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CROSS-LAYER METHODS
AND STANDARDIZATION ISSUES

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10.1 Introduction

This Chapter describes a number of different techniques, approaches and
architectures for cross-layer design. It also seeks to position the work presented
throughout this book with respect to current and anticipated standards,
indicating opportunities for future standardization.

The challenge to be faced is the design of cross-layer mechanisms that
can optimize the overall end-to-end application performance over satellite
links, while minimizing the utilized radio resources. This optimization can also
require additional signaling between the protocol layers. This new area of work
is consistent with the end-to-end argument \([1]\), provided that system-level
implications are understood \([2]\). Suitable methods are expected to improve
significantly the performance of applications in the next generation of satellite systems, but will require changes to the design of protocols and systems, with implications on the related standards. The discussion in this Chapter utilizes some basic ideas introduced in the previous Chapters 1 and 4.

10.2 Cross-layer design and Internet protocol stack

The current Internet protocol stack in Chapter 4 is used as the reference architecture for discussion of cross-layer design throughout this Chapter. Design principles categorize and define the placement and operation of functions within a given system. These design principles impose a structure on the design area, rather than solving a particular design difficulty. This structure provides a basis for discussion and analysis of trade-offs, and suggests a strong rationale to justify design choices.

The various standardization bodies define protocols that may be used by a system to exchange information typically specifying a protocol at a single layer of the system architecture. A cross-layer design goes beyond this structure in two ways: by increasing the awareness between layers or by implicitly conveying information between layers.

- The first case usually entails an exchange of information between protocols to enable them to work jointly towards a specific goal.
- The second case requires a redesign of the system architecture. This redesign allows layers to exchange implicitly information by, for example, mapping the functionality of one layer into a queue of an adjacent layer, without the need for cross-layer signaling. There is no actual exchange of information between layers: the traffic passing through a queue provides sufficient in-band information for the cross-layer method.

There are many mechanisms that display these properties and which have already been standardized, although these were not considered cross-layer approaches, since the term was not then defined. One possible example of cross-layer design is Random Early Detection (RED) that was initially proposed in 1993 [3]. The on-going standardization of cross-layer design will allow a better understanding of current schemes and “cleaner” approaches for future systems.

10.3 Cross-layer methodologies for satellite systems

The following sub-Sections provide a classification of cross-layer methodologies, based on a review of current literature and the work that has been presented in the previous Chapters.