UNIVERSITY OF STRATHCLYDE

DEPARTMENT OF MANAGEMENT SCIENCE

HOW DO MARKET FACTORS INFLUENCE THE DEVELOPMENT OF NEXT-GENERATION BROADBAND?

APPENDICES

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A thesis presented in fulfilment of the requirements for the
Degree of Doctor of Philosophy

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Ragoobar, T., Whalley, J. and Harle, D. (2011) Public and private intervention for next-generation access deployment: possibilities for three European countries. *Telecommunications Policy, Special issue on public support for the deployment of next-generation access networks: Why, when, how, 35*(9-10), p827-841.

Ragoobar, T., Whalley, J. and Harle, D. (2011) Optical fibre as an access network technology – is it worth it? *22nd. European Regional Conference of the International Telecommunications Society*, Budapest, 18-20 September 2011.

Ragoobar, T., Whalley, J. and Harle, D. (2010) The interplay between market factors and regulation in next-generation broadband: evidence from Europe. *21st. European Regional Conference of the International Telecommunications Society*, Copenhagen, 13-15 September 2010.

Ragoobar, T., Whalley, J. and Harle, D. (2010) Examining the Impact of Markets on Next-Generation Broadband Investment: a Focus on Europe. *1st PhD Seminar of the International Telecommunications, Society, Copenhagen*, 12-13 September 2010.

Ragoobar, T., Whalley, J. and Harle, D. (2010) Investment Opportunities and Barriers for Next-Generation Broadband: a European Comparison. *18th. Biennial Conference of the International Telecommunications Society*, Tokyo, 27-30 June 2010.

Book review: Next Generation Networks – Perspectives and Potentials by Jingming Li Salina and Pascal Salina. *Telecommunications Policy, 33*(9), p555-556.

Appendix II: Data collection documents

Preparing for data collection

The activity of data collection is influenced by the preparatory measures undertaken and for this study several requirements were imposed by both the University and the logistics of the data collection activity itself. This section describes these tasks undertaken to prepare for the fieldwork.

Ethics approval

The University of Strathclyde's research procedures is governed by a Code of Practice that is applicable to any study involving human beings. For any such study, ethical approval by the University is required. The current research involved interviewing key stakeholders and, as a result, ethics approval was required. This was requested and approved before the commencement of the interviews.

Consent forms and information sheets

The interview process planned for the research involved discussions with key stakeholders in the selected telecommunications markets. In order to protect both the interviewees and the researcher, consent forms were developed and signed by each party before the start of an interview. In addition, information sheets were developed and sent to interviewees before the interview. The information sheet outlined the research and the interview process. In both cases, participants were asked to ensure that they understood the information provided and to clarify any concerns with the researcher before signing the consent form or beginning the interview. Samples of both documents are included in this Appendix.

Interview guides

An interview guide is a list of pre-determined themes and questions that are used to guide the interview. In the semi-structured interview, discussions are based *around* the contents of the guide and do not have to strictly follow its content. Interview guides were developed for this study before the fieldwork began. The questions and themes in the guide were based on the research questions and the conceptual framework. A sample of the interview guide is included in this Appendix.

Pilot interviews

Pilot interviews provide an opportunity to test the interview questions for applicability, answerability and clarity and to estimate the duration of the interview. It also gives the researcher the experience of conducting an interview. Two pilot interviews were conducted for this research. One participant was an ex-employee of an international telecommunications incumbent and a mobile operator. In both companies, the participant worked in a senior legal capacity. The second participant was a researcher in the telecommunications industry. These participants were chosen because of their experience in the telecommunications industry, the fact that they were not one of the interviewees intended for the major research and for practical reasons, such as availability.

One of the key outcomes of the pilot interviews was a realization that the discussion can take any direction and that the order of interview questions, as included in the interview guide, is not important. However, attention to the flow of the discussion to suitably answer the relevant questions must be paid. A second important result of the pilot interviews was the need to clarify and re-phrase some of the interview questions.

Contacting potential participants

Emails and letters were sent to potential participants approximately one month before interviews were to be held. Reminders and all pre-interview documents, such as the consent form and information for participants, were sent at least one week before the scheduled interview date.

University of Strathclyde
Business School

CONSENT FORM

Title of study: How do market factors influence the development of next-generation broadband?
Researcher: Tricia Ragoobar
Name of participant: …………………………………
Company: ……………………………….

The participant:
I, ………………………….., declare that I have read and consent to the conditions of this investigation as stated below:

1) I have read and understood the information sheet for the above study and I am aware of the objectives of the study.
2) I understand that my participation is voluntary.
3) I am aware of the requirements of my participation and of any possible risks.
4) I have had the opportunity to consider the information provided about the study and have had any questions satisfactorily answered.
5) I am aware that I am free to terminate my participation at any time without giving a reason and without any of my rights being affected.
6) I understand that I can withdraw any information I provide to the study at any time.
7) I am aware that I am not obligated to answer any question that I feel uncomfortable answering.
8) I understand that all information will be treated confidentially and with anonymity at all times.
9) I permit the researcher to keep a record of the information I provide for follow-up investigation in this study.

The researcher:
I, ……..……………………., guarantee that the following conditions will be met:

1) Your name and that of your organization will not be used at any point of information collection or in the final written report.
2) Any information you provide will be kept confidential at all times and will be stored in password-protected locations.
3) If you grant permission for the interview or any discussion to be tape-recorded, the audio recording will not be used for any purpose other than this research.

4) Your participation in this research is voluntary. You have the right to withdraw at any point of the study, for any reason, and without any prejudice.
5) You will receive a copy of the interview report before it is used and you have the opportunity to suggest changes to the researcher, if necessary.

Participant's signature: ………………………… Date: ………………………..

Researcher's signature: ………………………... Date: ………………………..

INFORMATION FOR PARTICIPANTS

Title of study: How do market factors influence the development of next-generation broadband?
Researcher: Tricia Ragoobar
Company: University of Strathclyde, Glasgow
　　　　　　Department of Management Science

Contact information: (e) tricia.ragoobar@strath.ac.uk
　　　　　　(t) +44 (0) 141 548 2662
　　　　　　(f) +44 (0) 141 552 6686

Research background and objectives:
The telecommunications industry is plagued by rapid and continuous advances in technology and applications that promise benefits for both operators and consumers. At the present time, one of the famed technologies is based on IP communication and takes the form of Next-Generation Networks (NGNs). Additionally, new access mechanisms promise the capability and potential to deliver progressively higher speed and bandwidth-intensive applications in next-generation access (NGA) networks. It is widely accepted that these next-generation broadband networks will realize numerous commercial and socio-economic benefits. However, variations in NGN and NGA deployments have been seen across the world. This diversity in the development of next-generation broadband can be linked to the market conditions of the given country. This research examines this relationship in more detail by investigating the impact of market factors on the development of next-generation broadband. It aims to provide recommendations to policymakers and, ultimately, share lessons across markets so that investment and development of NGN and NGA can be accelerated. The research is undertaken using a multiple case study approach, with semi-structured interviews being conducted with key members of chosen telecommunications markets.

Interview procedure:
The interview will be an open-ended discussion based on the deployment of next-generation networks that the participant is familiar with. The interview will be approximately one hour and fifteen minutes long and will be tape-recorded once approved by the participant. Notes will also be taken during the interview as necessary. The participant's answers and comments will be summarized at the end of the interview and a written report will be sent to the participant later on. All information provided will remain confidential and will only be used for this research.

INTERVIEW GUIDE

Opening statement:
"Thank you for agreeing and taking the time to participate in this study. As mentioned before, this research examines and compares the impact of market factors on the development of next-generation broadband. The outcome of the research will be recommendations with regard to how the development of these networks can be accelerated in slower markets.

With your permission, I will be tape-recording this interview /[I will be making notes during the interview] so that I can verify the discussion with you and review it at a later time if necessary. If at any time you feel uncomfortable with this, please let me know. I assure you that any information you provide in this interview will remain confidential and used in the research with full anonymity. The interview will last for approximately 1 hour and fifteen minutes, and I will ask questions about your decisions to deploy [NGN] and/or [NGA], the services you offer, consumer demands and challenges you encountered in the deployment. After the interview, I will summarize your answers and comments, and you can make any clarifications as you see fit.

I'd like to start by finding out about your role in the company…"

Name of interviewee:
Category of interviewee: Operator
Company:
Role:
Date of interview:
Location of interview:

	Question	Probes	Comments
1.	What is your professional background and your current job responsibilities?	What role did you play in the deployment of the [*technology*] in the [*region*]?	
2.	What factors motivated the decision to invest in a [*technology*] network in [*region*]?	Initially, and have any other factors surfaced or become more important while deploying the technology, or after having offered it to the market/consumers? Existing infrastructure? Economy of the region? Equipment standards/compatibility?	
3.	I see that services such as [*services*] are being offered using this technology. Are there any other services that are currently available that I may have missed?		
4.	What features of the technology do you consider to be important in providing these services?	Is this technology required to provide these services?	

		Does the technology improve the characteristics of the services (cost, speed (response time), capacity (number of users), penetration, scalability)?	
5.	How have consumers responded to the services provided by the technology?	Have the services been widely accepted/used? Can you identify an increase in the use of telecommunications services since this deployment? If so, what can you attribute this to?	
		Do the technical capabilities of the service satisfy their requirements and/or needs?	
		Do you believe that the services offered meet consumers' current and future demands?	
		Are there any other services that they demand which are not currently available? If so, why are these services not offered by your company?	
6.	Can you describe the challenges you encountered in deploying this technology (technical, economic, regulatory, etc.) and how they were dealt with?	Were the challenges specific to any factor (your company, the technology, the region within which the deployment was taking place)?	
		In hindsight, had you been aware of the associated difficulties, would you have still chosen to deploy the technology?	
7.	How do you see competition developing in this market?		

8.	In general, what benefits has the deployment of this technology brought to your company thus far?	Where do you foresee this technology and its services going for your company/in this region?	
9.	Were any changes in the company required in order to successfully deploy and sustain this technology and/or its services?		
10.	Are there any other aspects of the deployment and its outcome that you wish to discuss or anything that you think might be useful for this research?		

Notes:

1. What does your company/you consider to be a NGN/NGA?

2. Who are your equipment vendors?

3. Is there anyone else I can talk to who will be able to assist me in this research?

Closing statement:

[Summarize the answers to the questions and other comments made. Then…]

"Thank you, once again, very much, for your cooperation and for the information you provided. This certainly was useful and I know that it will contribute significantly to my research. I will summarize the points you made and send it to you to review within the next few days [decide when].

As I continue my research, is there anyone else you would recommend I talk to?

Thank you, again, for your time and co-operation."

Appendix III: Details of the coding process

NVivo - Storing the data

Interview transcripts were imported from Microsoft Word into NVivo and stored as *sources[1]*. Each was labeled with the name and company of the interviewee, for easy retrieval and reference. A *casebook[2]* was created to hold all the interviewees' information. Each interviewee is a *case[3]*. Data such as category (i.e. operator, regulator, etc.), company, job role, interview date and time, interview location and interview duration were stored as *attributes[4]* for each case. This enables queries based on the interviewees' characteristics to be performed later on, if necessary. For example, a search can be performed to find out what all managers said about a particular topic. Figure 1 shows part of the casebook created.

