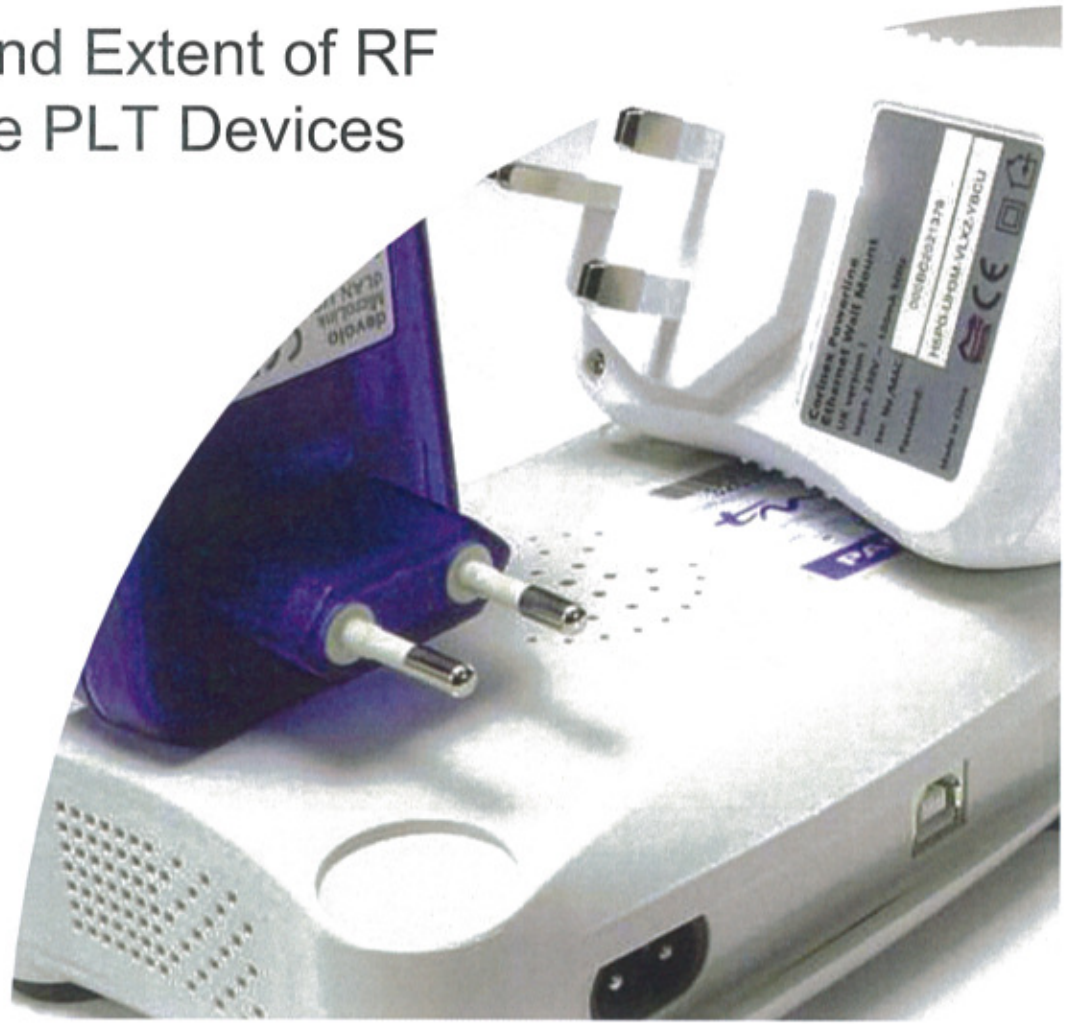
PA Consulting Group

Understanding the Likelihood and Extent of RF Interference caused by In-Home PLT Devices

Progress meeting



20th October 2009

Agenda

Quick update of progress against project plan	PA
Summary of final report and findings to date	PA
Feedback and discussion of the final report	All
Any other business	

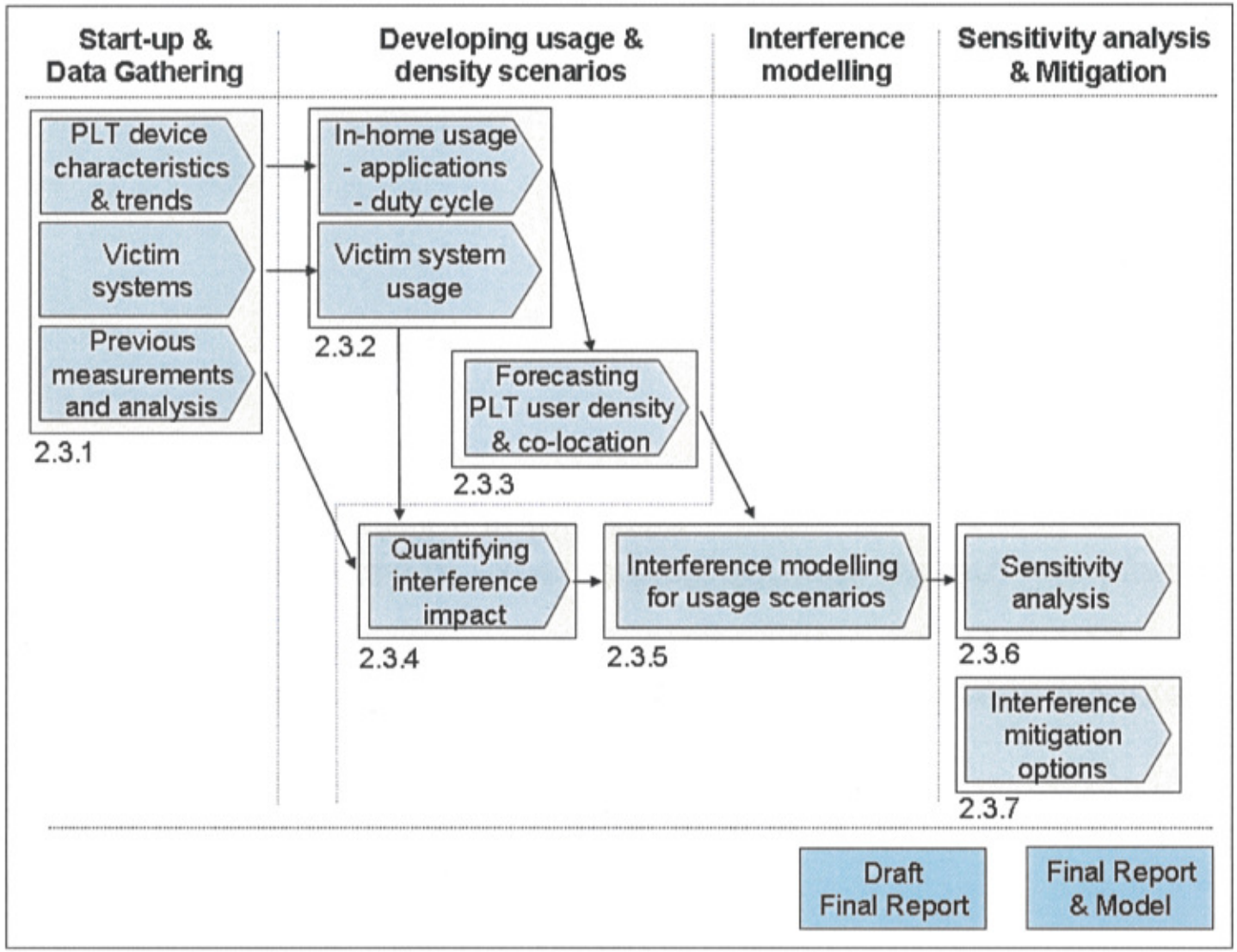
Study Objective

The objective of this study is …

… to understand the likelihood and extent of radio frequency interference caused by increased use of PLT devices and evolutions of the technology.

