK)	1.83	1995
4 Seeboard	Central & South West (US)	1.60	1996
5 Yorkshire Electricity	American Electric Power/Public Service Company of Colorado (US)	1.50	1997
6 East MidlandsE lectricity*	Dominion Resources (US)	1.30	1997
7 London Electricity**	Entergy (US)	1.27	1997
8 Manweb	Scottish Power (UK)	1.10	1995
9 Sweb	Southern Co (US)	1.10	1995
10 Swalec	Hyder	0.87	1995
11 Northern Electric	CalEnergy (US)	0.65	1996

COMPANY	MARKET CAPITALISATION (£BN)
12 Scottish Power	7.10
13 Southern Electric	2.61
14 Scottish Hydro-Electric	2.35

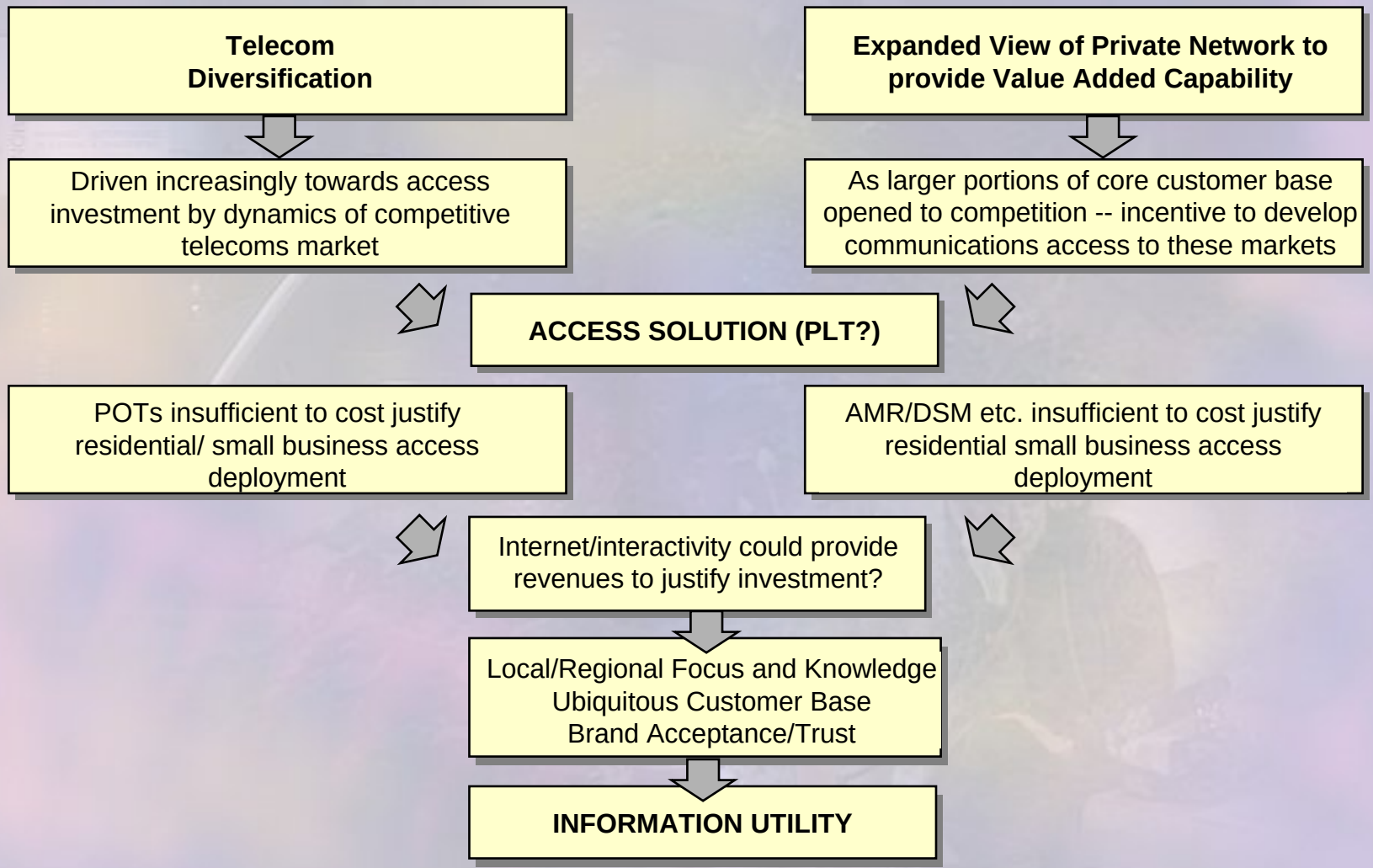
Note ** Dominion selling East Midlands to Powergen for £2bn*
*** For sale as part of Entergy disposal programme*
Source: Datastream/ICV; companies