	A : Category	B : Company	C : Date	D : Duration	E : Location	F : Role	G : Time
1 : Cases\Alan Lazarus	Operator	BT	26/03/2009	90mins	BT Centre, Londo	Unassigned	10:00am
2 : Cases\Joe Kelly	Operator	BT	09/03/2009	75mins	Joe Kelly's office -	Director Communi	10:20am
3 : Cases\Michael Doodson	Operator	BT	26/03/2009	90mins	BT Centre, Londo	Head of Portfolio P	10:00am
4 : Cases\Ruth Pickering	Operator	BT	17/03/2009	25mins	Phone interview	BT Group, Strateg	9:00am
5 : Cases\Sukh Dosanjh	Operator	Cable & Wireless	25/03/2009	75mins	C&W, Smale Hou	In capacity plannin	10:00am
6 : Cases\William Webb	Regulator	Ofcom	05/03/2009	90mins	Prof. Webb's offic	Head of Research	1:00pm

Figure 1: Casebook created in NVivo

NVivo coding

One of the most common techniques of data reduction or categorization is coding. Rossman and Rallis (1998) describe this process as organizing the material into chunks before brining meaning to those chunks. In essence, coding involves dividing a large volume of text into smaller segments or snippets, which are labeled such that they can be identified within the context of the research and used to organize and retrieve the data. Miles and Huberman (1994, p56) define the labels, or 'codes' as "tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study." Coding in this research was done in NVivo. The following sections describe how the codes were developed and used in organizing the data collected in the interviews.

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[1] NVivo defines sources as the "collective term for research materials." This can include internals (material imported into NVivo), externals (material used outside of NVivo and which cannot be imported) and Memos (notes created in NVivo).
[2] NVivo define a casebook as "a table containing your cases and the attribute values that have been assigned to them."
[3] A case is a node with characteristics and can be people, places or any entity used in the research.
[4] An attribute is a characteristic.

Creating codes

Various approaches can be followed in the development of codes. Miles and Huberman (1994) discuss three techniques. The deductive approach, which Miles and Huberman (1994) advocate, involves creating a provisional "start list" of codes which arise from the research questions, conceptual framework, hypotheses and/or key areas/variables involved in the study. Alternatively, a more inductive approach can be adopted. This approach involves firstly examining the data collected and proceeding to develop codes based on what has been observed. As with the a priori technique, the aim of inductive or "grounded" coding is to relate observations to a set of constructs or theory (Miles and Huberman, 1994). A third approach to the development of codes lies in-between the deductive and inductive approaches. This final method involves creating a general list of coding categories before reviewing the material to be coded and inductively creating codes under these general categories. This method is useful in determining the general domains that will be relevant to the study and also provides the advantage of the inductive approach – to code the data in its context. As such, it provides a focused but more open and flexible coding technique.

For this study, the 'in-between' method of code development was adopted. General areas of interest were identified from the research questions and the conceptual framework but more specific codes emerged as the data was reviewed. This method was chosen because it allowed the researcher to observe what emerged from the interviewee's responses rather than being prescriptive, while at the same time staying within the boundaries of the research. This technique was also undertaken to validate, to a certain extent, the conceptual framework established from the literature. Table 1 lists the initial general codes.

Network definition
Choice of network segment
Choice of region
Choice of access technology
Perceived benefit
Actual benefit
Challenge
Technical
Economic
Regulatory
Social
Service

Table 1: Initial general list of codes

The coding process

The process of coding is integral to the outcome of the research and a research guide from the University of Phoenix (Cybernos, 2009) explains that it is important for the researcher to understand that different types of coding are used at different stages of the analysis. Creswell (1998) discusses several of these. However, because coding was only utilized in this study to reduce and structure the data collected, only two of these classes of coding were adopted: open coding and axial coding. These two types of coding, as used in this research, are described below.

Open coding

Open coding is used in the first stage of data analysis and involves identifying the segments of data that are relevant for the study and labeling these under the general categories. Creswell (1998, p150-151) explains: "using the constant comparative approach, the researcher attempts to 'saturate' the categories – look for instances that represent the category and to continue looking and interviewing until the new information does not provide further insight into the category." Thus, the first stage of coding for this research involved searching for and coding phrases that were related to the general domains identified in the initial list. This was done in a detailed manner so that every aspect of the more general themes was distinguished and labeled. Richards (2005) recommends three steps in identifying what to code: identify what is interesting, ask why it is interesting (which will identify a potential node) and

determine why the researcher is interested in that node (which will identify a more general concept). These steps were followed in coding the interviews.

Figure 2 is a screenshot of NVivo that illustrates how open coding was conducted. The text shown is the transcribed interview that was imported from Microsoft Word. The colored stripes on the right show the codes that are used and the range of text that they cover. For example, the text highlighted in yellow is coded by 'perception of access network'. This coverage of this code is shown as a red stripe on the right side.
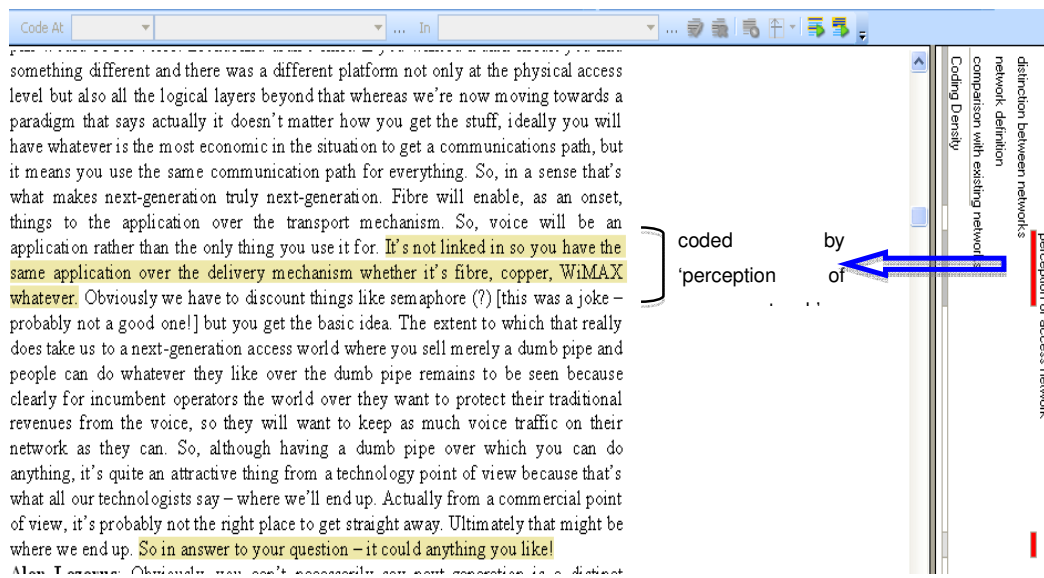

Figure 2: A screenshot of NVivo illustrating the coding process

All codes in the open coding stage were created as free nodes[5]. During this phase, additional domains or themes were also identified and free nodes were also created for these themes. After coding the first interview, sixty-four free nodes were created. After coding five interviews, there were seventy-four free nodes. This meant that the set of codes developed after the first interview was generally suitable for coding across the interviews, with only few additions as the coding progressed across

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[5] NVivo defines a free node as a 'stand-alone' node that has no clear logical connection with other nodes—it does not easily fit into a hierarchical structure. In the first stage of coding, all nodes are free nodes. In subsequent stages of coding, they are organized to form the hierarchical structure.

interviews. This implied that the codes were generally consistent and robust. Table 2 contains the list of free nodes developed.

Type	Name
Free Node	perceived benefits of NGN
Free Node	challenges - ngn
Free Node	factors influencing core network investment
Free Node	factor influencing choice of technology
Free Node	consumer behavior
Free Node	learning experience
Free Node	factors influencing access network investment
Free Node	challenges - nga
Free Node	comparison with existing networks
Free Node	perception of core network
Free Node	market status
Free Node	regulatory challenge access network
Free Node	access infrastructure competition potential
Free Node	deployment approach
Free Node	comparison of technologies
Free Node	required changes
Free Node	wireless - potential
Free Node	core infrastructure competition potential
Free Node	difficulty in defining NGA
Free Node	service trends
Free Node	perception of access network
Free Node	regulatory challenge core network
Free Node	geographical distinction
Free Node	nga economics
Free Node	need for service or speed
Free Node	service availability
Free Node	factors influencing region of choice
Free Node	actual benefits of ngn
Free Node	operators' considerations and thoughts
Free Node	uncertainty in services
Free Node	consumer usage
Free Node	aim of regulator
Free Node	uncertainty of consumer behavior
Free Node	regulatory solution
Free Node	rate of return on core network investment
Free Node	distinction in type of operator
Free Node	new sites
Free Node	distinction between business and residential customers
Free Node	perceived benefits of NGA
Free Node	comparison of countries
Free Node	anti-competitive behavior

Free Node	regulatory consideration - nga
Free Node	wireless nga - technical
Free Node	IP-based core
Free Node	rate of return - nga
Free Node	technology service trends
Free Node	service competition - core
Free Node	investment incentive
Free Node	distinction between networks
Free Node	aim of regulator - nga
Free Node	regulatory solution - nga
Free Node	wireless nga - economic
Free Node	factors influencing rural investment
Free Node	partnership
Free Node	regulatory requirement
Free Node	abuse of powers
Free Node	geographical distinction - wireless nga
Free Node	moving targets
Free Node	need for regulation
Free Node	monopoly
Free Node	uncertainty of investment in core network
Free Node	factors influencing competition in core network
Free Node	cross subsidization
Free Node	monopoly nga
Free Node	service competition - nga
Free Node	technology - regulatory distinction
Free Node	installation
Free Node	company operations
Free Node	India - drivers for investment
Free Node	switching
Free Node	co-opetition
Free Node	frienemies
Free Node	uncertainties
Free Node	uncertainties in nga investment

Table 2: List of free nodes

Axial coding: organizing the data and the formation of trees

Axial coding, typically used in the second stage of the coding process, involves organizing the individual chunks of data labeled in open coding. In NVivo8, this is achieved by the construction of *trees*, which is a hierarchical organization of the categories of data (nodes). Bazeley (2007) explains that trees should be developed

based on **conceptual relationships** rather than on observed or theoretical relationships.

The development of the trees was an iterative and continuous process. In creating the tree structure, several new nodes were created as concepts emerged, to group other nodes, and some references were moved around as more specific sub-categories were created. Codes that represented a characteristic or a dimension of a more general code were attached as *branches* of that general code. However, the coding and the structure were constantly reviewed during the process.

It is important to note that not all nodes were organized into trees. Several nodes were kept as free nodes. These were either nodes that did not yet belong, such as 'comparison of countries', which will be used at a later stage of analysis, or nodes that were more specific divisions or sub-codes of other codes that were already in the tree structure. These were kept as free nodes in the event that, after coding of other interviews, this more specific node was found to be necessary. The node 'nga economics' is one such node. References within this were coded at a more general level within the existing tree structure, but this more specific node was still retained as a free node.