A quantitative analysis of expected interference will provide input to any future debate on Ofcom's regulatory duties in this area.

Our structured approach to quantify interference risk



Project plan

Task	Activity	Aug-09				Sep-09				Oct-09				Nov-09			
	Start-up & Data Gathering																
2.3.1	Start-up meeting	X															
2.3.1	Desk research on PLT device characteristics																
2.3.1	Discussion with PLT industry for future trends																
2.3.1	Identifying potential victim systems																
2.3.1	Review of previous measurements and analysis																
	Developing Usage & Density Scenarios																
2.3.2	Develop usage scenarios for in-home devices																
2.3.2	Characterise usage of potential victim systems																
2.3.3	Forecast future take-up of in-home PLT																
2.3.3	Characterise co-location of PLT and victim																
	Interference Modelling																
2.3.4	Characterise interference between systems																
2.3.5	Perform statistical modelling for usage scenarios																
	Sensitivity Analysius & Mitigation																
2.3.6	Perform sensitivity analysis																
2.3.7	Comment on mitigation options																
	Reporting & Delivery																
	Draft Final Report - Month 3												X				
	Final report updates																
	Prepare model for delivery																
	Final Report & Model - Month 4																X
	Meetings with Ofcom	X							X					X			X

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We have been engaging with stakeholders throughout the study

Standards Groups	
UPA (Universal Powerline Association)	(Permanent Secretary)
Homeplug Powerline Alliance	(President)
PLT device vendors	
Comtrend (902 product used in BT Vision)	
DS2 (UPA chipsets)	(Product manager for home networks) (Standards) (Technical)
Intellon (Chipset vendor for the Homeplug 85Mbps)	(Director of Standards) (Vice President, Marketing)
Gigle	
BT Vision	
Victim receiver groups	
UKQRM	
EMCIA	(President of the EMC Industries Association)
BBC	Senior Frequency Manager, Broadcast Networks at BBC World Service
RSGB	(EMC Committee Secretary)
CAA	(Deputy Manager Surveillance and Spectrum Department)
MCA	Spectrum & Technical Standards Unit, Maritime & Coastguard Agency

In-Home PLT devices available in the market

Typical search results for PLT products:

- 40 at DABS
- 25 at Amazon
- 15 at PC world
- Price range from £32 - £125
- Data rates 14Mbps, 85Mbps, 200Mbps
- 1Gbps Belkin device recently released using Gigle chipset
- Not just a niche vendors. Netgear and Belkin are selling PLT devices

Different types of in-home networking PLT devices available:

- Single Ethernet connection and hubs
- Power line or coaxial
- WiFi access points
- Built into ADSL modems
- Part of multimedia packages like BT Vision

Applications of In-Home PLT Devices

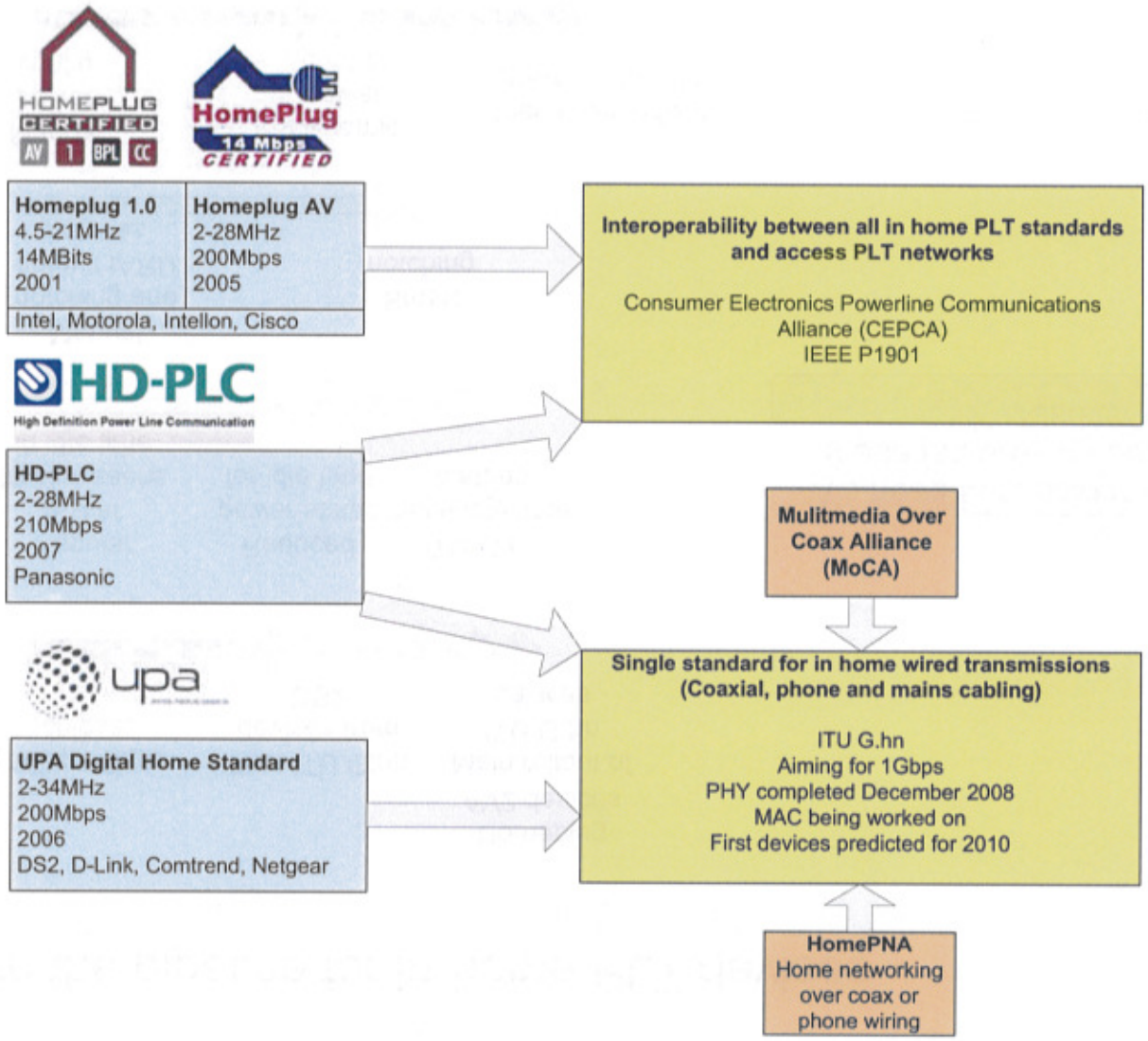
Name	*Description*	*Usage characteristics*
Broadband In Every Room	Connecting the internet to one or more PCs that are not co-located with the modem. WiFi has it sown up at present but can PLT make inroads?	7.3 hours broadband use per week average (Forrester, 2008). Mostly PC desktop applications with some video streaming
Wired For Sound And Vision	Early adopter of technology networking the PC, TV, stereo, Xbox etc. together. Sharing a broadband connection is the main motivation so overlaps with above	Content stored on or streamed to one device being played on a different device e.g. MP3 files on PC played on HiFi, or BBC iPlayer to TV
The Home Teleworker	A mini-LAN for working at home with PC, printer, modem, file server etc. Non-work devices likely to be on same network	Brings the work laptop home at least once a week to use on the home LAN
The Automated Home	Embedded / autonomous networked devices such as smart meters, security, health monitors.	A market that is not yet as developed as the others. Likely usage patterns are periodic at low overall data rates