MANY POWER COMPANIES ARE ALSO INVESTING OVERSEAS WHERE REGULATION PERMITS (EG. RWE - EASTERN EUROPE, VEBA-ARGENTINA, ENDESSA-BRAZIL, SOUTHERN AND AES - BRAZIL UTILICORP-AUSTRALIA)

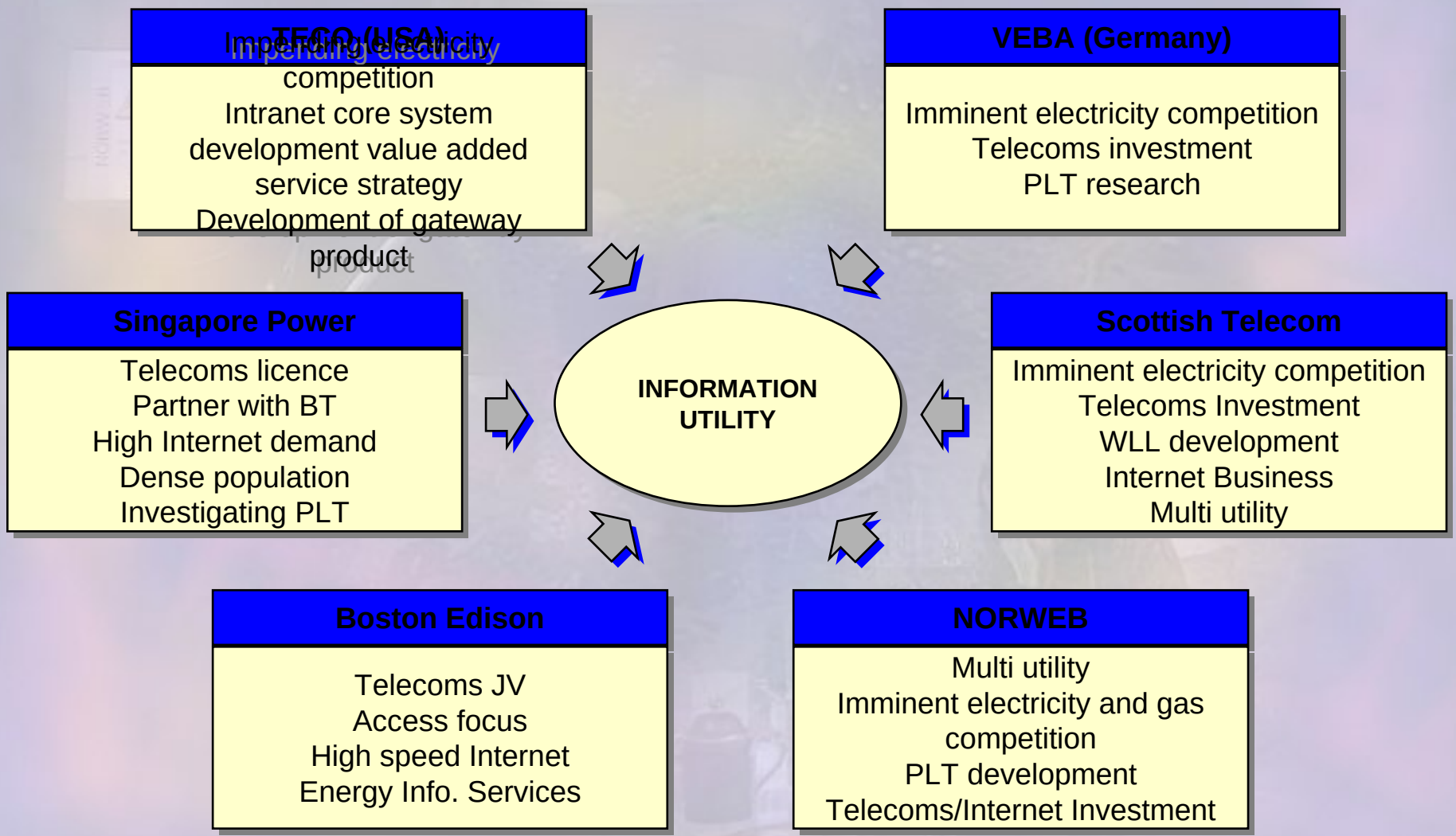
Strategic options for power utilities in response to environmental change.