Figure 3 shows an example of the outcome of axial coding: starting with the general category of 'NGN Deployment', sub-codes of 'ngn benefits' and 'ngn challenges' were created. These were further divided as other sub-categories or dimensions emerged. Each code was defined in NVivo so that it was easy for the researcher, or other coders, to review or continue the coding at a later stage. In addition, memo and annotation links were used extensively to note and describe thoughts and ideas that occurred during the coding process or which were implied in the data. As previously stated, coding of the same data was performed several times as a verification process. Figure 4 shows a section of the final structure.
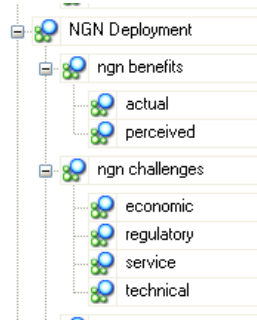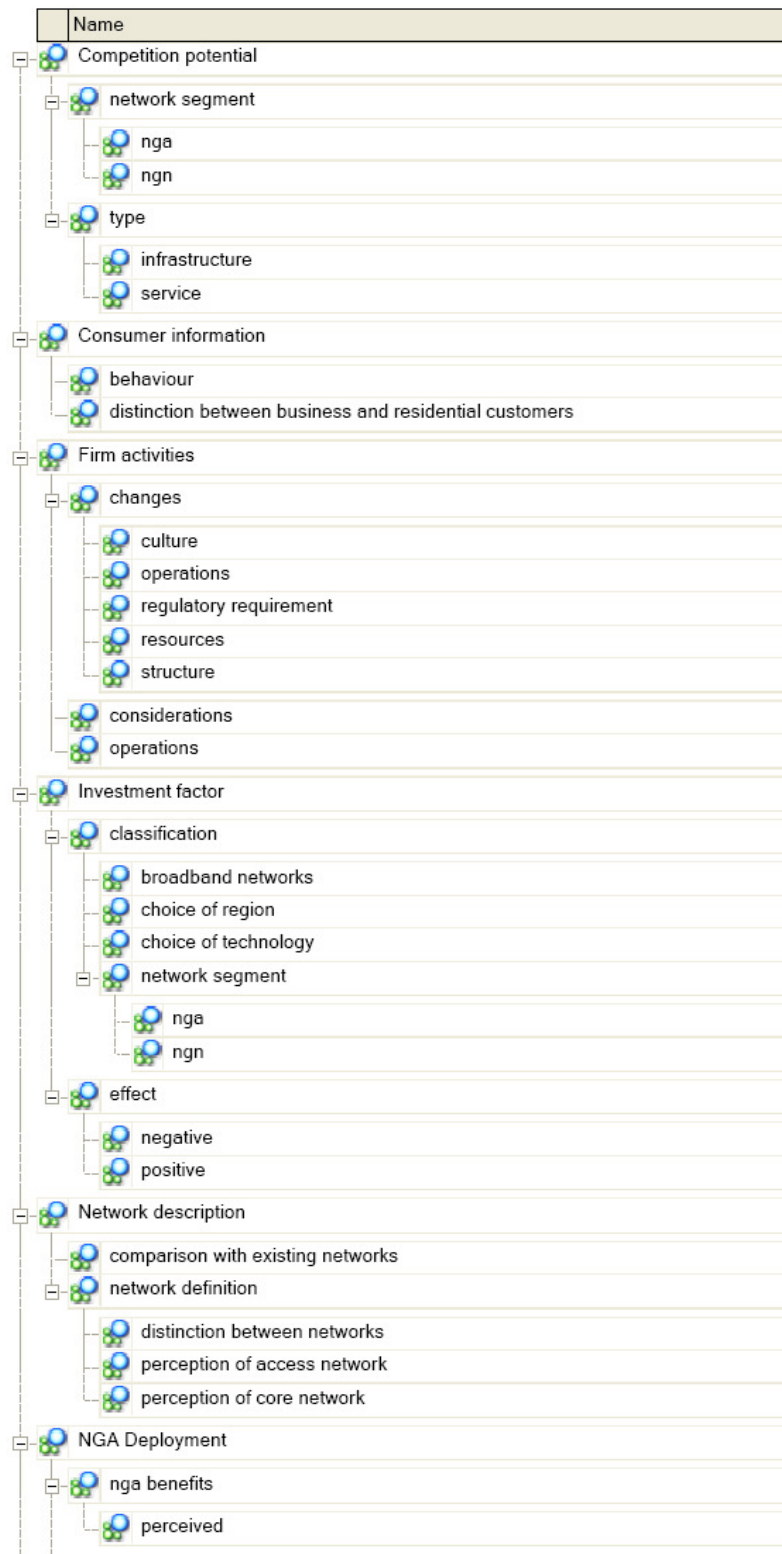
Figure 3: A result of axial coding

Tree Nodes

Name
Competition potential
network segment
nga
ngn
type
infrastructure
service
Consumer information
behaviour
distinction between business and residential customers
Firm activities
changes
culture
operations
regulatory requirement
resources
structure
considerations
operations
Investment factor
classification
broadband networks
choice of region
choice of technology
network segment
nga
ngn
effect
negative
positive
Network description
comparison with existing networks
network definition
distinction between networks
perception of access network
perception of core network
NGA Deployment
nga benefits
perceived

Figure 4: A section of the final tree structure produced in NVivo

Appendix IV: Sample of a transcribed interview

Name of interviewee: X and Y
Category of interviewee: Operator
Company: [Operator A]
Role: Head of Portfolio Projects/Regulatory policy and strategy on NGA
Date and time of interview: Thursday 26[th.] March, 2009 @10:00am
Location of interview: [Operator's location]
Duration of interview: 1 hr. 30 mins.

X: [*Y's*] lead, as I said, is on the regulatory side of NGA, obviously because we haven't done NGAs before, we needed to make sure that the regulatory regime was right for [company] so that we can maximize returns and minimize incentives and so forth, whereas my area of expertise is on Next-Generation Networks and the copper-based access input to next-generation networks. So, on next-generation voice, next-generation broadband, and the regulatory regime about the core of the network.

Tricia: So what's your actual title in [*COMPANY*]?
X: My title, we don't major in titles, my title is Head of Portfolio Projects, but that really means that my responsibility is really to do with the regulatory aspects of projects that happen in the company that straddle lines of business. We have regulatory functions in each line of business and my job is to look at things that kind of straddle more than one. Clearly next-generation network do, because they affect every part of the company.
Y: My role is really to look after the group on regulatory policy and strategy and NGA has up till now been treated as a strategic project because whilst NGNs have been, there have been investment plans for some time and there are portfolio issues of new products, the decision as to whether or not we actually do invest in NGA and how we do it has been treated as a strategic project. We're now in the beginning of a new phase because having got a reasonable level of regulatory certainty enables us to start to proceed. We're now in more of a process of starting to develop products and treat it more as a business-as-usual type activity although there are still a number of strategic discussions that we're still having with Ofcom that I'll still lead on.
X: We're on the cusp between it being a strategic policy phase and a business-as-usual, so we haven't really launched products but essentially we're at that stage of saying the products are going to look like this, they're going to work like this, you are going to be able to buy them like this and put them together like this.
Y: Openreach have been consulting on their preferred NGA products and they've consulted with industry and there are their product specifications on the Openreach public website, they've announced to industry the first phase of pricing, there are two pilot sites in Muswell Hill and South Glamorgan which with six participating CPs, two internal *[COMPANY]* CPs and four external CPs, and we announced at the beginning of this week the exchanges that are going to be the next phase, so there's I think 20 odd exchanges that will get us to 500 000 homes as part of the staged roll-out to pasting 10 million homes by the end of 2012. So that's starting to now become real and now if you like I suppose we're at the stage of having got a first of a series of green lights in terms of regulation and knowing that we can do products we want and the pricing rule we can get on delivery whilst thinking around more strategically how NGA goes forward. There are lots of issues in public policy sense that are broader.

For example, some of the issues in relation to NGA that the government is interested in as part of its Digital Britain project in terms of what intervention would they to do or should you be doing at this stage or in the future to ensure that NGA goes beyond the roll-out plans that *[COMPANY]* and Virgin have which are largely going to be where you go commercially. I have to say, we're quite at an early stage to start thinking there's a digital divide in relation to NGA we're only starting to roll it out and it's also a little bit hard to start thinking in black and white terms that there is a definitive cut-off beyond which commercial roll-out will go. We've announced that we will pass 10 million homes by the end of 2012 and that broadly equates to about 40% of homes. Whether 40% is the cut-off or whether or not you go could go further commercially. Equally, the business case for that 40% remains challenging and we don't want to think that it's easy. At the moment we don't know enough about the costs and the performance and all those things which is part of the reason obviously for the piloting. I guess the biggest issue is we don't know about people's willingness to take up, we don't the extent to which people want to pay the premium for faster bandwidth. At the moment, it's not clear what the killer applications are that we could really get everyone to take up NGA. There is a range of things that people could imagine you could do with NGA and we could obviously do existing things faster and I ought to say we ought to differentiate between those people who can't get any broadband at all in the not-spots and those people who would be satisfied with a slightly faster current generation broadband, between that and those who will say what would you use NGA for? There's a difference between saying I would like to have a guaranteed 2M or 5M or 8M which is all within the bounds of current generation broadband and saying I need 30M. Then you start thinking what would you need 30M for? Clearly you could do some things faster, and if you're a particular multi-household you could do different things in each room. There's lots of potential for health and education and all those applications. A lot of it has not yet been invented or developed yet. The experience of looking around places like the Far East in particular where they're further ahead we are on NGA is that there hasn't yet been a new killer application. One of the interesting differences – and there's a number of differences between the UK and other countries in terms of things like the population density, how easy it is to roll-out NGA, the costs if you've got large apartment blocks like people have in Korea it's much cheaper than elsewhere, but also the fact that a phenomena is the popularity of Sky and the fact that people tend to watch their pay TV over satellite where in most other countries IPTV is seen as the reason why people would develop NGA. If you look at somewhere like Germany where DT has got the rights to the German league football and as part of their TV offering. We've also got *[COMPANY]* Vision in the UK. Everyone takes Sky because Sky has got the premier league football and most of the best sporting events. So there's lots of uncertainties around the business case which will relate to the commercial roll-out and regulatory uncertainty is also an area because I think the whole issue of which wholesale products we should have to provide and on what basis is obviously quite fundamental. If you read the Ofcom statement which came out on March 3rd, and if you read our response to that which is on the Ofcom website, there's a lot of discussion around this subject [?] – active and passive remedies and the extent to which allowing people to unbundle a product could in fact destroy the business case. In commercial terms, we've got a business case that has got a long pay-back period, a longer pay-back period than the city would like and particularly what the city would like in the current climate. The important thing is you don't want the regulator to come along three, five years down the road and say well you now have to offer this on a different basis,

asking people come in and buy at what we would regard the marginal cost which will undermine the expected returns in the pay-back period in our business case. That's part of a very big debate that we will carry on with the regulator.

Tricia: What do you consider to be NGA? Can you attach a specific bandwidth to it or any particular feature?

Y: It's a very good question. Some people characterize next-generation access as being fiber technology. I think that is probably slightly wrong. We like to take a technology-neutral view. So, you could argue that the enhancements we do to copper – the current generation broadband, ADSL2+ - is part of that. You could argue that some of the enhancements that the mobiles are doing are. There's a question as to whether or not 3G takes you far enough. It may be that the LTE will take you into next-generation access speeds. It's quite hard to say. In terms of defining markets for perhaps regulation, the regulators – the European Commission, Ofcom – have essentially said that it's quite hard to define a cut-off at the present stage which is why they say that generally NGA forms part of the existing broadband market.

X: Basically it's the same stuff but just faster. It's harder if you do the economic analysis to try and do a SSNIP [standard economic test used by regulators to identify separate economic markets – "small but significant non-transitory increase in price"] test to say it's a different market - you go, well actually it isn't. If you're given two very big [?] differences, it might be, but actually there isn't. There's a range of different products at different speeds and obviously depending on where you are geographically, there may be a very clear difference between these different products and therefore different markets.