Competing technologies

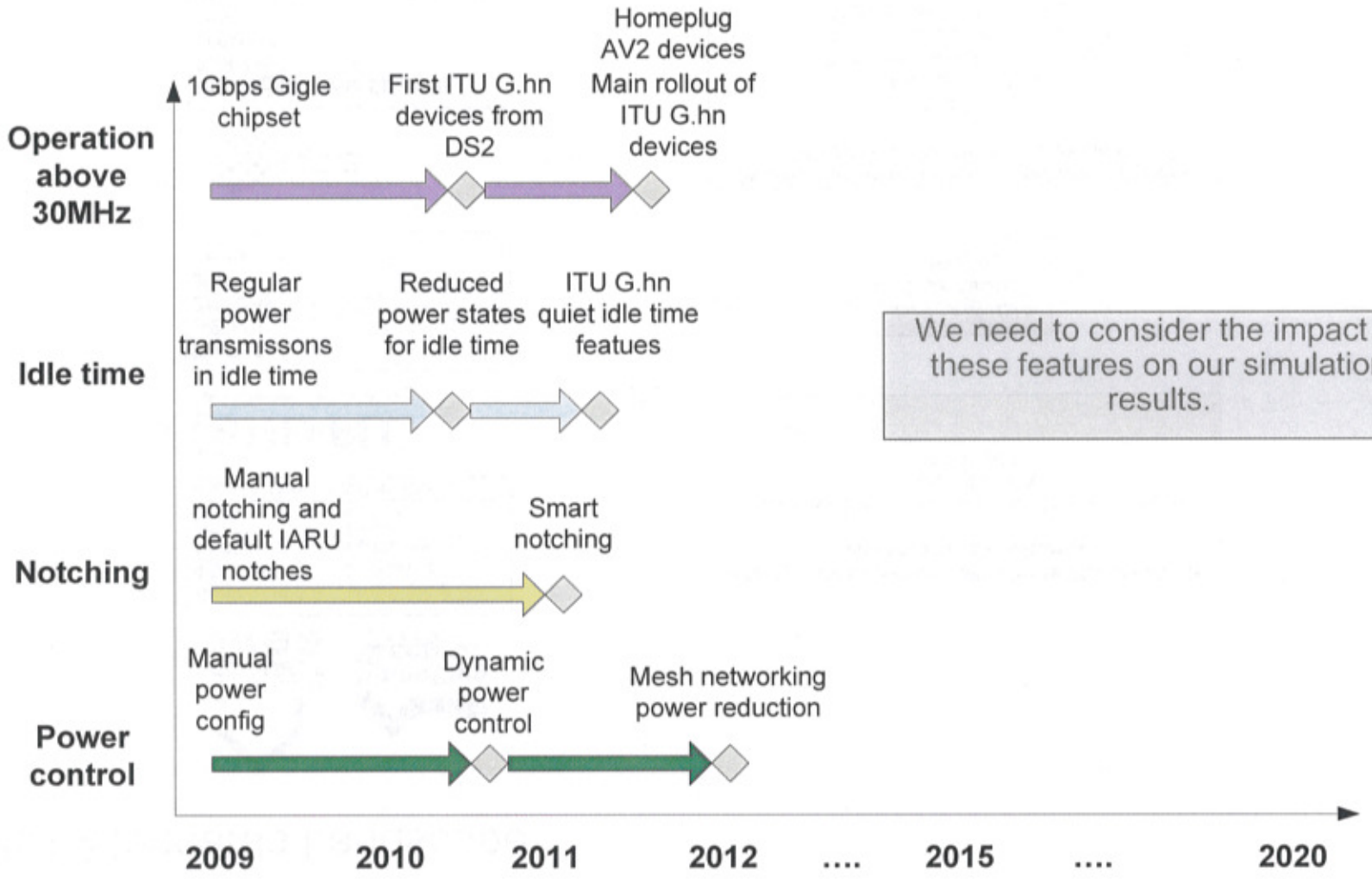
- Main competitor highlighted by stakeholders is WiFi
- In-home networking via telephone cables or coaxial cables is being combined into PLT devices rather than being a direct competitor

Strengths	Weaknesses	Opportunities	Threats
• Easy setup • Longer range • Reliability	• Price • Lack of mobility	• IPTV and triple play services • Smart metering	• Uncertainty around EMC testing • Lack of a harmonised single in-home PLT standard

PLT Standards Landscape

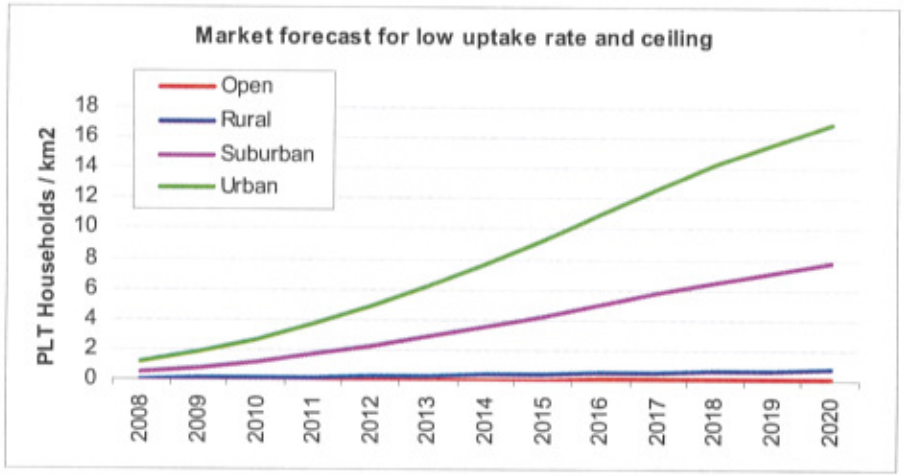


Features in the pipeline for in-home PLT devices

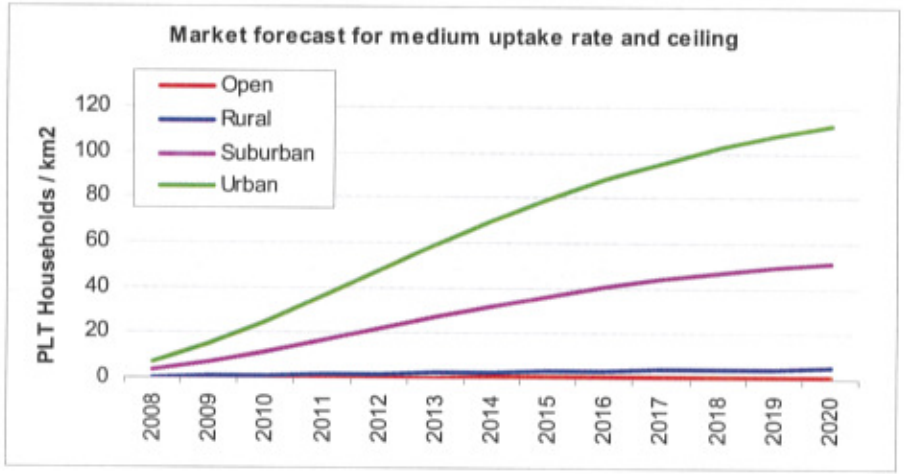


We need to consider the impact of these features on our simulation results.