Signs are developing that that utility activities are beginning to converge upon this service concept of the "information utility".



A growing number of much larger utilities are beginning to converge upon this concept from different strategic viewpoints.



STATUS OF PLT SECTOR

PLT SWOT ANALYSIS

PLT SWOT Analysis - Strengths.

- Potentially higher bandwidth delivery than existing Telco's network.
- Connects to whole population.
- Low system maintenance requirements.
- Can be implemented on targeted cellular basis.
- Can support voice and data services
- Tree and branch system more efficient than the PTSN star network.

PLT SWOT Analysis - Weaknesses.

- May need to filter local terminations.
- Each local node has different propagation characteristics.
- Limited network trials.
- No commercial product available.
- No standards for equipment design or operation.
- Uncertainty regarding economics of deployment.

PLT SWOT Analysis - Opportunities.

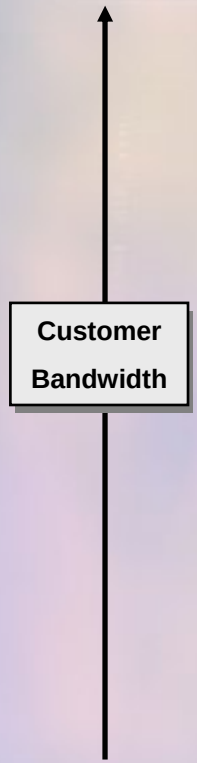
- Range of appropriate radio systems available.
- Growing number of manufacturers involved.
- Opportunity to lead market with first available product.
- Large demand from utilities moving into telecoms.
- High voltage solution will reduce costs.
- “In home” systems will increase value for the customer.

PLT SWOT Analysis - Threats.

- EMC restrictions.
- Lack of manufacturer interest.
- Customer safety concerns.
- EC open access provisions undermine market for access.
- Regulatory obstructions or commercially unattractive regulatory framework.

The upgrade path for PLTs is highly attractive by comparison to other local Access technologies. Other Access infrastructure's require significant capital investment to deliver more than one or two telephony lines. PLT systems are in development which will allow bandwidth delivery to increase incrementally as demand increases.

ACCESS TECHNOLOGY UPGRADE PATHS



	TELECOM	CATV NETWORKS(2)	FIXED RADIO(3) (WLL)	PLTs(4)
Broadband 1Mbps	↑	↑	↑	Requires compression ?
Wideband 128 kpbs-1Mbps	Introduction of ADSL	Introduction of cable modems	Introduction of broadband radio	✓
Midband up to 128 kpbs	X	X	X	✓
SIGNIFICANT INVESTMENT IN NETWORK REQUIRED				
Multi-line telephony (minimum data)	Requires additional build	Requires additional build	Requires additional build	✓
Telephony (minimum data)	✓	✓	✓	✓

Notes: (1) Copper twisted pair.
(2) Hybrid fibre-coax with copper termination for telecommunications.
(3) NORTEL Proximity 1 system
(4) Based on OFDM implementation.

THE DECISION TO CLOSE NOR.WEB

What are the possible reasons for NORTEL and United Utilities deciding not to proceed with the NOR.WEB business?

- ***Status of the NOR.WEB business at time of announcement.***

  - NOR.WEB had achieved many notable market successes. Extensive system trials in UK, Sweden and Germany and preliminary trials in ten other countries.

  - The DPL technology had been brought to commercial availability in extremely short timescales (2-years).

  - The latest generation of the DPL modem provided significant advances in performance.