Y: In some ways you could argue that FTTC which is obviously what we're concentrating on rolling out at the moment because obviously it's got a lot less cost implications, and at the moment we plan to do an overlay network as well which don't have to take away people's existing copper products and replacing those, but that is in some ways nearer to what you could probably get out of the copper network for broadband than FTTP, because obviously FTTP which obviously is perhaps at the moment more suitable for brownfield sites you can get a lot faster speeds out of it. Ebbsfleet, which is the new town where we are providing service in Kent, people are getting 95M and there's a quality difference between 95M and perhaps 30/40M that you will get on fiber-to-the-cabinet, so how it goes forward…Possibly the extent to which you could get upstream speeds is probably also a defining factor in relation to NGA.

X: I think there's another way of looking at NGA which is not to do with the speed at all and it's something that has come up in the work that I've been doing in looking at the convergence of the copper, fiber, all these bits of technology. So if you look at it in a truly technology – a physical transport technology – way, you could say that NGA is something very much at the edge which says it's more about what protocols are being presented at the end-user's premises. So for example you could image a world in the future where it doesn't matter how the stuff gets to your house or your office but the key thing is that it's always presented. If all we get is an Ethernet socket and you can do what you like with an Ethernet socket, so ultimately the convergence in the core which is heading towards MPLS and IP spreads out to the backhaul – clearly it's all going to be IP and Ethernet eventually – why not the last mile, and the last mile in this sense could be a fiber, it could be copper, it could be something else, it could be wireless, it could be WiMAX, it doesn't really matter too much. I think what this particular way of looking at NGA ends up with is that you simply have a

mechanism that gets your messages and your data from one place to another, and you can plug in whatever your device is knowing full well that it will be utterly compatible wherever you are. Ethernet across the entire network is one technology view of the future which means that acutely the core, the backhaul and the access all become essentially just players in the same thing. So, that's looking at it at a different layer entirely.

Y: I think the other thing is, just to be clear, the application as well and to think what do you need for those applications. So in the context of Digital Britain and discussions about what a universal broadband commitment should be, a lot of the discussion has been about having something that is capable of watching video, so the characteristics that you need to support BBC iPlayer and things like that are important, which might mean there are things that…if you take that forward, you think what might be the future of TV over broadband. There are characteristics that are also about quality and those things that might be different if for example, what you might deliver over wireless or mobile, where based on a reasonable view of the number of base stations you're likely to have against density of cells, you could imagine that you might not be able to guarantee the same quality and reliability that you would over a fixed network. So, some of it is about turning it around and saying what do you need to use the bandwidth for? I think I spotted one of your earlier questions – do we regard wireless as an in-fill or a substitute? I think we probably regard wireless probably as an alternative – something that is designed to help you get mobility and to do things while still having fixed. Clearly, mobile broadband has taken off massively. Quite where it will go, I don't know, where LTE will go, is interesting. It isn't exploited enough to know that yet. There will be instances where both mobile and satellite solutions do enable you to get to places that currently can't get broadband, but I think that's more about giving people some broadband rather than saying wireless or satellite can replicate the speeds you can get over fixed.

X: I think we're bound to look at wireless technology in many different parts of the network – we already have some wireless.

Y: We use them for leased lines, we use them for fixed.

X: We already have line-of sight and there's a whole bunch of different technologies that we use and depending on what the commercials are, what the regulatory regime says, we're bound to use wireless.

Y: We're at a real interesting stage with everybody looking at technologies around the world – what works. We have our people at Adastral Park who are the technical people and they continue to evaluate what they think satellite can do. Obviously, there are a lot of companies and manufacturers who've got a vested interest in selling up what they can do and you need to therefore take that with add a pinch of salt and evaluate whether or not technologies are capable of doing those things.

X: That's true and what we can link to that is the idea of convergence of technologies. In the olden days, one could say that old generation access was about you have a particular bit of kit that does a particular thing so for example the copper pair would be for voice. Broadband didn't exist. If you wanted a data circuit you had something different and there was a different platform not only at the physical access level but also all the logical layers beyond that whereas we're now moving towards a paradigm that says actually it doesn't matter how you get the stuff, ideally you will have whatever is the most economic in the situation to get a communications path, but it means you use the same communication path for everything. So, in a sense that's what makes next-generation truly next-generation. Fiber will enable, as an onset, things to the application over the transport mechanism. So, voice will be an

application rather than the only thing you use it for. It's not linked in so you have the same application over the delivery mechanism whether it's fiber, copper, WiMAX whatever. Obviously we have to discount things like semaphore (?) [this was a joke – probably not a good one!] but you get the basic idea. The extent to which that really does take us to a next-generation access world where you sell merely a dumb pipe and people can do whatever they like over the dumb pipe remains to be seen because clearly for incumbent operators the world over they want to protect their traditional revenues from the voice, so they will want to keep as much voice traffic on their network as they can. So, although having a dumb pipe over which you can do anything, it's quite an attractive thing from a technology point of view because that's what all our technologists say – where we'll end up. Actually from a commercial point of view, it's probably not the right place to get straight away. Ultimately that might be where we end up. So in answer to your question – it could anything you like!

Y: Obviously, you can't necessarily say next-generation is a distinct cut-off. The reason it's dealt with separately is the regulatory issue is generally about upgrading the access network and I suppose one of the differences between that and the enhancements that you can do on the current generation broadband is those enhancements are generally things that are exchange-based whereas the things that take you beyond what you can do with the copper, the current generation broadband does require some intervention in the access network of some form

X: It also blurs the definition of access and backhaul. Generally with fiber you will take it much further back into the network than you would with copper. Where does the access and backhaul definition change and clearly the regulator, the way we're regulated at the moment is on the bottleneck local access bit which is generally speaking from the home to the local exchange, whereas the fiber theoretically you don't need an exchange. You theoretically would have fiber 50 exchanges in the country with all the fiber going back to those places. So, what does that mean for the way we're regulated? That's one of the big questions.

Y: Currently, some incumbents around the world have used NGA as a way of radically changing their network. *[COMPANY]* has obviously announced its 21CN plans to the industry in terms of numbers of points of connection and our current thinking in relation to rolling out fiber and NGA is that it fits with that announced topology. We're not looking to do what potentially you could do with fiber which is to have very few exchanges and very long links because it does completely change the UK regulatory-competition model. I guess you come to a point in ten year's time where the economics were so compelling it was worth doing that then regulators around the world would have to decide whether or not it was worth doing in order to make that amount if the demand for bandwidth was such that only economic way of delivering that amount of bandwidth was to do it in that way then that would be another discussion but I think we're quite a long way away from that.

X: We're in an interesting situation where clearly the commercial decisions we make as an organization are partly driven by what we can sell stuff for and how much it's going to cost to put it in the ground, but also the extent to which what we decide to do will affect the regulatory regime which can then come along and say either I'm going to take away your access profits – your super rent – or I'm going to not regulate at all and you can get on with it, but then they have the threat at the back of their mind that they might come on later. So, it isn't just a matter of it makes commercial or technological sense to do this which might be fiber, we have to bring all these things together. As a consequence of that, you end up with what looks like a bit of a hybrid

mish-mash of technologies built all together and that's inevitable. We're not in the luxurious place where we can say we're going to scrap all that copper-based stuff and all the TDM-based stuff and put in MPLS, IP, fiber, etc. We can't do that because first it will take a long time and cash but also if you did that the whole regime would have to change and it's sort of an unsettling situation that we don't want as a company because it makes it impossible to have investment certainty. The city don't want it because they want certain return and the regulator would just go well I can't even regulate this stuff yet because it's sure that it will change. So, you in inevitably end up with this evolutionary hybrid approach and an awful lot of time spent trying to work out the regulatory ménage [doesn't sound like a word I'd have used, but can't work out what it would have been - "regime' maybe?].

Tricia: Do you see next-generation access in the UK becoming competitive?
Y: Yes, but it depends at what layer. The Openreach model that we have in the UK is built on competition, it's built on the fact that Openreach will offer what we will regard as the bottleneck product which is the one at the end. We then sell it to people who will then sell the NGA, the fast broadband products. The trialists of Openreach apart from parts of *[COMPANY]* are people like Sky and Carphone Warehouse.
X: So essentially we're saying that our bottleneck will remain the bottleneck. The only place where it may be different is if we decide to put fiber in Virgin areas. Now there will be a choice between different high-speed providers, but again we've got to look at what would we do as a commercial organization. We'll have to make a decision: is it worth our while to out these new fiber access where there's already a very firm competitor?
Y: In terms of fiber-to-the-cabinet and the scaled roll-out in existing populated areas, you do come back to this point again around the active/passive debate and what are the appropriate points of competition and where you can introduce competition and whether the economics sustain it because there's been a lot of discussion about how you could mirror the success of LLU in NGA and obviously LLU is exchange-based so you're able if you put your LLU equipment in an exchange to address the population served by that exchange. In fiber-to-the-cabinet you're faced with having to access other cabinets where your addressable market is generally only about 300 lines, so there's quite a lot of civil engineering to do to put your own cabinets in to try for more than one operator to compete for 300 lines of which at the moment perhaps only about 50% of them actually have any broadband at all let alone might want to pay extra for fast-generation broadband. So there is an issue of the extent of competition economics will allow and the economics of next-generation access is different to what you can do with current generation.
X: Certainly in the first phase we would expect, I think most people would expect competition to be based on the bottleneck product, so where we have put out the product and Openreach sell the wholesale super-fast broadband product, the competition will be based on that. Now it clearly will have an overlap and a distortion effect on LLU, it's bound to, and it might be that in some places LLU operators can find the economics to put in kit at the cabinet because essentially they have to put their own fiber down to the cabinet and do essentially what Openreach is doing.
Y: But again a lot will depend on the economics of the individual operator. Carphone Warehouse has got a particular business which is largely about offering cheap broadband bundled with calls. They may be less interested in investing more deeply in the network than someone like Sky who's got a different business model that might decide, I don't know, to put more content in broadband. So, it really depends how

people want to use it, so what Openreach is trying to do is to offer that building block for different people to do different things. The other area where it's interesting to think how competition will develop is obviously on new-build sites. As I said, we're building out Ebbsfleet, it's very slow because of the recession, but again the Openreach products there allow other CPs to offer service. No other CP has chosen to do so yet but they could. There are a scattering of other new –build sites around the country. There's one in Corby, there's one in Belfast, a number of places where other people are putting in fiber and we would say that they need to make that available so that other downstream providers like *[COMPANY]* Retail and other retailers can offer service, so I think there is an issue of common standards being available such that whoever provides fiber can allow other people to hook in otherwise you'll end up with these technology pockets where there can only be one provider, which isn't good for competition.

X: I think an interesting bit of asymmetry area is where Virgin have got already a high-speed fiber network, they're under no obligation to offer that to anybody, whereas *[COMPANY]*, because we're the big bad old incumbent, essentially we have actually volunteered to launch these products as wholesale products with as lax regulation as we could get away with, but at some point you can imagine that high-speed broadband will become essential in some sociological or economic sense, and at that point how far will *[COMPANY]* have got in launching its super-fast broadband, at what point does the regulator say actually it's important that, in the Virgin areas where we may not have chosen to go, Virgin is obliged to offer a wholesale access product as well. There is an interesting battleground there because at the moment the economics for anybody to go into Virgin area aren't as good as going into an area next-door where there's lots of people to offer fast broadband and you could end up with local monopolies. In Brighton, that would mean that essentially there was no other supplier apart from Virgin for super-fast broadband. At that point the regulator has to, we will force the regulator to, at least consider this because it's going to be a big issue at some point.