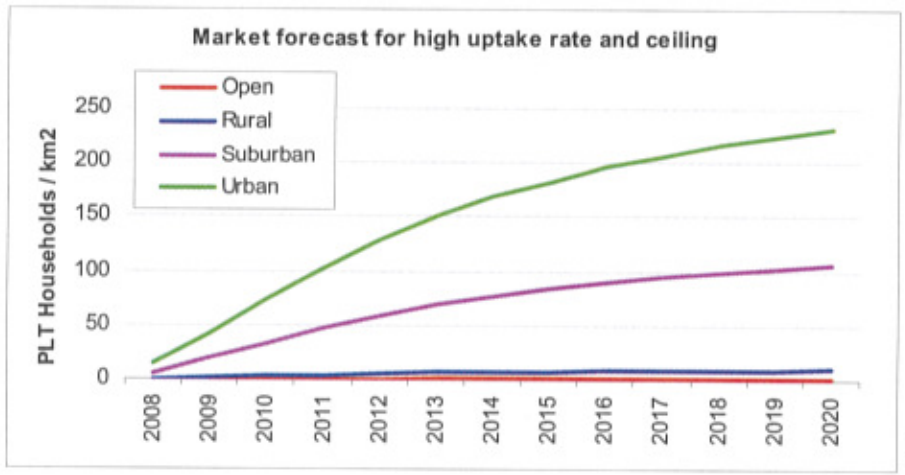
We developed a model for market uptake of PLT devices



5% of home networks ceiling



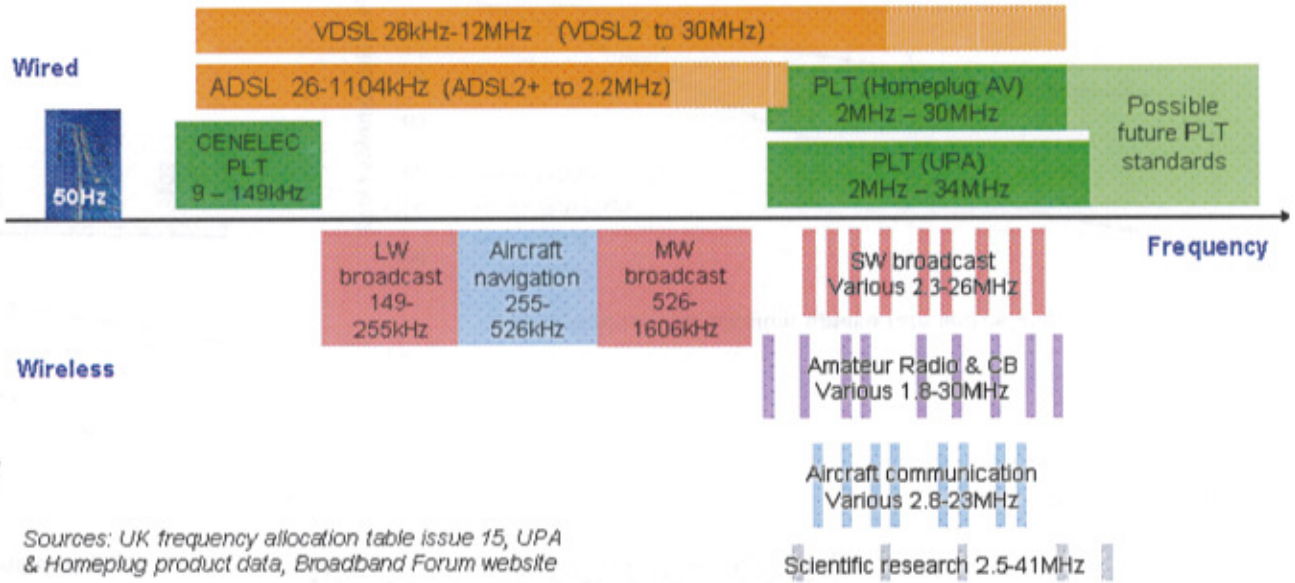
30% of home networks ceiling



60% of home networks ceiling

Potential Victim Systems discussed at the kickoff meeting

- 5 • Emergency communications
- 1 • Short wave broadcasting
- 5 • Land stations for trans-oceanic aviation and offshore marine
- 3 • Military and diplomatic communications
- 4 • Amateur & CB radio
- 1 • Frequency references and time signals
- 2 • Scientific research, including radio astronomy
- 0 • On-site paging
- 0 • Analogue cordless phones



Sources: UK frequency allocation table issue 15, UPA & Homeplug product data, Broadband Forum website

Victim Systems considered

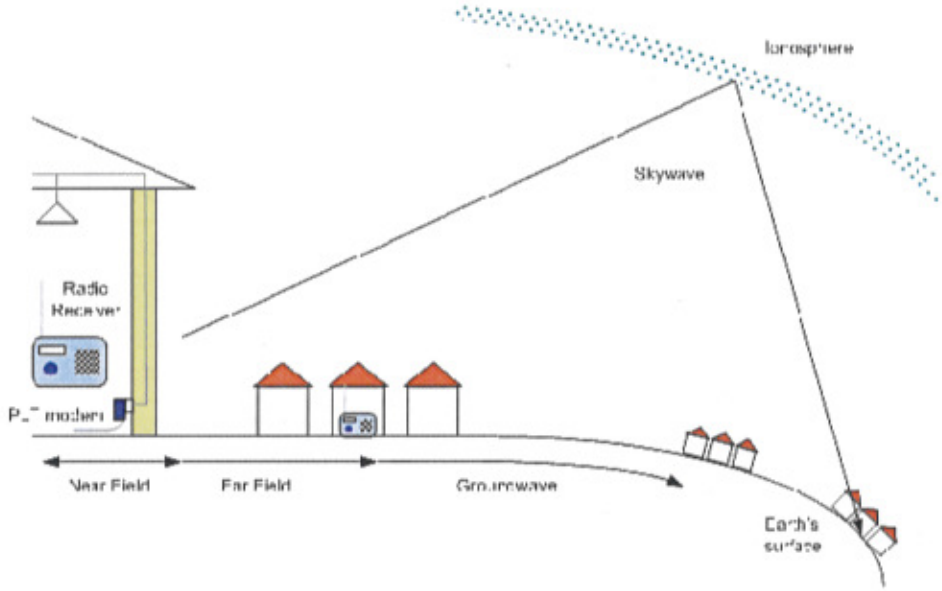
Victim User Type	Shortwave Listener	Radio Amateur	Professional User
Rx sensitivity	-115dBm	-118dBm	-116dBm
Rx noise bandwidth	4kHz	2.2kHz	3kHz
Antenna type	0.5m vertical whip	G5RV horizontal dipole	Equivalent to G5RV
Source of noise level	ITU-R BS.703 (3.5uV/m)	ITU-R P.372, Residential	ITU-R P.372, Business
Frequency 1	2.3MHz	3.5MHz	3.0MHz
Antenna gain at f1	-3dBi average	+2dBi average	+2dBi average
Noise level at f1	-78dBm	-84dBm	-78dBm
Frequency 2	7.1MHz	7.1MHz	9.0MHz
Antenna gain at f2	-4dBi average	+1dBi average	+1dBi average
Noise level at f2	-89dBm	-94dBm	-92dBm
Frequency 3	26MHz	28MHz	23MHz
Antenna gain at f3	-5dBi average	0dBi average	0dBi average
Noise level at f3	-101dBm	-111dBm	-104dBm