  - NOR.WEB employed only approximately 50 people. Estimates of total investment in the business over the two years have ranged between only £15m and £20m, an extremely small amount in view of the achievements.

Continued….

Status of the NOR.WEB business at time of announcement (cont.).

• After initial problems, particularly in the UK, NOR.WEB had begun to make significant steps forward in the field of PLT regulation and Standards development. As a leading member of the International Powerline Communications Forum (IPCF) NOR.WEB had been instrumental in commencing initiatives within CENELEC, CISPR and ETSI, aimed at developing operational standards for PLT implementation.

• After lengthy discussions with NOR.WEB, some utilities had made public statements that they did not intend to proceed with DPL deployment. It can be seen, however, that some of these companies have subsequently identified an on-going interest in PLT as a general area of opportunity.

• NOR.WEB have developed a comprehensive portfolio of Intellectual Property Rights (IPR's) - representing every aspect of DPL deployment and implementation. Many of these original "foundation" patents are particularly broad in their scope (e.g. Propagation of signals over 1MHz, point to multipoint on power distribution cables).

The NOR.WEB initiative has identified and established a significant market for an effective "mid band" (1-2 mbit) PLT system.

• Proven technically sound within eighteen different power networks around the world.

• Over the last two years, NOR.WEB has developed effective techniques for transformer by-pass, repeating, filtering, signal injection within operational power networks which have made PLT a realistic network option.

• Other companies have built upon NOR.WEB's developments. Today, PLT systems are in development which can offer:

- Home Networking service at 10 mbits.
- Multi 2 mbit service over medium voltage transmission network.
- Propagation systems capable of delivering up to 10 mbits within the access environment.
- PLT systems which are capable of supporting switched voice and data.

Residential and SOHO market segments are likely to require mainly Midband services, which can be supplied using PLT.

DEMAND FOR BROADBAND AND IMPACT ON INFRASTRUCTURE BANDWIDTH REQUIREMENTS

MARKET SEGMENT	BENEFITS OF BROADBAND	EXAMPLE	IMPACT ON FOR MARKET	IMPACT ON INFRASTRUCTURE BANDWIDTH REQUIREMENTS
Residential	Enhanced quality of life	• Convenience • Timeliness • Control • Choice • Quality • Speed	Demand for multimedia enhanced existing applications	Mainly Midband
SOHO (Small Office Home Office	• Competitiveness • Efficiency	• Improved business processes • Cost savings • Time savings • Information flow	Demand for new applications enhanced with multimedia	Mainly Midband

NOR.WEB HAD ESTBLISHED AN EXTREMEMLY STRONG POSITION IN A FAST GROWING MARKET - WHY DID IT CLOSE?

- Very likely that NOR.WEB would be first in launching a commercial volume PLT system.

- At time of closure, NOR.WEB had a small but growing order book with numerous utilities participating in network trials.

- Performance of the DPL was improving with each generation and according to NOR.WEB and it's customers were performing effectively.

- The level of investment was relatively small in relation to the potential size of the opportunity.

A natural conclusion therefore is that the decision was taken based upon an internal business decision - probably driven by NORTEL - that their priority should be other access products which are perhaps better established in their particular market.

There is a view however that more recent PLT developments had opened opportunities and markets that NOR.WEB through it's original choice of technology and market strategies were unable to easily address.

• Although NOR.WEB had reviewed the Home Networking opportunity the system did not offer this important capability and further development would have been required if NOR.WEB had wished to move into this area.

• By focusing upon a data only solution many utilities, particularly those who had implemented second telecoms operator businesses would have to be disregarded because real time voice would be an essential part of their service offering.

• A growing number of specialist chip set design companies were committing to PLT solutions based upon Orthogonal Frequency Division Multiplexing (OFDM) systems, which potentially would be able to offer much greater bandwidth delivery than the DPL solution.

There is no doubt however that many organisations active or interested in PLT will now be looking at the assets and resources contained within NOR.WEB.

• Patent portfolio is by far the most comprehensive within the industry and will attract significant interest from other vendors/developers.

• The experience and expertise regarding application and operation of PLT systems around the world is second to move. The majority of this expertise is planned to be re-arranged back into NORWEB and NORTEL.

• There are significant capital within NOR.WEB and numerous trials around the world.