Tricia: So is that one of the factors then that determine where *[COMPANY]* deploys a next-generation access network – for example where Virgin might be?
X: Well, if you think about what would incentivize us to put super-fast broadband is we think we're going to get enough take-up on our cabinet and on our exchange to justify us spending a whole bunch of money, and if there's already an availability of Virgin and a high penetration of Virgin and they've already rolled out their 50M service, then we're going to go well I'm sure not about investing there, but it may not be quite as clear-cut as that.
Y: I think it's a balance because on one hand you roll out but on the other hand the economics that would drive Virgin to go there probably would also be the economics that would make those some of the more attractive cabinets to deploy. It's a mixture.
X: That's true, but a lot depends on what else *[COMPANY]* is able to offer over its super-fast broadband so, as I started saying, we haven't got the killer application. As far as Virgin is concerned the killer application is HDTV probably in the sense that…the fact they've got this network there already the application is not the broadband application. It's here is HDTV, oh and by the way here is broadband super-fast thrown in, whereas *[COMPANY]* is in a slightly different place because our vision product isn't the flagship product, it is an add-on, so the economics are different.

Y: The choices of where we deploy are not the *[COMPANY]* Retail choices, they are with *[COMPANY]* Vision so it's Openreach so I guess it's about understanding also where people like Sky would serv. So obviously you could imagine there would be urban areas where there is competition between a Virgin offering that offers Virgin's content and Virgin's broadband and by Sky who offer their service and also by the Openreach products. So it's interesting. It's worth having a look at our announcement of the exchanges. We have announced a couple of rural exchanges as well because we are interested in understanding how it works. Some people do think that you might be surprised and rural exchanges might be as interested as urban exchanges. Our research team has done a lot of work looking at cabinets and looking at as much information as you could find about who is a particular cabinet and it would be great if there were some cabinets that were really 100% broadband and some you could write-off but it's a very mixed picture. So, there will be pockets of people in every cabinet who might be worth addressing. That's the sort of thing that we learn a lot as we go through the next stages, as rural to broadband and why and how much people are prepared to pay.

X: And I think the fact that the way that we're doing it means that it is as granular as by cabinet. It isn't here's geography, here's a whole town, but actually here's a town that has some potential – which cabinets in that town has the potential to deliver something for Openreach which is economic? You made a good point – the decisions about where things are going essentially are being led by Openreach and they're at least more or less independent of the rest of the company although they're obviously part of the *[COMPANY]* Group, so when they decide on their commercial activities they need to take into account, not just what *[COMPANY]* Retail will want or *[COMPANY]* Wholesale will want but who they can sell this stuff to in general? So they have to look at Sky and maybe even Virgin might find the fiber product attractive outside their area.

Y: Virgin is a signed-off trialist.

X: So outside their area they may find it more attractive.

Y: We also spend a lot of time talking to regional authorities like the government, regional developers, agencies that involve government because there are one or two proper state aid bids going on. There's one in Cornwall at the moment, but apart from that there is a role that the RDAs can do to try to stimulate demand and to encourage take-up and those things so I think also a factor as to whether they're successful or not is also about where there is a local momentum of people who want it, those sorts of things, the extent to which…if you could get local government in a particular area to, if you like, almost be an anchor tenant that decided that they wanted to buy a lot of fiber and use that. That would itself create momentum.

X: I guess you may get the parallel, parallel to what we had in broadband where there are little villages that had local campaigns because in those days, there was a period where we went with broadband when we certain they were committed to having broadband in our exchange. I guess the same sort of thing is likely to happen with fiber as well because there will be little pockets which don't figure on our list where there are either business parks or there are people or designers or something that happen to live in a particular part of town. Brighton is a good example of that where there are parts of town which probably will never figure on the *[COMPANY]* list but actually that's where there is a lot of demand for high bandwidth.

Y:Cornwall is amazing. I've talked to colleagues who've been down in Cornwall talking to small businesses and there's huge creative industries down there – animation for Disney based in small cottages in Cornwall, which is like a lifestyle thing as well as everything else because it's trendy and they go surfing and do all that

stuff as well. So, it is quite hard to predict geographically where boundaries go. I guess what we can do is more easily predict where there are supply issues, where it is more expensive to serve areas for particular reasons and that becomes an issue.

Tricia: What do you think is the key regulatory challenge in deploying NGA for *[COMPANY]*? Would there be any factor being specific to *[COMPANY]* being *[COMPANY]*?

Y: The fact that no-one else has any regulations so, to be honest, that's the key difference. I think we touched on a number of things. Obviously the asymmetry is something that we believe will be an issue. I think, as I said earlier, it's about the extent to which we have to unbundle our offering and offer our wholesale products and particularly the pricing in terms of that. If the regulator decided that we would have to make access to our cabinets on a basis that were below costs that will destroy our business case, it will be a big issue. I think there is an overarching issue around regulatory certainty. Regulation is in the European frameworks, it drives you to relatively short-term chunks of regulation dictated by market reviews which I think works fine because where you want to be supportive, where you're talking for example about competitive retail markets and you want to show that you have deregulation because it keeps up with technology. I think there is a slight issue that where you're making big investments where you've got a ten-year plus payback period trying to get some regulatory certainty that straddles market reviews – there's an issue. For example, we've had the NGA policy statement that came out on March 3rd which we're broadly happy with because it gives us a step forward but we know that in 2 years' time Ofcom will then have to do the next set of market reviews that they are required to under EU law. They could change tack; they're not saying that they will and clearly there will be some expectation they won't but in two years' time they'll probably have a new chief executive in Ofcom, different lobbying by different people. It remains a concern that you can't actually get anything that gives you any guarantees on the regulatory regime more than a couple of years ahead, so I think that's an overarching issue and it's not an easy one to fix.

X: Also the traditional approach to regulating *[COMPANY]* as the provider of local access up until now hasn't been a problem because there's only been copper access and therefore we have the USO obligations which say, somebody comes and says they want a telephone we have to go off and find a telephone. The temptation would have been for the regulator to translate all those copper-based regulations into a fiber-based world, and you can see the logic – you can say I want a phone, the fact that there's fiber coming to me shouldn't make any difference.

Y: I think this is a huge issue because you're absolutely right, so on one hand I want to be technology-neutral and you can't see a cut-off between current generation and NGA. On the other hand, all the regulation of ex-utilities comes from privatization and a view that in some ways a lot of the investment and the creation of those networks was paid for by taxpayers and almost there is some element that the people should expect access. Now, when you come to something like NGA which even with FTTC it's still quite a big element of a new overlay network that anyone could do, you do start to think that maybe you should go back to first principles and question the extent to which new investment like that should be regulated because anyone with deep enough pockets, and we haven't got particularly deep pockets, could come along now and choose to say I want to build a fiber network, but they won't necessarily be regulated, but we would.

X: And if they were regulated it would be in a very different way, it would be in a very hands-off way. It's a bit like the difference between regulating our fixed network and the mobile networks. They've got far more freedom than we have. There's obligation to be able to, if I'm living in rural Kent and I can't get a mobile phone signal, I've got no rights. I can't go to Ofcom and say there's no mobile phone signal, make sure there is, because there's a commercial case, whereas with copper there is a slight wrinkle that if it costs a lot to get a copper line to a house there is a bit of a cost sharing going on but nonetheless we're still obliged to make the offer. Essentially, the way that you could look at it is say it's simply a faster way of doing the same thing, but as Alan said, it's not, because there's a massive investment required and there's a commercial decision needed, there's a funding got to be had from some place and therefore it's not a trivial thing to say it's just the same because we need to make sure we've got sufficient regulatory and commercial certainty, and the commercial certainty we should have should be the same as anybody else, not as a regulated utility. It should be, well here we're making a rational business decision – and we need to be able to go…here are the bits we're uncertain about, here are the bits we're certain about, just like you would do normally.

Tricia: In the Ebbsfleet project, what was the motivating factor for *[COMPANY]* to invest in that area?

Y: We have universal service obligation anyway so in a sense if there is a new-build we're asked to provide service. We have an obligation to do that anyway and I think there were some circumstances in Ebbsfleet that made fiber as least as cheap as new copper, circumstances were to do with the exchanges and things like that. Also, I think the developer was very keen to try and make it a prestige fiber-only site. I think the initial aspirations of the developer may still be for the future of Ebbsfleet is that it's sold at a premium because you've got this very fast access, and you're able to attract a particular type of person. However that's not actually how it pans out – it's a different matter. It's a bit hard to tell. I've been to Ebbsfleet just before Christmas and there's about 40 flats occupied so it's hard to tell how the project materialized but obviously the future aspiration of Ebbsfleet is 10000 homes by 2025. What you are getting is these pockets of developments where developers have got particular aspirations to do something with a new-build site and it's up to obviously operators to want to tender for them. I guess *[COMPANY]* is generally supportive of wanting to do it and we generally tender for this even though there are challenging economics.

X: I think for a lot of new-build in the future, even though the economy is in a bit of a terrible state, wherever there is new-build, it will still be a perfectly rational choice to say I want fiber, because everybody knows that it costs the same to dig a trench to put fiber in as it is to put copper in, and if the trenches are already there all you have to do is go we know you can blow fiber down them and we got fiber. I suspect even though the economy is in a bad state you'll still get new-build requirements from developers for the fiber, because they'll say fiber is the future, that's obvious, we know it costs you the same to put in, so that's what I want.

Y: And I think generally quite a lot of developments are mixed residential/commercial and there are the aspirations at least are there to attract IT and broadcast – that's the rationale for at least some of the cities such as Titanic Quarter in Belfast.

Tricia: What has take-up been in Ebbsfleet?

Y: The issue has been they built in the houses. It's not an overlay; it's fiber-to-the-premises so if you move in, you have your services provided over fiber and you get fiber.

X: So everyone that is there has fiber.

Y: There are only about 40 people at the moment and we're developer-led. There are more properties that have been built that the developer has decided not to market yet because of the house prices so we're purely in their hands.

Tricia: You were involved in the core NGN deployment…

X: It's part of the core network deployment and particularly it's the extent to which that links in with the next-generation voice, the next-generation broadband, not over fiber but over copper because obviously copper is going to be here for quite a long time.

Tricia: Just as I asked you all before, what do you consider to be a next-generation network?

X: It's going to be a long complicated answer probably, just like the one for next-generation access. I think that depends on who you talk to, either you get quite a simple definition or quite a complicated definition. I think for simplicity sake, though, a next-generation network is a converged core where you have the same transport protocols across the core and frankly it doesn't really matter what they are but as it happens they're tending to move towards MPLS/IP networks because from a technical point of view, that makes sense: it's modern, they're relatively cheap and you can buy the kit off the shelf and the only way is up in terms of speed, so we know we're going to eventually hit extraordinarily fast speeds and extraordinarily high capacity of the network. It's all fiber and the key to next-generation networks for us and for lots of other incumbents is rationalization of platforms. That's to say, where you previously had different protocols, different kits, different networks, even different fibers for different services, you now move them all onto the same. So you have a totally homogenous core where your voice goes, your data, your video, your content distribution, whatever you like, goes across the core, essentially in a content-neutral fashion. So, you have to have a way of getting stuff onto there whereby it can be transported in a neutral fashion. But it means that increasingly the sophistication of the network is at the edge rather than the core because the core is essentially just the big lumpy, cloudy thing which transports bits.