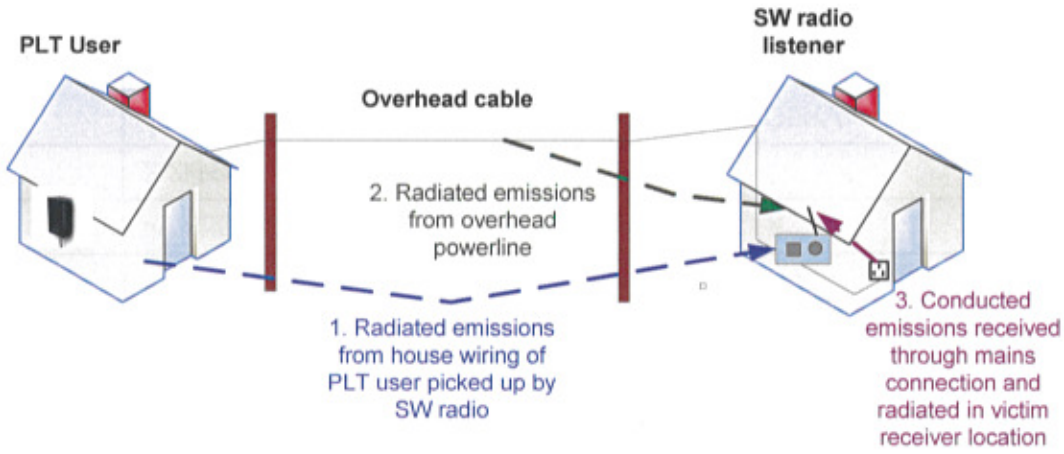
Interference Mechanisms

We have considered the following types of interference from PLT devices:

1. Radiated emissions from the PLT user's house
2. Radiated emissions from nearby overhead powerlines
3. Conducted emissions received via the mains and then radiated in the victim receiver house
4. Cumulative effect of groundwave
5. Cumulative effect of skywave
6. Interference to aircraft

Our main focus is on 1. and this has been modelled in Seamcat





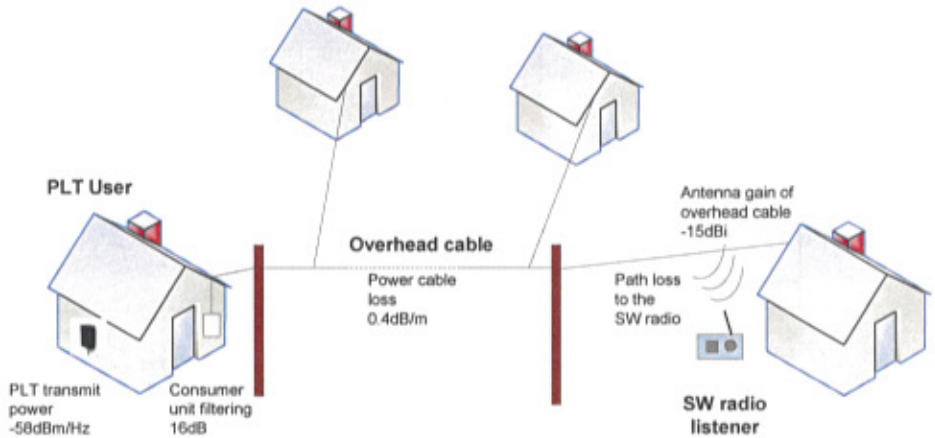
Interference Mechanisms – Summary of conclusions

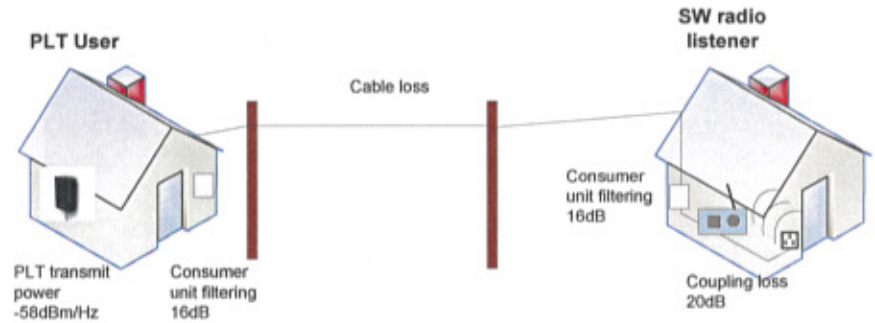
2. Radiated emissions from nearby overhead powerlines
   - Performed simple link budget for baseline case
   - 16dB of cable loss required between the PLT and victim location to avoid interference
   - This translates to 40m of overhead cable
   - 13% probability of interference

3. Conducted emissions received via the mains and then radiated in the victim receiver house
   - Similar approach to 2.
   - 17dB of cable loss needed to avoid interference
   - Probability of interference is 60%

Probability of interference is high if no mitigation techniques are used…..

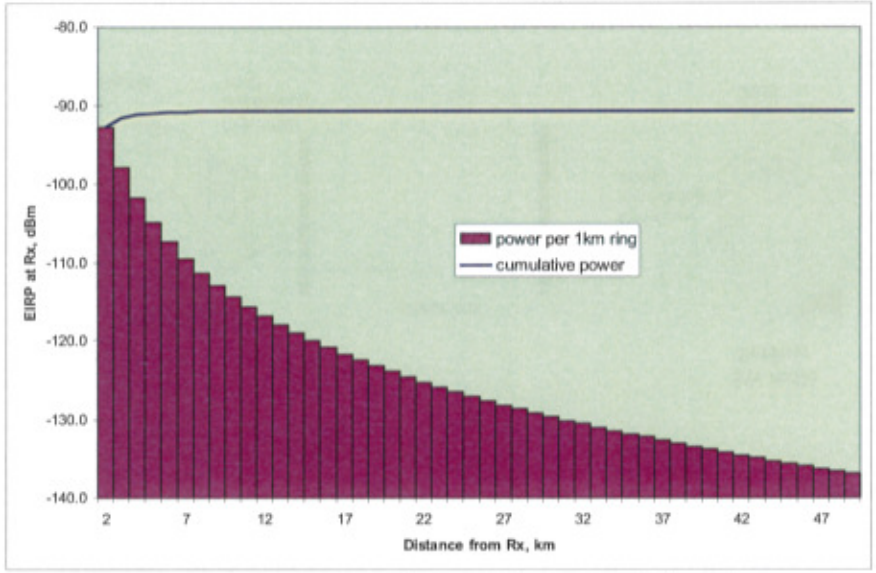
But dynamic power control should reduce the transmit power of PLT devices by 22dB which would remove interference via these routes.