• The investment in the NOR.WEB brand has been considerable and is clearly established in many markets around the world.

The obvious conclusion is that it is highly likely that offers to acquire either parts or the totality of NOR.WEB will be forthcoming. It therefore follows that a re-launch of NOR.WEB under new ownership is also a possibility.

Whatever the final outcome of the NOR.WEB story, the growing commitment and momentum within the PLT sector is not likely to be undermined.

• Already competing vendors are lining up to offer ex NOR.WEB customers alternative systems.

• Many technology and system development companies have established business plans upon which their investment plans have been based. It is probable that the end of their major competitor will have only a positive impact upon these plans.

• Undoubtedly, some prospective utility customers will now have reservations regarding the viability of PLT. The alternative offerings which are now becoming available should address such reservations however.

• The progress made recently within the Regulatory and Standards arena will undoubtedly attract further interest in the PLT sector from potential developers and operators.

THE FUTURE OF PLT

The potential added value for customers arising from broadband home networking has resulted in the largest telecom and media companies in the world recently announcing initiatives in this area.

- "HOME PHONE NETWORKING ADVANCE" includes: 3 Com, AT&T, COMPAQ and Hewlett-Packard and is developing technology to employ the in building copper telephony cables as high bandwidth Local Area Network (LAN).
- "HOME RF" is a consortium which includes: Microsoft, IBM, Motorola Samsung, 3 Com and Hewlett-Packard. It aims to develop radio systems using the 2-4 gigahertz band to offer 1mbit-2mbit communications in the home over distances of 50-75 meters.
- Ericsson announced a similar development to "HOME RF" at Ce-bit last month called "Blue Tooth".
- PLT Home Networking solutions are being led by developments in the USA. A number of companies now suggest that systems offering 10 mbits on in-building power networks will be commercially available in 2000.

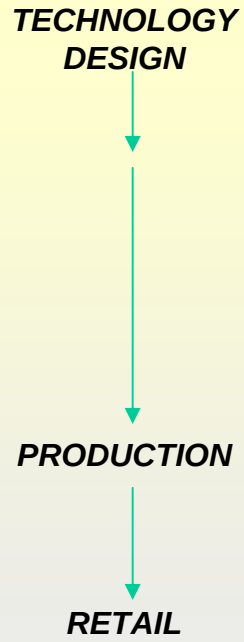
The growing number of organisations actively involved in developing PLT technologies provide a range of business opportunities arising from various points within the PLT value chain.

1. **DESIGN & MANUFACTURER OF CHIP SETS/SOFTWARE WHICH CONTROLS OPERATIONAL PERFORMANCE OF BASIC RADIO SYSTEMS/PROTOCOLS.**
   E.G. POWERTRUNK, DS2, ECI, ENIKIA, BEWAG, NOR.WEB.