Tricia: What were some of the reasons for *[COMPANY]*'s investment in a NGN?

X: The predominant one is about the fact that if you can rationalize the number of networks you need fewer people to maintain it, the operating costs are lower, because you are essentially taking a kit off the shelf rather than having to have bespoke UK versions, you can make maximum efficient use of your fiber, it gives you a lot more operational flexibility in the core. Theoretically, it enables you to rationalize the number of buildings you use as well so your real estate, because when you've got a multiplicity of networks you have to have these networks with nodes which may be different for each networks and you need lots of kits, and as soon as you rationalize you maybe need 1/3 of the number of bits of kit and 1/3 of the locations. Because you're the incumbent, if another CP comes along and says I need some space, we essentially have to offer that space on commercial terms, and clearly if we can make money out of that, then that's great, they're going to come along and ask us anyway,

but we have to have the space in order to do that. So, it's mostly about saving money in terms of operating cost and over time it should save on CAPEX as well because you're only buying one set of stuff for one core network rather than having to buy specialist kit for the different platforms. The downside of it probably is that modern kit depreciates far quicker, be cause it gets replaced by faster, cheaper...the usual staff happens…but the fiber itself will go on forever, not like the old-fashioned copper which we still had in various parts at the edge of our networks. The cash flow benefit was expected to be substantial.

Tricia: Has it actually been?
X: Today, it has in various parts. It hasn't been as big as we thought because it's taken us longer to get to where we want to get to, but there has been substantial saving, and I can't remember how much it is but I think it hasn't been as big as we were expecting because it's been more complicated than we were expecting and it's taking longer.

Tricia: Would you say that the benefits have actually changed over time, let's say from the initial deployment to today?
X: I would say yes. There are certain types of technology which we've been able to migrate over quite easily. But there are other types of technology which have been far more difficult, so some of the TDM-based services, you can't simply put them onto an IP network because of timing requirements. The electricity industry needs a lot of TDM circuits for doing timing-dependent activity on their distribution networks for switching. You can't do that currently over an IP network, so you have to keep some TDM going, so rather than simply saying that's all going and this is going to go on the IP network, it hasn't been as easy to do. So, I think the plans have gone from here's a nice simple outturn to well it's not quite as simple as we thought, the old maxim the devil is in the detail really does come out when you start to do this sort of stuff. I think the other thing that has affected it is when you haven't got so much cash to spend you have to be more careful about where you spend it and where local access has evolved so the development of faster broadband and the rise of LLU, the balance of corporate strategies is going to change as well in response to that. So you might say well actually our investment in next-generation network, the core network, is not as important as it was, because we've rung a lot of benefit out of it. If we were to keep going with it, we'll get even more benefits but for now there's a slight change because next-generation access is necessary to respond to local loop unbundling and the rise and success of Virgin.

Tricia: What are some of the challenges that you encountered in deploying this network? I know regulation is your area but if you're aware of technical and economic issues as well.
X: I'm not so much in the detail. The technical aspects of getting some services to work over an IP-based core have been substantial in some areas. I think getting equipment…when you start saying you can just buy it off the shelf, you know there's a slight fib there. It a bit like when you're buying a new accounting system for a company, you say well I could just go out and buy this general system and we could just use it as it is, but you end up having to tinker with it and tailor it to your specifications every time. So, just buying off a shelf isn't simple so I think they have found that various specifications of the off-the-shelf equipment hasn't been as robust as they wanted. I think from the technical aspect has been about resilience of the network and I'm not really sure how they've resolved this one but you know that the

resilience and the robustness of a voice network traditionally has been very very high, so like five 9's or whatever the measure is, because of an expectation that *[COMPANY]* the incumbent, and the Post Office in the past, would deliver a system which was extraordinarily robust with lots of pairing of exchanges so that if something went wrong with things we used to just make a phone call. So, the engineers have got this challenge of do you build it to the same specs which would therefore cost a lot or do you say actually do we really need all that robustness? Do we need every exchange to be paired to multiple call servers for example, which actually adds an awful lot to the cost of the network? And I think that's the sort of economic or technical challenge they've had to grapple with is do you really need what you had in the past? It's a bit like when we started to look at the definition and the design for voice services over the next-generation network, do you need it to exactly replicate what you had on the old network? So, at the moment, the PSTN network is built to a particular specification, has a load of features which we've agreed over years and years and there are some things which date back 70/80 years, some things that we do, and they're built into the Wholesale Line Rental product, so it's like an access product but these features are deep in the network so do you really need to replicate those on the new network? Well, the answer is probably no because a lot of these features we're not going to be able to use, although in different ways they're doing the same thing. So that has been an extraordinarily difficult challenges because you don't want to repeat your mistakes of yesterday, you don't want to build it like it was because you should, it's because commercially it makes sense to do that, so depending on how you design your voice services, you can simply replicate or you can build something that gives you something new. And I can talk more about the voice services because that's what I've been involved in but this is about the technology and the architecture of the 21CN network. One of the things that Alan was saying about voice being application is almost an advantage, it's like one of these catch phrases that you hear in the industry, voice is an application, voice is an application, and really nobody really knows what it means. But, essentially it means that you have a pipe that you can provide any old service you like down including voice. How do you do that? Well, it's a lot easier if you're using SIP as the key protocols for your calls, in which case you use a different call server to do that than the one you might if you simply connecting it to your exchanges. And, that gives you another set of opportunities to offer tailored services because SIP is inherently a more flexible protocol. So, depending on how much money you've got available and how much of a risk you want to take with the technology, bear in mind nobody's built that voice as an application on a network as big as the UK, do you want to go down that route or do you want to stick to something that will deliver voice, because really people don't want something sophisticated with the voice, they just to be able to pick the phone up and make a call and receive a call, so making that balance between investing in something which will give you the opportunity to innovate for uncertain revenues or build something which simply does what you did before, and perhaps take out some of the unnecessary 80 year old features…it's partly technical, it's partly regulatory, it's partly commercial and partly political because clearly because we're the provider of last resort, the only provider of USO services, you got to have emerging services that they will be happy about – you can't afford to upset them, you can't afford to upset the national security services and so forth – so those more technical aspects have been a big problem, a big challenge.

Tricia: Do you think there's any particular feature of next-generation networks that is required to deliver the services that consumers might demand in the future or can those services be delivered over a legacy network?

X: That's a tricky one. You could argue that you could do all these things over broadband over copper and if you're very prudent and you really were stuck for cash, you'd say actually IP stream, data stream are perfectly adequate, LLU, broadband is perfectly adequate for actually doing everything you like over broadband so voice could become an application over broadband. We could do it now, we do – *[COMPANY]* and lots of other companies sell VoIP telephony but at the moment you have to have to do that you have to have a voice line as well so there isn't naked DSL which has been suggested where you simply sell a wholesale broadband access line and the company can do whatever they want and the customer doesn't have a narrow-band PSTN service at all. So, theoretically, that's all you need. You don't need a next-generation network as such to do any of that stuff, because broadband works just fine. Ok, you might want to upgrade it to ADSL2+ but you don't need a next-generation network to do that particularly. All you need is a way of transmitting the content across the core, so if that was our existing special Colossus network, which is a big IP network [it's *[COMPANY]*'s core IP network for transmission of internet traffic across our core], you could do it over that. But, Colossus is old and expensive and actually it does make sense for us to rationalize the core platforms but it's not essential.

Tricia: It's not essential for the delivery of the services, but it's beneficial in terms of the cost savings, etc.

X: Absolutely. I think there are some quality-of-service characteristics of having a consolidated, converged core because it means that for voice in particular you've got much more control over the quality-of-service across that core because you've got control of the core, therefore you can label the voice packets accordingly to give them priority. But theoretically if we weren't doing a next-generation network, if we weren't doing the converged core, you could still do these things over broadband but you couldn't guarantee the quality-of-service you want, and we haven't yet got this naked DSL product that essentially is a logical next–step. Why don't we want to do naked DSL? Because it would take revenue off our traditional PSTN product. That's true for every incumbent. No incumbent really wants to have to do naked DSL which is a logical thing to do and in France they do it, but in the UK our voice revenue is declining but it's still very important to us.

Tricia: Obviously there were sufficient incentives for *[COMPANY]* to invest in the core network. Do you think currently that there are incentives for other operators to invest in this network as well?

X: Do you mean in the UK in the core?

Tricia: Yes.

X: Well, a lot of the CPs claim they have a next-generation network already and essentially, or a core IP/MPLS networks, and it makes sense for them in exactly the same way. If they've got a separate voice and data network, why would you do that? You may as well have a single core. So, interconnecting between our next-generation network and their next-generation network will be all at the IP level so there will be no PSTN to IP translation in due course, and at the moment, as it's currently PSTN/TDM and there are one or two which are already IP networks, so C&W I think have got a next-generation network which is all IP/MPLS and I think Carphone

Warehouse will assert they've got the same. If they have I don't know but they assert they have the same. So, the incentives for them are essentially the same for them as they were for us. They're probably simpler for them because they haven't got any regulatory obligations that we've got. So, if somebody comes along and says I need a TDM service that goes from this point to this point, they can turn around and say, well I can give you this, which is not as good as your TDM from *[COMPANY]* because it's all going over my IP network. I can make it pretty close so the response time might be 150ms rather than your 40ms, is that enough? But they haven't got the regulatory obligations that we have, so I think at the end of the day it does boil down to the same incentives. If they can do something which use the existing kit as much as possible, but rationalize what they've got, stuff that's already fully written-off they can simply write-off and take out of the network. If they can re-use fiber using dense wave division multiplexing to maximize their bang-per-buck on their core fiber networks, and make them all converged, then they're going to do it, and they already have.

Tricia: Looking back at the experience, do you think if you were aware of some of the challenges that you encountered during the process you would have proceeded with the investment?

X: I'm pretty certain *[COMPANY]* would have proceeded but they probably would have done several things differently. They would have probably pitched it in a slightly different way to the city. Like all companies when they've got a good idea they [no idea what this should have been] and say this is a great idea and it's going to save us a lot of money and deliver a lot of dividends, so we probably would have been a bit more cautious about it. And, I think some of the design options would have been different. One of the problems you've got of course is that over time the technology available to you changes. When we started the design for example, SIP based call servers were really in their infancy. There was very little VoIP happening 4/5 years ago. There wasn't much VoIP anywhere; what little there was it was really internet VoIP. So, the call servers weren't standardized and they weren't scalable, and therefore we didn't really consider it as being a way of doing voice over our next-generation network. If we were to do it now, we would start from scratch, which obviously we can't because we've invested a lot of money already, we might well have taken a different design decision that would have used SIP-based call servers. That would have made quite a big difference instead of the for example the MSANs, the multi-service access nodes, that we're putting out are designed to work with a particular type of call server which isn't a SIP-based call server so the protocols they use are different. Today if we were designing it we would probably go and order a different set of MSANs, we would probably order a different set of combi-cards to go in the MSANs, we would probably order a different call server. So, I think the design decisions available, and that's always going to be a problem for next-generation networks. Technology will always advance quicker than you can actually do stuff unless you take a different design approach, but the design approach that we're taken means that – and I think most incumbents are doing the same sort of thing – you're left with this risk that technology will come along and make your design decision less optimal.