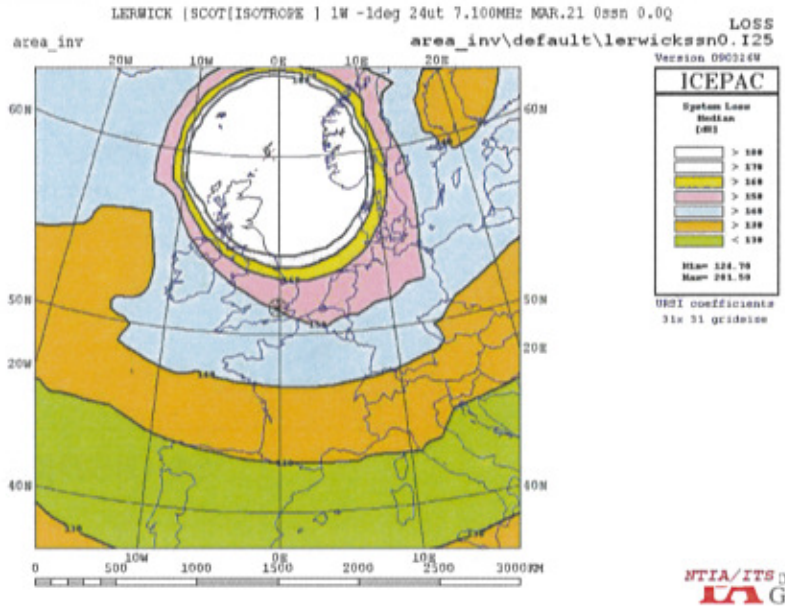




Interference Mechanisms – Summary of conclusions

4. Cumulative effect of groundwave
   - Used GRWAVE to estimate interference from a series of concentric rings of PLT devices
   - Groundwave interference is dominated by the devices closest to the victim receiver
5. Cumulative effect of skywave
   - NATO have modelled this extensively
   - Scaled their results to our market uptake figures
   - Quiet rural areas will see significant increased in noise floor
   - Impact is likely to be minor in areas where most homes and businesses are based
6. Interference to aircraft
   - ITU Working party 1A have analysed an aircraft with line of sight to a large number of PLT devices
   - Scaled their results to our market uptake figures
   - UPA with power control and notching would just meet the 0.5dB rise in noise floor criteria
   - Some issues with Homeplug as this has a higher transmit power





NTIA/ITS Consulting Group

Seamcat Model Outline

Propagation Model

-20dB/decade up to groundwave transition

-40dB/decade in groundwave region

Protection radius

SW radio – 1m

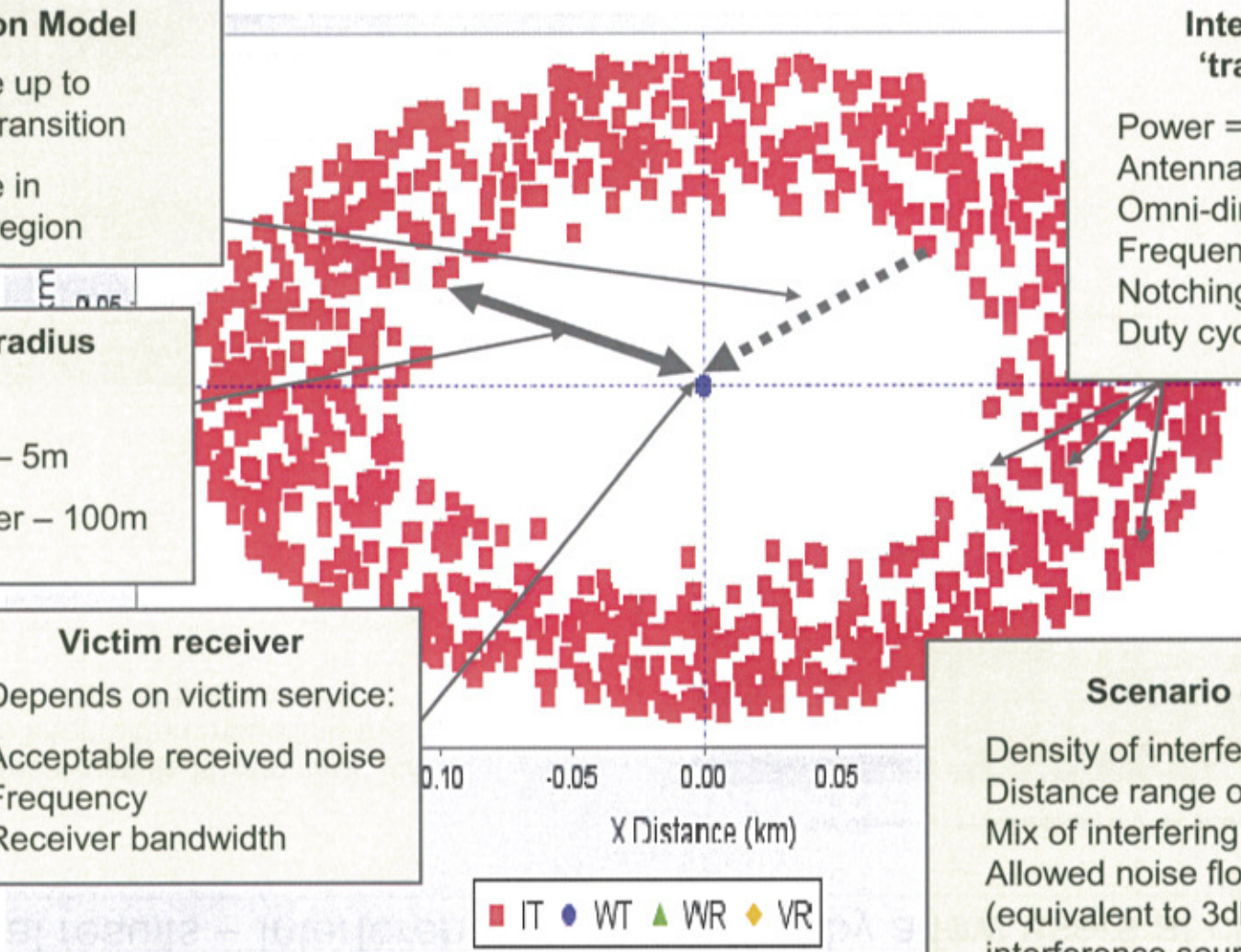
Radio amateur – 5m

Professional user – 100m

Victim receiver

Depends on victim service:

Acceptable received noise
Frequency
Receiver bandwidth



Interfering PLT 'transmitters'

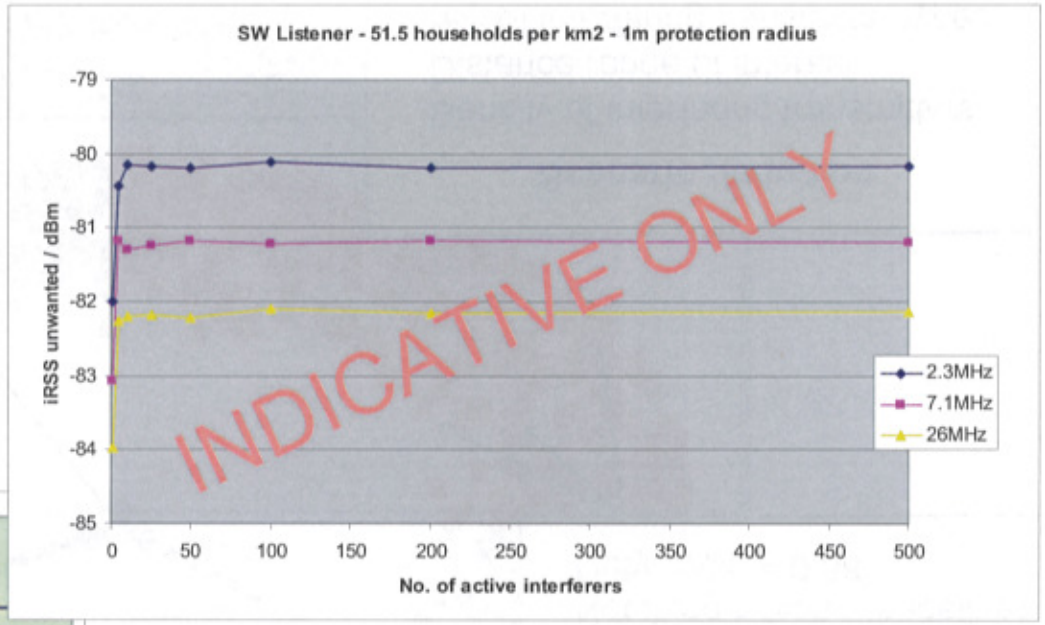
Power = -58dBm/Hz
Antenna Gain = -24dBi
Omni-directional pattern
Frequency = 2-32MHz
Notching = None (baseline)
Duty cycle = 0.58