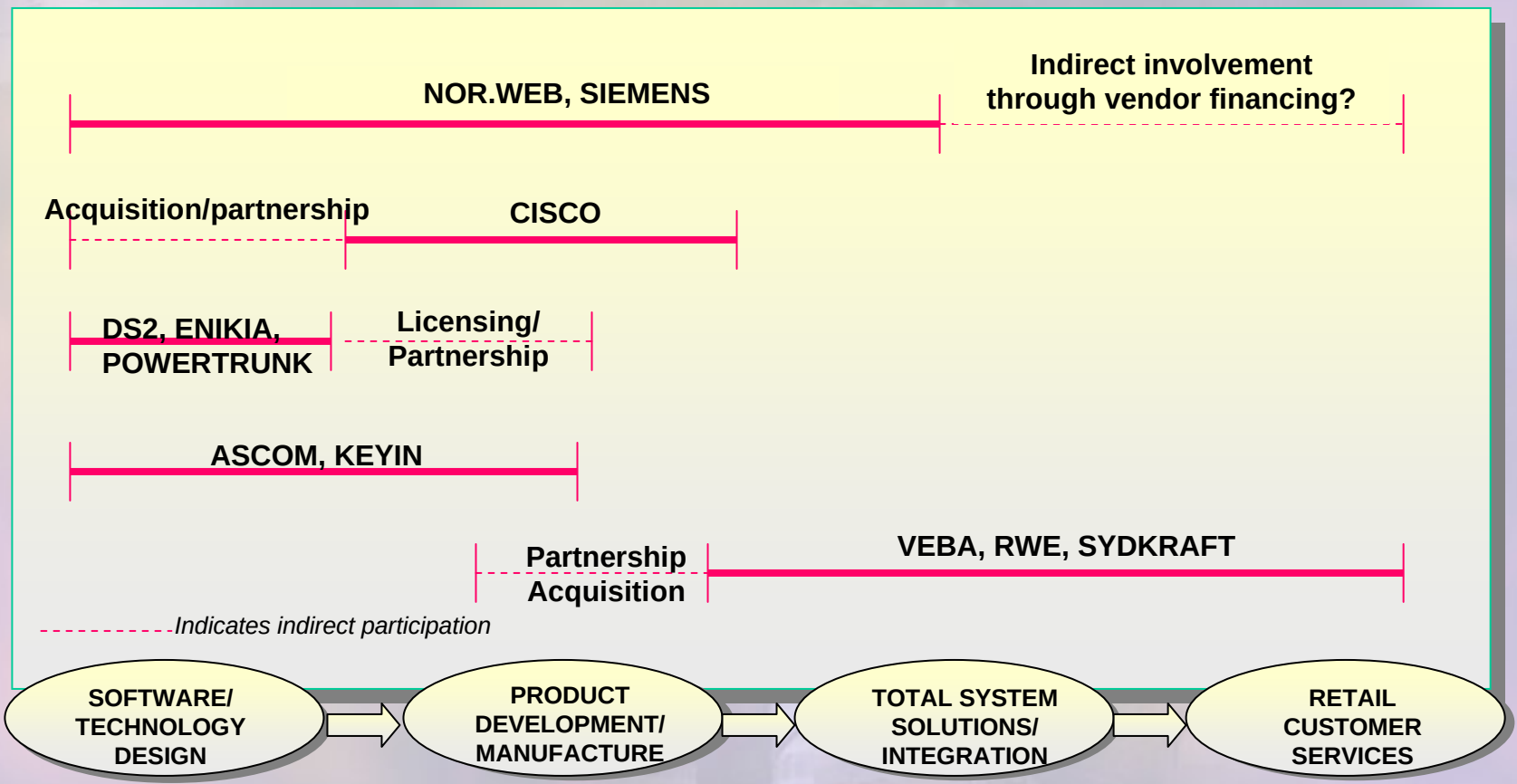
2. **DESIGN/MANUFACTURE OF SPECIFIC ELEMENTS OF THE PLT NETWORK ARCHITECTURE INCLUDING, IN SOME CASES, HARDWARE SOLUTIONS.**
   E.G. ASCOM - Access product - software & hardware.
   SYDKRAFT - Gateway system-management in house services.
   TADPOLE - Gateway system.
   ENIKIA - In house PLT solution.

3. **SYSTEMS INTEGRATOR - DEVELOPING OR PARTNERING TO CO-ORDINATE VARIOUS TECHNOLOGIES INTO END TO END PLT NETWORK SOLUTION.**
   E.G. NOR.WEB, SIEMENS, ERICSSON, LUCENT, ALCATEL?.