Tricia: Were any changes required within *[COMPANY]* in order to deploy the next-generation network or any changes were made in relation to this whole transformation?

X: In terms of organization?

Tricia: Yes.

X: Because the previous set of, the tangle of different platforms, were managed by different teams and there was no overarching architecture responsibility, well it was essential that we did do all these things, so there was an architecture team set up and a whole division essentially created to manage the transition from the old network to the new networks, and new technologists were brought in that understood the new technology because of the old people dealing with TDM for the past 40 years understand that but don't understand the IP base. So, there was quite a big swing of new blood brought in and new organizational structures within so there is a particular group, specifically responsible for 21CN, architecture, planning, resource deployment and so forth. It didn't affect the lines of business of the market facing units – they stayed as they were – but it affected the design and operate functions that exist underneath those market face units.

Tricia: What do you think about Ofcom's approach to regulating *[COMPANY]* in the deployment of the core network? It's not really a specific question, but do you think they've been fair or do you think that there's anything more that Ofcom can do to progress investment?

X: Ofcom has got a tricky situation I've got to say because they do periodic review of the regulation and the market – they do market reviews and price control reviews – and the key ones that affect the next-generation network, the 21CN, is the network charge control. NCC really is about voice services and the compensation of voice services on our network and when they do those reviews which they do every four years, they have to make an assumption about what the costs are going to be for the next four years, and the last time they did one four years ago, we were expecting to have our 21CN essentially in and working today/next year, and here they are four years later and we've got it sort of but the voice hasn't been deployed on 21CN and the design decisions for the core haven't been entirely finalized either. So, although the rationalization of the core networks is more or less there, the services that we provide over that network essentially are still as they were before. So what does the regulator do? When they did the review four years ago, they say I ignore your 21CN investment entirely, I'm going to assume you continue as you are today, I'm going to make some estimates of what the depreciation and operating costs are going to be and what the valuation of your network is and I'm going to regulate on that basis. Fair enough. And they also didn't need to worry about the architecture of the network being so fundamentally different meaning that some of the things they regulate us on won't exist anymore. So for example the way the network charge control fee works is the network components are separately identified, so single tandem, inter-tandem, so there are various essentially architectural components which are regulated, where we either have significant market power or not, and they look at the specific costs of those bits of the network, and in 21CN those things disappear – because they just don't exist anymore - because you end up with a longer path all the way from the end-user all the way to the point of hand-over and nothing in-between that breaks out. So, you've got fewer points of hand-over, so the regulator's got a little problem, so what do they do this time? Well this time, can they still ignore 21CN? And they may have to do, because there isn't any factual information. So to be fair on the regulator,

they're having to take essentially a technology-neutral approach that says I don't really care what's going to happen your network, first - because I'm not certain, second – because you're not certain, and I've got no facts, I've got no cost information because that's what they need – cost, so I'm going to have to take the punt again. Where it gets a problem for *[COMPANY]* is that the core network assets, the existing ones, are starting to become fully depreciated. So, if you have that you have fewer depreciation charges coming to your account, and the way that the regulatory accounts work is that the overheads are allocated on the basis of all these other costs adding together, so you get fewer overheads out of it. So, the cost that are in the projections are far lower than previously even though the actual costs are likely to be just as high and we're going to be replacing it with 21CN and our volumes are going down very quickly, so if you just take the technology-neutral approach just looking at the basis of the accounts, you'd end up with far cheaper charges but actually we know that the costs are going to go up per unit rapidly, even if you ignore 21CN and if you bring 21CN into account, the regulator needs to give us the incentive to keep going with the expense and the migration of voice from 20CN to 21CN. At some point the regulator needs to take a punt on yes you will put 21CN fully in for voice, there'll be migration and I'll calculate on that basis. Now, they're almost there. The negotiations are happening at the moment so I can't really tell you much about the negotiations but I think the regulator has been pretty pragmatic about it so far. It's a massively difficult problem – how do you do it? It's an impossible thing to do. They've probably made the best of a bad job and they've been reasonably pragmatic about it. Now, this particular review that's happening at the moment is the key one for us because if the regulator gives us massively negative x-factors because that's the way that they're using technology, it would be massively bad for *[COMPANY]* – we'd lose so much revenue from the voice conveyance. I don't know what we'd do – it would be a really bad outcome, because we would still have the costs that are coming through. So, I think on that aspect, on the voice aspect, the regulator is doing a pretty reasonable, pragmatic job but they just need to be pushed a bit harder to give us an answer which makes sense from our product point of view, commercially. On other aspects of 21CN, where we're rationalizing platforms, that all comes through in the regulatory reviews of the different markets, so when we've got high bandwidth leased lines for example, some of those go over our NGN, some are on the access and backhaul parts, but some of them generally are over the NGN and the cost that come through simply flows through the regulatory account and the regulator looks at them. What the regulator tends to do is look at the very high bandwidth and services and deregulate them anyway because there our core network overlaps with C&W's core network and THUS' core and whoever else there are these days, so there's massive overlap, and with that many high-bandwidth services, we've been deregulated. So, it doesn't explicitly say, is this the NGN or not? It's saying what's the market like in these areas as opposed to is it all IP/MPLS – it doesn't matter because when you get to that point it will be Ethernet 10G service or whatever it is. I think the technology-neutrality has been workable and fine and it looked at the market conditions, but it has been on a market-by-market basis.

Tricia: A question just came to mind on next-generation access. There was a lot of discussion and concern that certain parts of the world were progressing quite quickly with regards to next-generation access network deployment. Do you think that is one of the factors for motivating *[COMPANY]* to look at next-generation access as well – saying that the UK is behind in NGA?

X: It's clearly been a pressure on the company. Government ministers, Ofcom and the BSG and a whole bunch of people will come beating to our door and say I think it's disgraceful you haven't invested. MPs are great at that because they look at what's going on and say well we're behind Korea, or whatever countries they choose, and a lot of that has motivated a particular type of communication from *[COMPANY]* to the outside world along the lines that the economic conditions are different in these different countries, the topology of networks is fundamentally different, take Korea – most people live in blocks of flats where it's easy to put a fiber to the bottom of the block of flats and everyone get access. It's easy and it's cheap, relatively speaking. The fact that there is no killer application even in Korea, unless you count downloading pornographic movies and doing online gambling as killer applications, which frankly personally I don't – there isn't something that says they've benefitted economically massively from having super-fast broadband, We've also made very plain that if we're going to do it we have to do it on commercial terms that will give us a return on our assets. Otherwise, why will we do it? We're not irrational, we're not government-funded, we're not subsidized by anybody, we have to get our shareholders to keep stumping up the cash and if we can find a business model that will allow us to do this thing and make a return and have a regulatory regime which allows us to control the way we do what we do and where we do it and to make a profit, then we'll do it. And I think that's a perfectly rational response. I mean a real rational response. I think people at Virgin would agree. Why are Virgin doing what they are doing? They're doing it partly because they got a lot of their networks in fire sales essentially when they took over NTL and a whole bunch of other cable companies. They got these things at a relatively knocked-down price, and they have technology which is upgradable to faster speeds. Some might say DOCSIS 3.0 isn't as technology-advanced as what *[COMPANY]* is going for, but nonetheless they've got that advantage over us. But they're still only going to put 50Mb broadband where it makes commercial sense to do so. If they can do it and it costs nothing, sure they're going to do it. If it costs them a lot of money, they're not. So when their announcement in the past few weeks about 100Mb broadband they made it very plain that they would only do it where it made commercial sense to do it. So, I think too much can be made of international comparisons. It is far too much to be made. At the end of the day if there was a sociological/political/economic requirement for national roll-out of fiber, it wouldn't just be *[COMPANY]* that thought it was a good idea. The government would be wanting it to happen far more. The government has been pretty rational about it as well. They've sat back and said, look we haven't got the deepest pockets either, European law probably prevents them from going out and massively subsidizing fiber and all that, and if there was an economic benefit it would be happening anyway. So, I think we've taken a pretty rational and measured approach in response to the international comparisons. Clearly we don't want to have a comparison made between ourselves and a very similar incumbent, but actually most incumbents that you look at aren't similar to us, for lots of reasons. France Telecom is very different – it has a mobile arm and the regulatory regime is very different in France. Germany – it looks kind of similar until you realize that DT is a different sort of company in the economic environment. So I think that's probably all I could say about that.

Tricia: Is there anything else you would like to add or anything else you think would be useful based on your experience on deploying the NGN?

X: I think from my point of view every NGN is almost certainly going to be built in response to what the market will bear, that's to say the services they get provided over NGN and the speed with which the NGN is constructed, will all be about commercial pay-back. So, for example, if it becomes economically viable for *[COMPANY]* to start to sell NG naked broadband, so there's no requirement to have a fixed line, if there's an economic case for doing that, we'll do it, and the whole economics of the industry will change if we did that. Life would change radically if that happened. But it's only going to be if we're either forced to by the regulator or we can find a good commercial case for doing it. Interconnecting at the IP layer is only going to happen once there are enough networks that need that and it's economic for us to do so. So, even if the regulator wants to constrain what we do, NGNs and NGAs are driven by what's commercial. At the end of the day, we've all got shareholders, and if we were to launch products which can be done on NGN or NGA just because it can be done, if the shareholders don't see a return on that, they will want to know what the heck we're doing. So, NGA we could have tried to push very hard for no regulation at all or we could actually have tried to get to not have to offer it to anybody, so Openreach could have simply launched the NGA product that only *[COMPANY]* could buy. That would have been a perfectly rational thing to try and argue for, but actually on the balance offering it as a wholesale product gives us a far better commercial outcome. So although traditionally the regulation would say we'll keep this for ourselves, and the nasty monopolist would try and keep it all for themselves, it's the commercial business case that drives us down a certain route to try and persuade the regulator that actually this is the things that you ought to be supporting. Where they have the freedom to support a particular technological route, they should be doing it to make sure the competition can develop on its own merit. Generally our take as a company is that we should be treated like a regular commercial company wherever that's possible and appropriate, but when we do recognize there are certain things that we do where actually it is in any rational sense, an economic bottleneck, but that's where regulation should focus. If there's a genuine economic bottleneck, by all means regulate it, but recognize the bottleneck changes its nature as time goes by. Will it always be the case that local access is a bottleneck? Possibly, in some parts of the country, but in many parts of the country, I suspect not. As the mobile becomes the norm for people, why would you want to regulate copper-based services? I'm not saying that's what our position is but that's the sort of logic you could use that says if it is a genuine enduring bottleneck, regulate it – fine, we're happy with that. But the rest of it, give us the freedom to do what we want.

Tricia: Who are your equipment vendors for the NGN?
X: That's a good question. I know some of it I can't tell you because of the confidential things but I think people like Fujitsu, Ericsson, Cisco, the usual culprits basically. I know that we've had various tenders of for other parts of the network and the usual suspects have been involved – Nortel for example – but they tend to be the usual big iron corporates because what we want is as much as possible stuff which is off-the-shelf which is already well-advanced, which is already proven, because what we really in the designs wanted to avoid was having UK-special because that's the way the networks in the past have been. Everything we do essentially up to now has been, we'll buy something from Ericsson or whoever else and then say well, in the UK we've got to have it this way. There are various services that we've applied – very simple little things, like the way when you call emergency services if they put the phone down that ends the call, but if you put the phone down when you call the

emergency services, that doesn't close the call. It would in every other circumstance if you made a call and put the phone down that would have closed the call but for that particular application, that's UK-special so we have to have a design that satisfies that. So, we wanted to avoid UK-specials because they cost a fortune. So we want to be able to just go to the leading industry vendors and say I want a bit of kit that does this. I want to take it off the shelf and stick in my exchange and just plug them all together. That was a real key factor because that's how you're going to save cash long-term by buying off-the-shelf stuff.