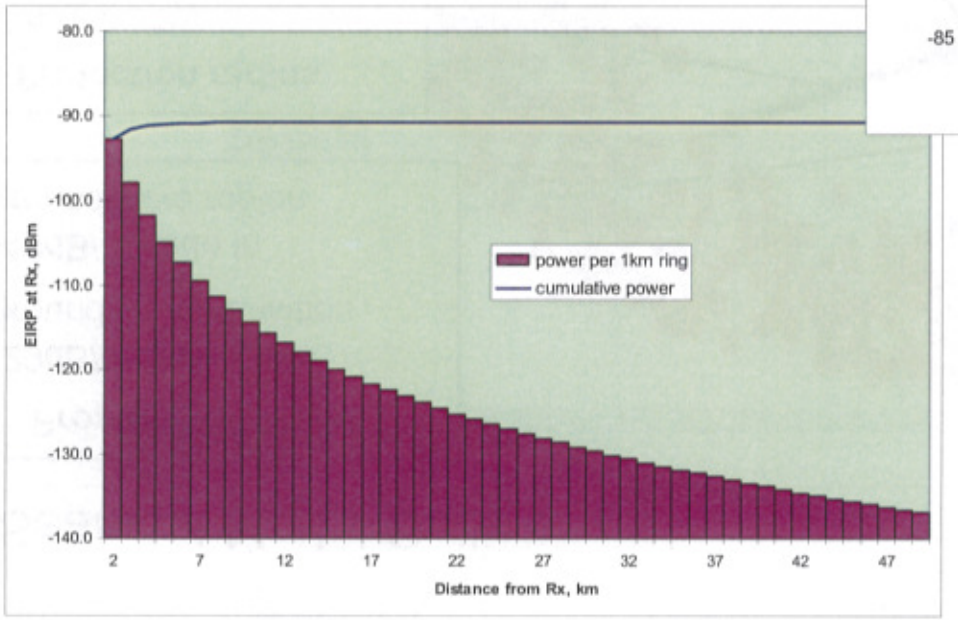
Scenario definition

Density of interfering transmitters
Distance range of interest
Mix of interfering transmitter types
Allowed noise floor rise = 2dB (equivalent to 3dB rise of AWGN interference source)

Provisional results – Interference is dominated by a few users at close range

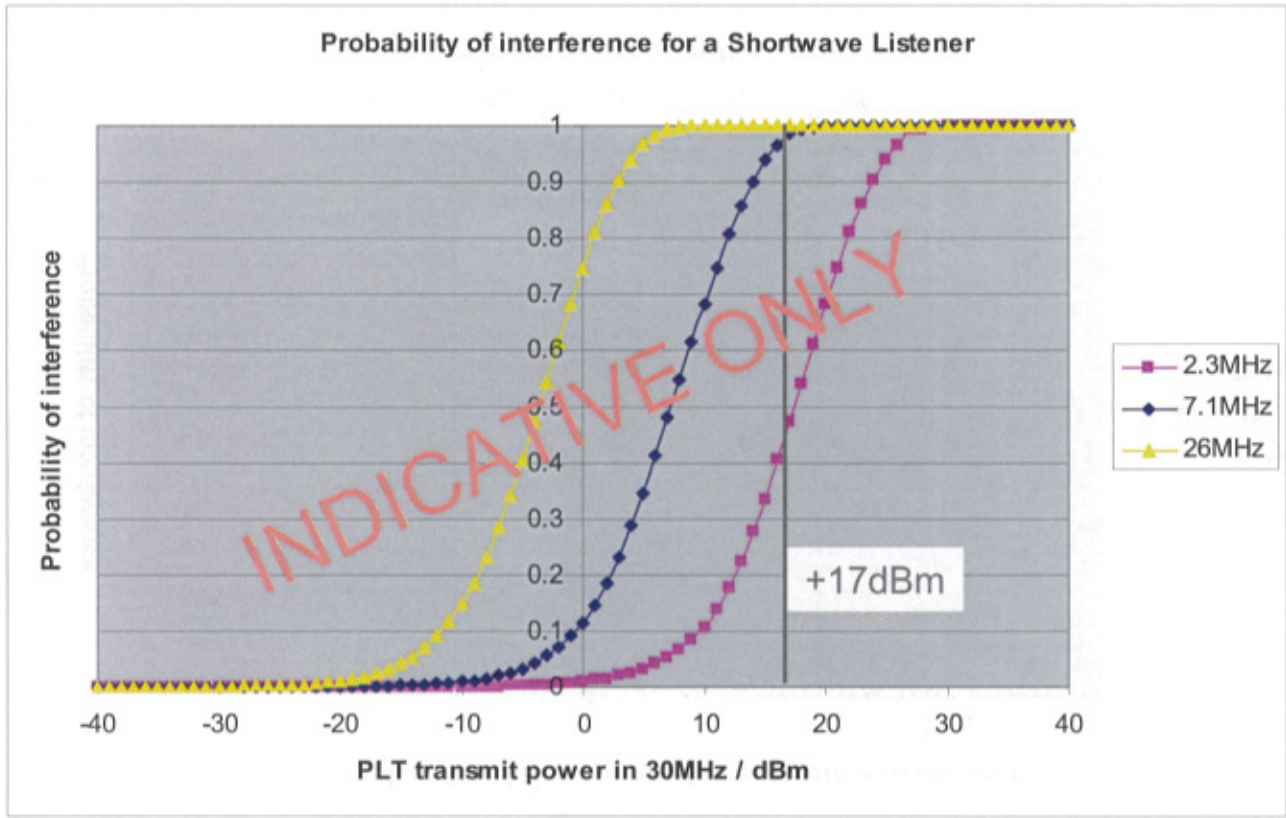
- Our Seamcat results fit with what we have also seen when modelling the cumulative effect of groundwave