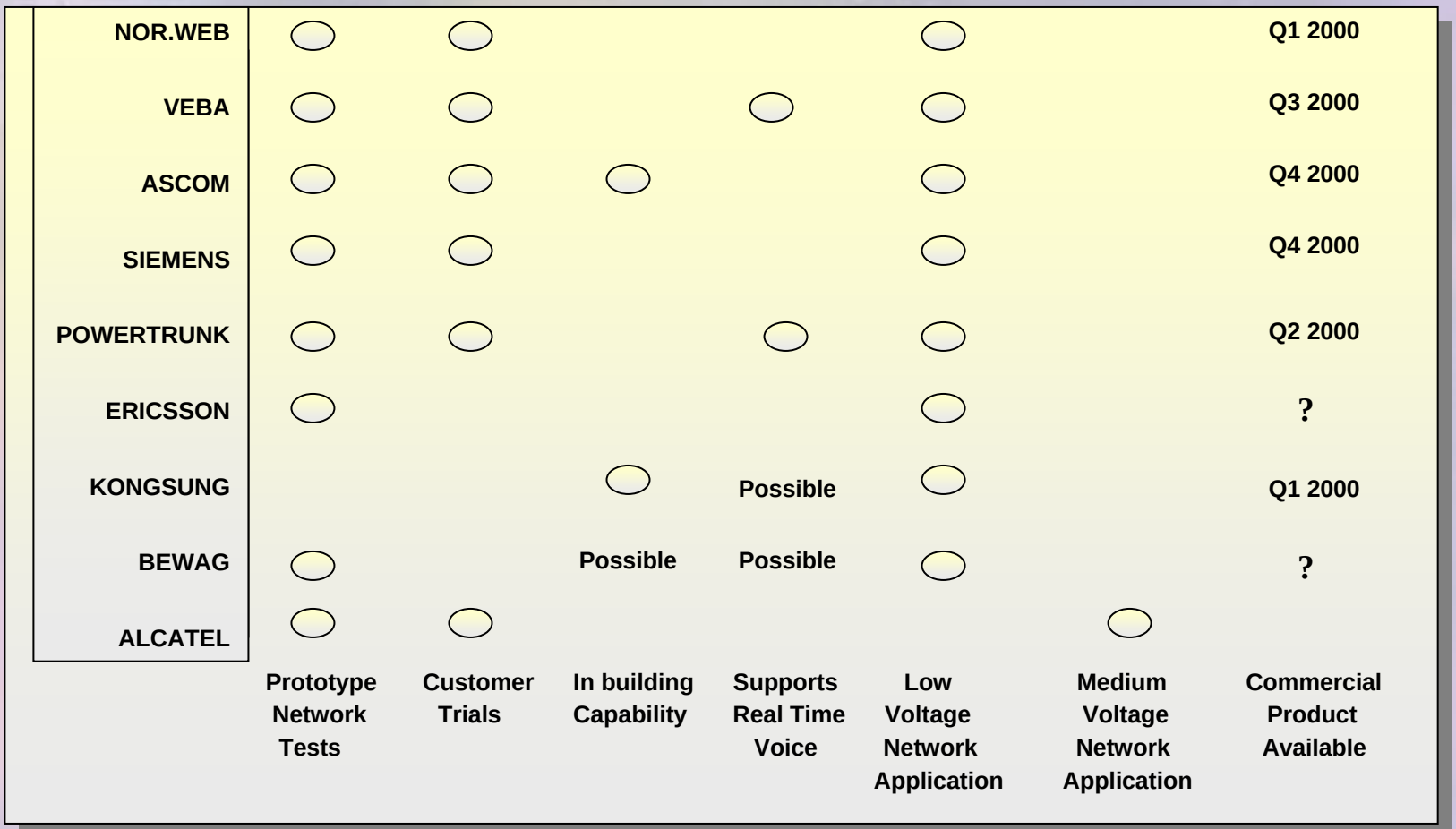
4. **SERVICE OPERATORS WHO ARE ALSO EVALUATING PROPRIETORY TECHNOLOGY DEVELOPMENTS/OR PARTNERSHIPS TO DRIVE APPROPRIATE SOLUTIONS.**
   E.G. Veba, RWE, Sydkraft, Singapore Power.



Participation of the PLT developers in the particular levels of the value chain.



Comparison of present PLT technology development.



The likelihood therefore is that the PLT sector is likely to flourish, based very much upon the foundation of the work carried out by NOR.WEB.

THE VENDORS - are likely to see much of the expertise and experience gained by NOR.WEB assimilated within other vehicles - possibly a new version of NOR.WEB itself.

THE REGULATORS - as probably the most active in this area, progress in Regulation and Standards development will be affected for a short time by the closure of NOR.WEB.

THE UTILITIES - only once a demonstrable economic volume product is made available will the majority of utilities be willing to participate in PLT deployment. This is likely to happen at the end of 2000. Broadband Home Networking products may arrive sooner.

THE END CUSTOMER - Economic mid band access is likely to be universally available for some years to come, even in USA and Europe. XDSL, Wireless, Cable or PLT will not be the sole winner. Each will play its part in delivering increased bandwidth to the majority of homes around 2005.