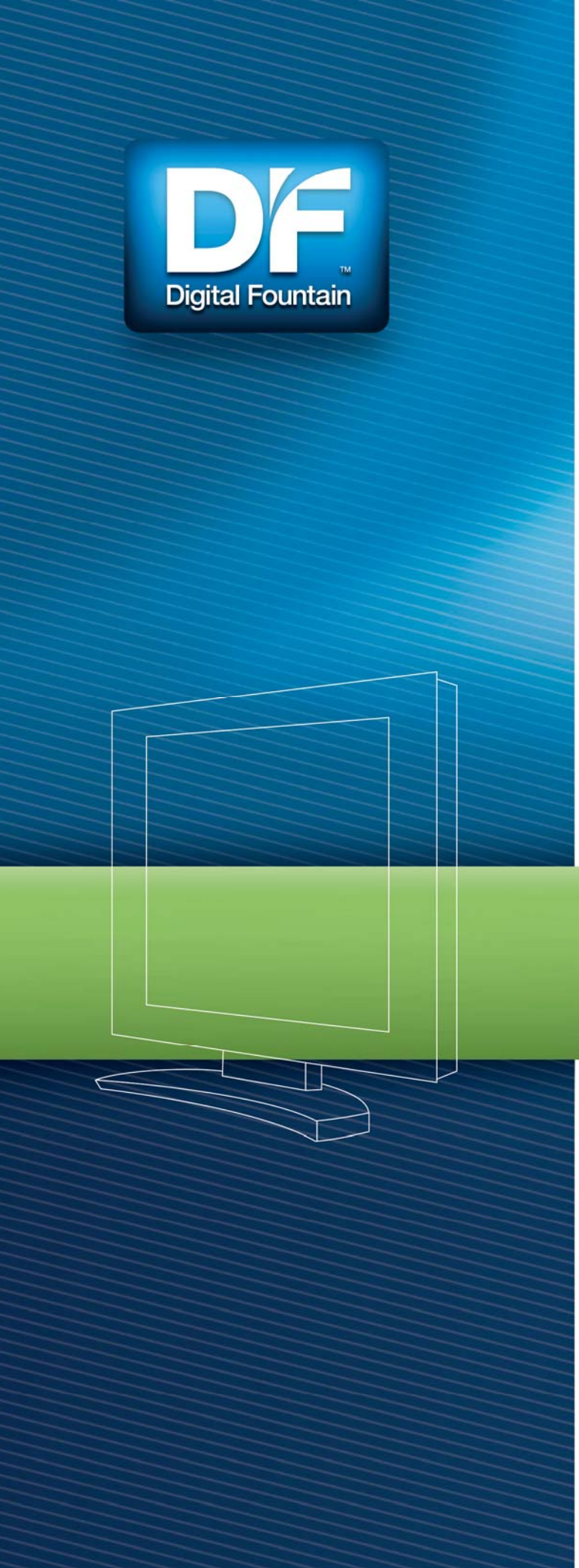


Layering and Backwards Compatibility for Packet Loss – A New Approach for Addressing IPTV QoS

Dr. Michael G. Luby
Jerry W. Miller

September 12, 2007

Introduction

One of the greatest challenges facing telco operators wanting to offer IPTV services is providing sufficient quality of experience (QoE) to the customer. A major source of customer complaints from existing IPTV deployments is visible video artifacts, which are typically caused by packet loss. But operators struggle with how to effectively and efficiently deploy a solution for the packet loss problem.

Most IPTV QoE solutions, whether hardware-based retransmission solutions or Application Layer Forward Error Correction (AL FEC)have historically taken an all-or-nothing approach, i.e., they require all customer set top boxes (STBs) to support a new or revised protocol in order to roll-out the solution. This can be a significant deployment burden when trying to introduce a QoE upgrade into a deployed IPTV network especially if the operator chooses to deploy the solution on a phased basis. While AL-FEC solutions are more scalable and less costly than hardware retransmission systems a criticism has been that while the packet loss problem tends to be localized within a customer base affecting some parts more than others, AL-FEC solutions have historically provided only one level of protection that must be applied across the entire network.

This paper outlines forthcoming new capabilities in Digital Fountain's advanced AL-FEC solution, ToughStream™. The new ToughStream will allow operators to address their quality issues in a scalable strategic manner while eliminating the historical one-size-fits-all problem of previous AL-FEC solutions. This paper will discuss the concerns of operators when deploying AL-FEC and how these can be addressed by the enhanced ToughStream architecture.