Appendix V: Data displays

Choice of displays

Miles and Huberman (1994) identify four categories of displays: partially ordered, time-oriented, role-ordered and conceptually oriented. Conceptually oriented displays are used to organize the information by concepts or variables, rather than by time or roles as the time- and role-ordered displays do. This approach to displaying the information collected was considered to be most suitable for this research and, therefore, conceptually oriented displays were used. In particular, cognitive and causal mapping were employed. The nature of the individual research questions and overall research objective was the key factor in this decision.

The research is aimed at determining the market factors that influence next-generation broadband development and how these factors impact on the decisions of operators, based on empirical evidence. This requires, therefore, a proper reflection and understanding of market players' contribution. Perhaps more importantly, however, is the need to determine and understand the relationships and links among the factors. Cognitive mapping addresses the first requirement while causal mapping is effective in illustrating drivers and their effects. Cognitive mapping was done in Decision Explorer and the causal loops that resulted were mapped in Vensim PLE. Vensim PLE provides a user-friendly interface for producing causal loop maps and was only used for this purpose.

Why Decision Explorer?

Decision Explorer is a mapping tool that is proven to be effective in mapping qualitative information or "soft" information. Beyond its provision of many mapping style features, such as the capability to create and use different styles (fonts, colors and formats) for links and concepts[6], Decision Explorer provides several features that make the tool extremely powerful in the mapping technique. For example, Decision Explorer enables a large number of concepts to be added to one model and provides the capability to view a given model in different ways. This allows smaller segments of a map to be examined effectively.

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[6] Any variable entered onto a model in Decision Explorer is referred to as a concept.

Several analysis techniques are integrated in the Decision Explorer software. These include domain, central, collapse and cluster analyses, among others. Domain and Central analyses were found to be particularly useful for this research. These are described in Appendix VI. In general, the availability of this range of analysis tools in the software makes it possible to perform a comprehensive analysis on any kind of qualitative data.

Finally, Decision Explorer, like NVivo, has been developed, in part, by academics at the university and widely used in this environment. Therefore, both the software and support are easily accessible. While modeling could have been performed in NVivo, this software was not developed for modeling as its primary function and is therefore not as powerful in this capacity as Decision Explorer.

Appendix VI: Domain and Central analyses in Decision Explorer

Domain and Central analyses

The Domain and Central analysis functions of Decision Explorer were used extensively in analyzing the cognitive maps. Domain and Central analyses were performed on each map to identify the key concepts or key themes spoken about by interviewees as related to the given research question. Brightman (2002)[7] explains that Domain analysis is based on the fact that people talk a lot about what is important to them and, therefore, the key issues in this regard are those that have the most links around them. Central analysis goes beyond the direct links into and out of the concept and captures the impact of the concept throughout the whole map. It is analogous to examining the ripples in a pond created by a pebble that is dropped in as shown in Figure 5.
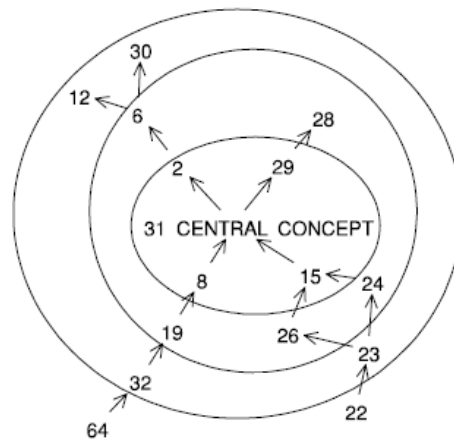

Figure 5: An overview of Central analysis

Both Domain and Central analyses weigh concepts based on these features and do not necessarily give the same result. While these analyses are not sufficient on their own to make conclusive deductions, they are useful when employed in combination. In addition to these two techniques, the researcher observed the frequency with which responses were given and the number of interviewees who referred to the same concept to determine the key concepts.

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[7] Banxia Software is the developer of Decision Explorer.

Appendix VII: Verification of data and results

Verifying data and results

Verification is an integral part of research, necessary to ensure the validity of conclusions. In this research, verification was done from the data collection phase until the end of the data analysis. Therefore, both the original data and the conclusions drawn from the data were verified.

In relation to data collection, Miles and Huberman (1994) explain that the circumstances of data collection have an impact on the quality of the data. Based on their list, shown in Table 3, data collection in this research conformed to four of the circumstances that result in better quality data. These are highlighted in green in the table.

Stronger data	Weaker data
Collected later, or after repeated contact	Collected early, during entry
Seen or report firsthand	Heard secondhand
Observed behavior, activities	Reports or statements
Field-worker is trusted	Field-worker is not trusted
Collected in informal setting	Collected in official or formal setting
Respondent is alone with field-worker	Respondent is in presence of others, in group setting

Table 3: Impact of circumstances of data collection on strength of data quality

In the data analysis stages, verification was achieved by a combination of feedback from the participants and replication of the findings. In the first case, all interviews were transcribed verbatim and the report sent to the interviewee to be reviewed. Interviewees were informed that they can modify their answers in the report. In this way, they were given the opportunity to highlight any information they considered to be confidential and, more importantly, clarify and confirm the data collected and subsequently used in the research. Any information that the researcher missed was filled in by the interviewee at this stage. The data used in the study was therefore considered to be valid, reliable and of high quality.

Both coding and mapping were used to analyze the data. Since the data collected from the interviewees were meant to be kept confidential and anonymous, cognitive maps cannot be validated by the interviewees. Instead, a second mapper internal to the

University of Strathclyde was used to repeat the mapping process to double-check the maps produced by the researcher.

During the coding process, several propositions emerged. During the mapping stage, these propositions were confirmed or rejected. If there was replication of the propositions in both the coding and mapping processes, these propositions were regarded as conclusive answers to the research questions. Propositions that could not be validated by replication were tested by further data collection through follow-up questions. These were sent to the interviewees and the data collected from them used to verify or dismiss the propositions.

Finally, a generic map that provided an overview of the results of the study was produced. Since this showed generic issues and relationships, it was possible to have this reviewed by the participants without violating the confidentiality agreement. This map, therefore, was validated by feedback from the participants. Table 4 captures the verification measures employed at the different stages of the research.

Stage of research	Verification measure
Data collection	Firsthand data collection Trustworthy interviewer Favorable setting Time alone with interviewee
Data preparation	Feedback from interviewees (review of transcripts)
Data reduction - coding	Second coder
Data display - mapping	Second mapper
Drawing conclusions	Replication across different analysis stages Feedback from interviewees

Table 4: Verification measures used in the research

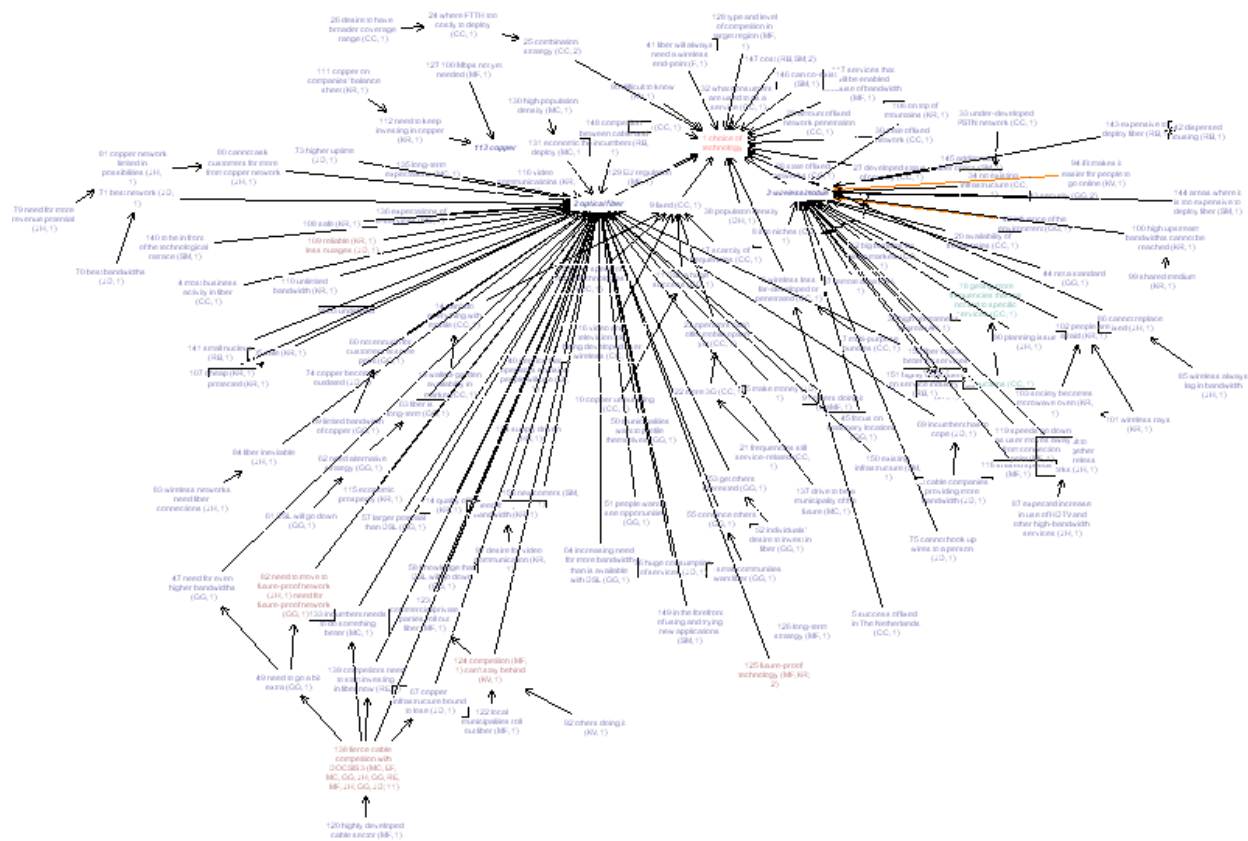# Appendix VIII: Example of a cognitive map

Figure 6: A cognitive map before analysis

References

Bazeley, P. (2007) **Qualitative data analysis with NVivo**, London, Sage Publications.

Brightman, J.R. (200ri2) **An introduction to Decision Explorer: Decision Explorer workbook 1**, Banxia Software Ltd.

Creswell, J.W. (1998) **Qualitative inquiry and research design: Choosing among five traditions**, Thousand Oaks, CA, Sage Publications.

Cybernos (2009) **Qualitative research analysis: Grounded theory & NVivo 7** [online] cited (11 September 2009) Available from <http://www.cybernos.com/UOP/Qual.htm>

Miles, M.B. and Huberman, A.M. (1994) **Qualitative data analysis: An expanded sourcebook**, USA, Sage Publications.

Richards, L. (2005) **Handling qualitative data: A practical guide**, London, Sage Publications.

Rossman, G.B. and Rallis, S.F. (1998) **Learning in the field: an introduction to qualitative research**, Thousand Oaks, CA, Sage Publications.