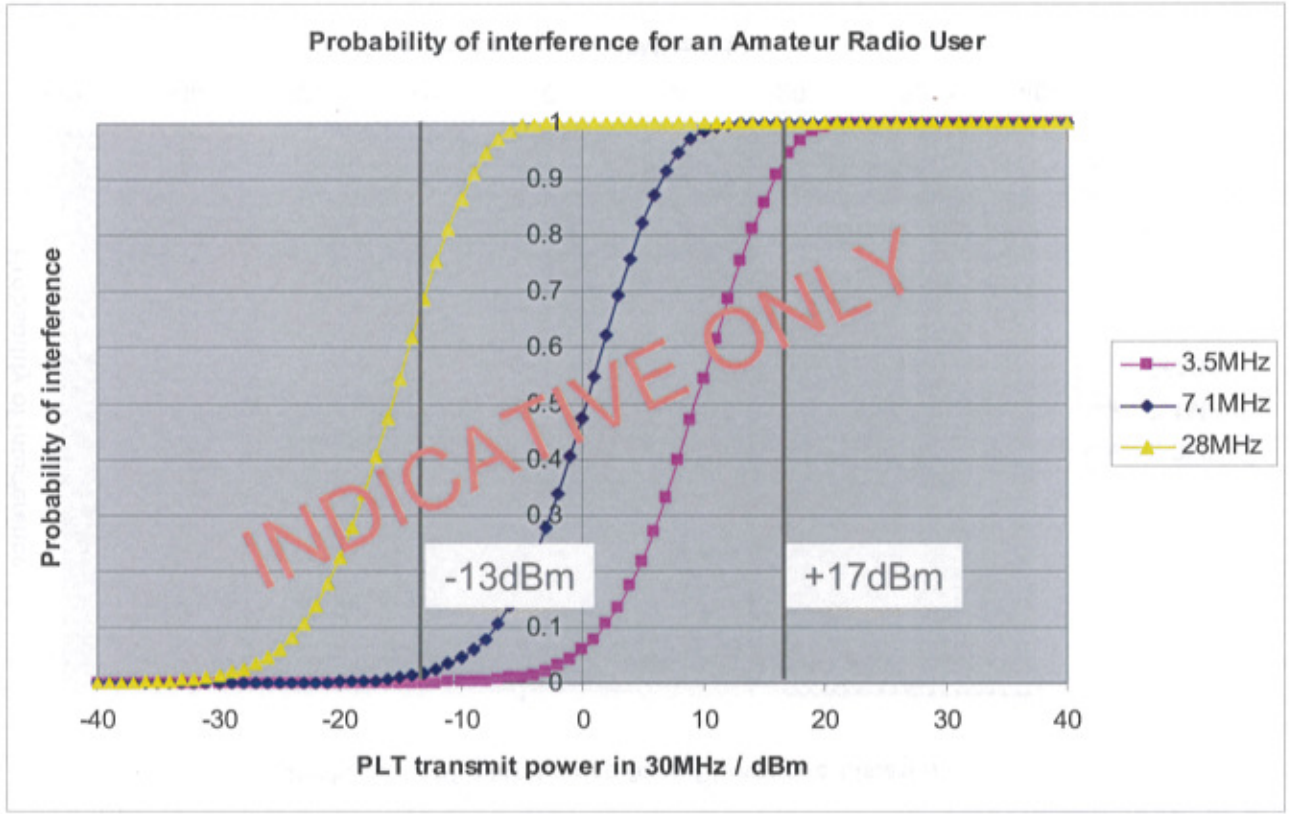
Provisional results – Shortwave radio listener

- Transmit power of a Comtrend UPA device is 17dBm
- High probability of interference at this baseline case
- To avoid interference requires:
  - 20dB reduction at 2.3MHz
  - 40dB reduction at 26MHz
- This is achievable with planned interference mitigation techniques:
  - 22dB from power control
  - 30dB from notching



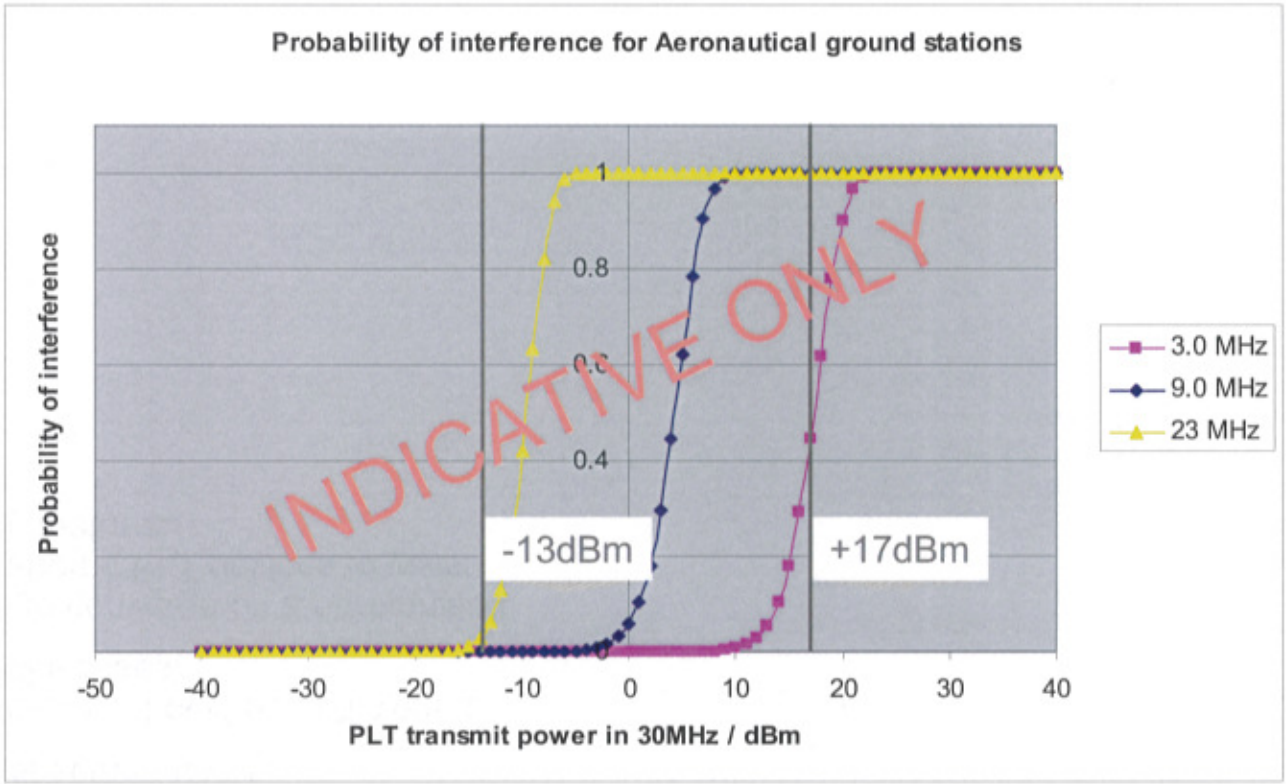
Provisional results – Amateur radio

- Transmit power of a Comtrend UPA device is 17dBm
- But most PLT devices notch the IARU bands by default
- Notching gives a 30-40dB reduction
- Therefore looking at interference for a PLT transmit power of -13dBm is more realistic
- Interference is only significant in the high frequency case
- Adding power control would provide a further reduction of 22dB



Provisional results – Professional user

- Assumes a 100m protection radius
- Transmit power of a Comtrend UPA device is 17dBm
- At this baseline level probability of interference is significant
- Adding 30dB notched for these bands would eliminate the probability of interference



Provisional Conclusions

- If in-home PLT devices don't change there is significant risk of interference to existing HF spectrum users.
- Mitigation techniques in the pipeline should be sufficient to limit interference to a few special cases.
- International regulation needs to converge on a harmonised approach to EMC testing of in-home PLT devices to insist that vendors include mitigation features.

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