Background – Requirements to be Addressed

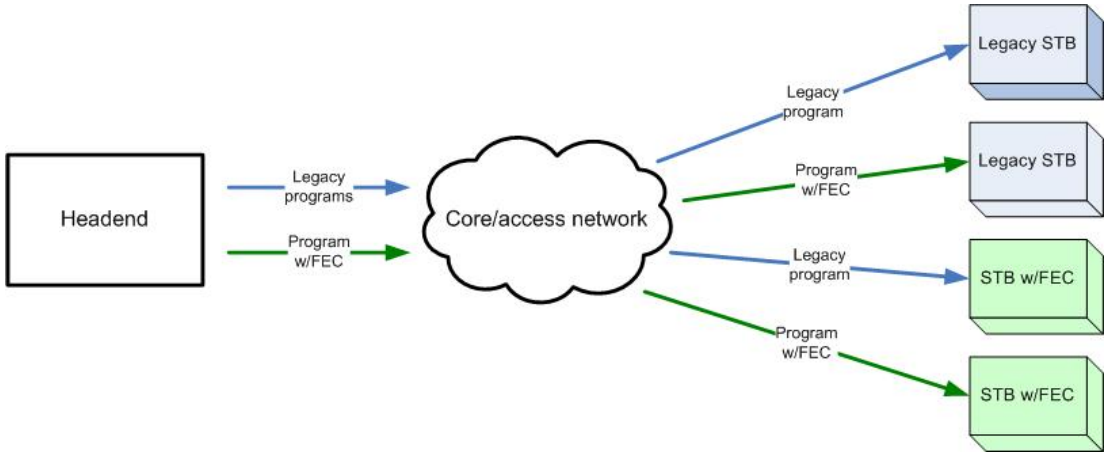
AL-FEC provides a means to recover from data loss occurring during transmission by adding *repair data* at the point of content generation or aggregation, typically the head-end or SHE/VHO (Super Head End/Video Hub Office). AL-FEC is an end-to-end solution meaning that the solution must be implemented not only at the head-end, but also in the STBs. However, this has produced the following issues for operators wishing to deploy AL-FEC:

- Every STB must support the AL-FEC functions (backwards-compatibility requirement) which can be very difficult if an operator has multiple STB vendors or models on his network
- Either every STB gets the repair data or none does)—preventing phased rollouts (phased rollout requirement)
- Every STB gets the same amount of repair data, which is undesirable for heterogeneous networks where different areas of the network suffer from different levels of loss (multiple protection levels requirement)

Backwards-Compatibility Requirement

In a phased deployment, one will need to accommodate a mix of FEC and non-FEC streams and set-top-boxes. Therefore, the are two backwards compatibility issues:

- STBs with legacy (non-upgraded) firmware, must still be able to play program streams that may now include FEC.
- Upgraded STBs supporting FEC must be able to play streams with and without FEC.



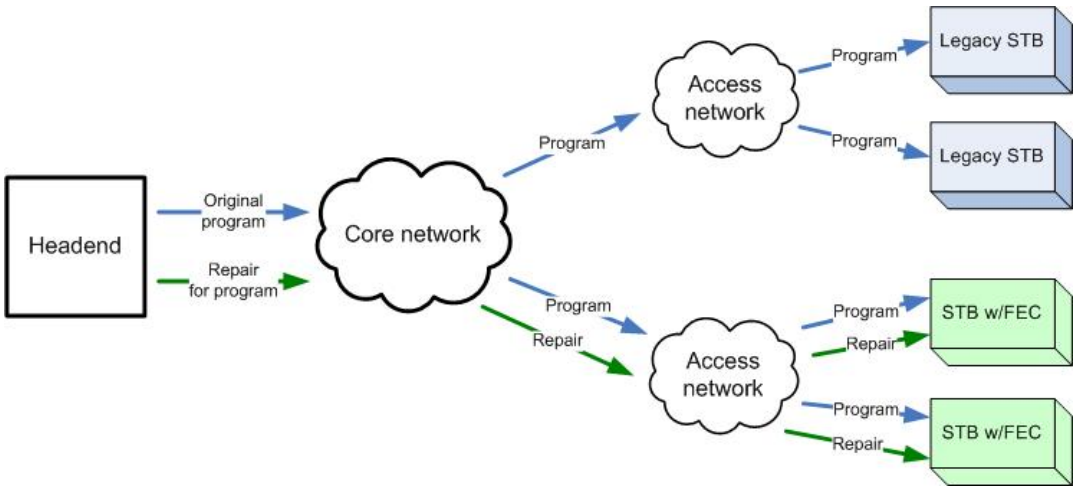
STB scenarios for backwards-compatibility.

