Chapter 1

Introduction

FPLMTS (future public land mobile telecommunications systems) are the future of mobile telecommunications beyond the year 2000. They are a third generation of mobile systems, currently being developed whilst the second generation of mobile systems is still being rolled out. In fact, most mobile communications in the world today still use first generation systems that were developed and built over ten years ago and still offer competitive services. Upgrading to second generation systems was prompted by increased congestion resulting from the success of first generation systems and the tremendous number of customers that they attracted. Even today the proportion of people choosing to use mobile communications is still a small percentage of people using telephones. The popularity of cellular phones and cordless phones with their owners shows a desire in most people for this kind of freedom to move whilst talking but the cost of this freedom prevents more people from going mobile. Second generation cellular will allow more people to use mobile networks but the need for more mobile radio spectrum and for more imaginative use of it to provide services to customers was recognised in 1992 when WARC '92 allocated 230MHz of spectrum to FPLMTS world-wide.

Since 1992, the developers of the first and second generation systems have learnt from experience and expanded the range of services they offer and improved their quality. This constant evolution of highly profitable first generation systems has made the jump to investing in new infrastructure for second generation systems difficult to make at the right time. It has also raised questions about the need for a distinctive third generation of systems when second generation systems are expected to evolve long into the next century.

1.1. Outline of Thesis

This thesis describes what customers and operators have to gain from FPLMTS, drawing from people's experiences with first and second generation systems. It describes roles for satellites in FPLMTS and the kinds of satellite technology that will be in use at the roll-out of FPLMTS. It describes what could be the core of FPLMTS, a network architecture developed in Europe to be open to different FPLMTS from all over the world. UMTS (universal mobile telecommunications system) is the name of Europe's third generation mobile system, designed to be one of the FPLMTS. The way in which

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its network architecture is described in functional terms will help migrate second generation mobile systems into FPLMTS to join the numerous different networks that are FPLMTS.

This thesis mentions remarkably little about the air interfaces of first, second or third generation systems except to note that no one air interface is ideally suited to all radio environments. FPLMTS will be made up of many different networks competing for custom and using a number of different standardized air interfaces. Accepting this, it will be the standardized network architecture and the capabilities for inter-working between FPLMTS networks that will be their distinctive feature. The benefits from this will be service providers' abilities to provide services across all FPLMTS networks in a uniform way, allowing their customers freedom to roam to any FPLMTS network and still maintain their own personal communications service. It will also reduce the complexity of roaming between networks, allowing service providers more flexibility to use many different networks to provide services to customers in different places.

Throughout the thesis the description of FPLMTS concentrates on their satellite components. There is a chapter on channel assignment that faces some unique complexities in certain satellite systems, complementing the discussion of the decisions made when the UMTS network architecture was developed for satellites.

Finally there is discussion about the range of services and the grades of those services offered in different places by FPLMTS. The interfacing of customer's applications to FPLMTS' communications services is addressed, highlighting a need for more concentration of effort in this area.