The enhanced DF ToughStream architecture will address these requirements in three ways:

1. Streams with FEC are generated in such a manner that repair data does not alter existing program streams and therefore non-upgraded STBs are unaffected by FEC
2. The addition of FEC data does not impact video timing or any buffers
3. The FEC client in the upgraded STB's supports both legacy and FEC'ed streams

Phased Rollout Requirement

Operators with existing services often choose to roll out solutions in logical or geographic phases to better manage any upgrade deployment issues that may arise. The DF ToughStream architecture will allow operators to roll out FEC to different parts of the network while keeping the remaining network on the legacy streams as shown below.

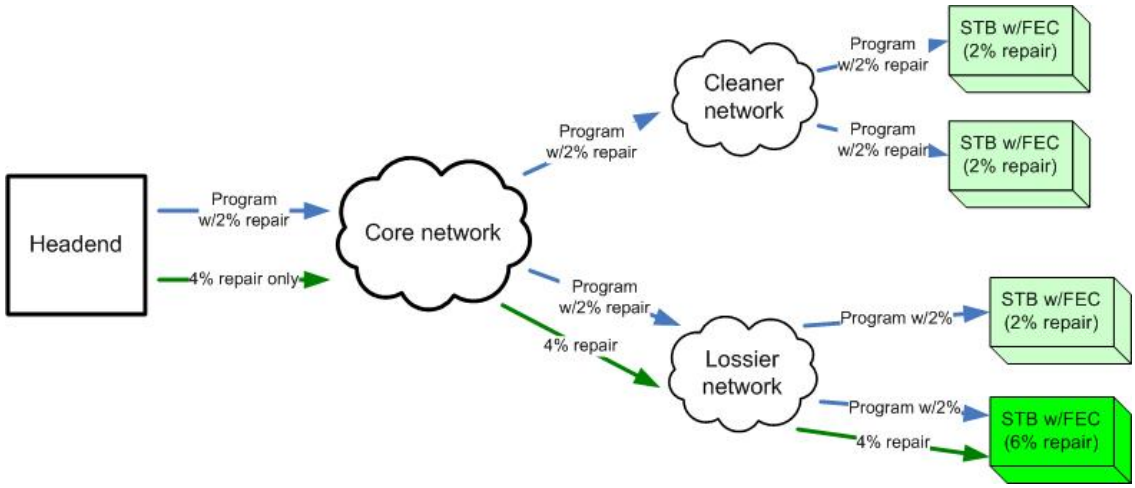


STB scenarios for phased rollout.

Multiple Protection Levels Requirement

Many operators, due to acquisitions, new equipment rollouts, or legacy infrastructure, have heterogeneous networks with different quality and packet loss profiles. Historically, FEC has required a lowest-common-denominator approach whereby the worst-case port drives the amount of repair sent to all STBs. This is a sub-optimal approach when only a small fraction of customers need this amount of protection.

The DF ToughStream architecture, on the other hand, will enable multiple layers of repair to be available on a per-network or even a per-STB level as shown below.



STB scenarios for heterogeneous networks

Summary

FEC is a powerful means to protect against packet loss in a telco network. Historically it had many limitations for real-life deployments making it a significant challenge for operators to deploy. The enhanced DF ToughStream architecture offers telco operators the ability to provide for backwards compatibility, phased rollouts and multiple protection against packet loss, thus providing a controlled, surgical means to protect against packet loss customized to the actual last-mile conditions.

About Digital Fountain

Digital Fountain software optimizes the delivery of digital media over any network, even in the most challenging environments. The company's proprietary DF Raptor technology redefines the science of forward error correction (FEC) and sets the standard for efficient and reliable transmission of digital media. Digital Fountain solutions and services are used today in advanced mobile broadcast, IPTV, streaming video, file transfer, and national defense applications, and are recognized by leading international standards bodies including DVB, 3GPP and IETF. Partners and customers include leading global companies such as Cisco Systems, Sumitomo Electric Networks, Scientific Atlanta, Northrop Grumman, Pioneer, KDDI, Sirius Satellite Radio, XM Radio, Sony, Nokia, and many more. For more information, please visit www.digitalfountain.com.