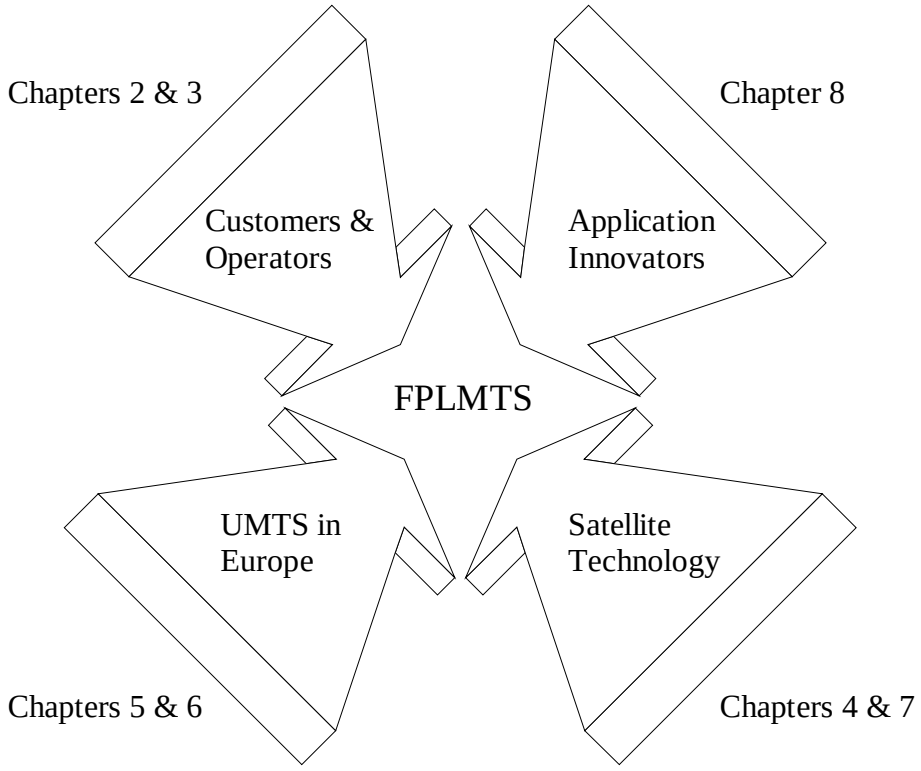

Figure 1 Aspects of FPLMTS covered in this thesis

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This outline of the thesis is depicted in figure 1. Chapter 2 concentrates on customers' and operators' requirements to make a third generation of mobile communications worthwhile so soon after roll-out of the second generation. Chapter 3 makes clear what the role of satellite access to FPLMTS could be and exactly why it is worthwhile designing the core of FPLMTS, the network architecture, with satellite compatibility in mind. Chapter 4 illustrates the kinds of satellite technology that FPLMTS will support and chapter 5 presents and justifies the UMTS network architecture that is capable of supporting this technology. Chapter 6 illustrates the way in which the UMTS network architecture handles terminal and satellite motion both during calls and when the terminal is idle. Chapter 7 goes into the detail of channel assignment mechanisms that can be used in satellite FPLMTS. Chapter 8 describes the interface between customer's applications and a FPLMTS network, highlighting the need for a set of standard facilities which application designers can use to make best use of FPLMTS. Finally, chapter 9 concludes and suggests the future of the work in this thesis and areas of concern that require more attention.

1.2. Original Achievements

The descriptions of FPLMTS (chapter 2) and the role satellites have in FPLMTS access networks (chapter 3) introduce the subject from an original viewpoint that leads directly to the requirements on FPLMTS which are met by the work in later chapters. Chapters 5, 6, 7 and 8 contain the original achievements of this PhD thesis.

Chapters 5 and 6 describe the satellite aspects of the EU Race Monet project, Europe's first attempt to define a network architecture capable of achieving FPLMTS' objectives using satellite, cellular and cordless radio. The overall direction of this work, the promotion of the FES (fixed Earth station) as a network node guaranteeing fixed geographic coverage and the responsibility for the definition of location update and paging facilities in the satellite domain are the original work of the author and are key to the integration of satellites into UMTS. The author has also been responsible for the standardization of these facilities in ETSI SMG5 and will continue this throughout 1996 in SES where the relevant network standards for satellite UMTS will be written.

The definition of the FES as the fixed reference point in satellite UMTS networks (section 5.4) is new to the work of this thesis and the defence of this proposition is detailed in depth in this thesis. This includes simulation of the areas which FESs can guarantee to serve given all the constraints of the UMTS network architecture on a satellite system.

The advantages gained from defining the FES in this way are explored further in chapter 7 on channel assignment in a satellite system. This work includes original simulations of DCA (dynamic channel assignment) in satellite networks. Whilst DCA techniques have been considered since the late 1980s their application in a non-geostationary satellite network, with the emphasis on handover performance, had not been studied before this work.

The European Commission is emphasising that UMTS is not a replacement for GSM but a broadband multi-media system to complement terrestrial broadband access with mobile access to B-ISDN. There is much hype about how mobile communications,

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including mobile satellite, must be able to match terrestrial facilities otherwise nobody will want to use them. Chapter 8 takes a pragmatic look at how multi-media applications, with the help of the UMTS network, can work with the physical limitations of mobile networks to provide the best possible performance from the application at a price which customers will be prepared to pay. This is the author's current area of work.

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