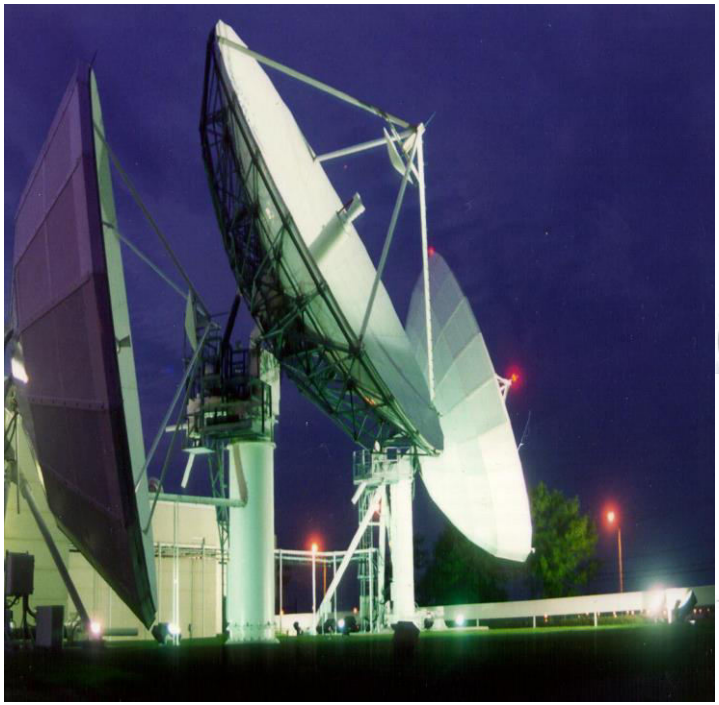
International Conference and Exhibition on Satellite Communication
Houston: Texas, 17th to 19th August 2015

Mitigating the effects of rain-induced fading in Ka-band satellite video broadcast system using Time Diversity in concert with Maximal Ratio Combining



DVB S2

HD TV 4K ULTRA HD

Dr. Leshan Uggalla, Dr Jon Eastment & Prof Ifiok Otung

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Introduction

Steadily increasing user demand for higher capacity satellite links has driven satellite operators to move into the higher frequency bands, such as Ka-band and above, in order to accommodate the necessary data rates.

However, a major issue at these frequencies is the effect of severe rain-induced fading on link reliability, which requires that the system must be designed to implement mitigation techniques in order to achieve an acceptable quality of service.

In this presentation, we analyse and quantify the benefits of adding **Time diversity (TD)** and **Maximal ratio combining (MRC)** to the widely used DVB-S2 standard.

Our results, which are based on combining

a) 3 years of satellite beacon propagation measurements from 2 UK sites

b) High-fidelity computer simulations of the DVB-S2 standard for a typical satellite-broadcast communications link

c) Our new TD / MRC technology, indicate that substantial improvements in data throughput and significant reductions in outage time are readily achievable.

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Demand for Higher Capacity

Higher Frequency = More Bandwidth = Higher Capacity = More Services

4K ULTRA HD

HD TV

- More TV and Radio Channels
- SDTV, HDTV, Ultra HDTV .....
- High speed Internet access
- High bandwidth lease line facilities for business purposes
- Higher Security

WiFi INFLIGHT

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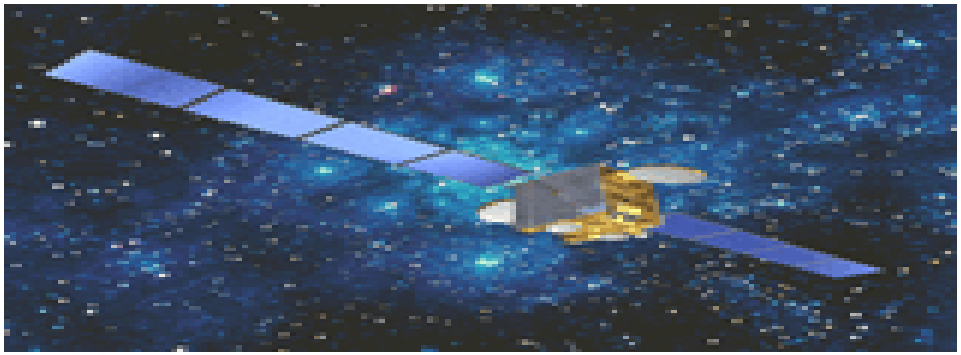
Leading Names in Ka Band Communication

1. Avanti Hylas 2 –October 2012

2. Eutelsat Too- way (KA Sat) –February 2011



3. Inmarsat I-5 –2015

* Intelsat still operating in Ku and C band –October 2012 Intelsat 23

INTELSAT

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The satellite link availability

Intelsat - 99.6 % (Ku-band) of Year
unavailability – 0.4 %
Unavailability - **35.04 Hrs**

Inmarsat - 99.90% (BGAN) of year
unavailability – 0.1 %
Unavailability - **8.76 Hrs**

Sky UK - **Extreme weather** -Gales, snowfall or heavy rain can affect your signal but your viewing should return to normal when the weather improves.

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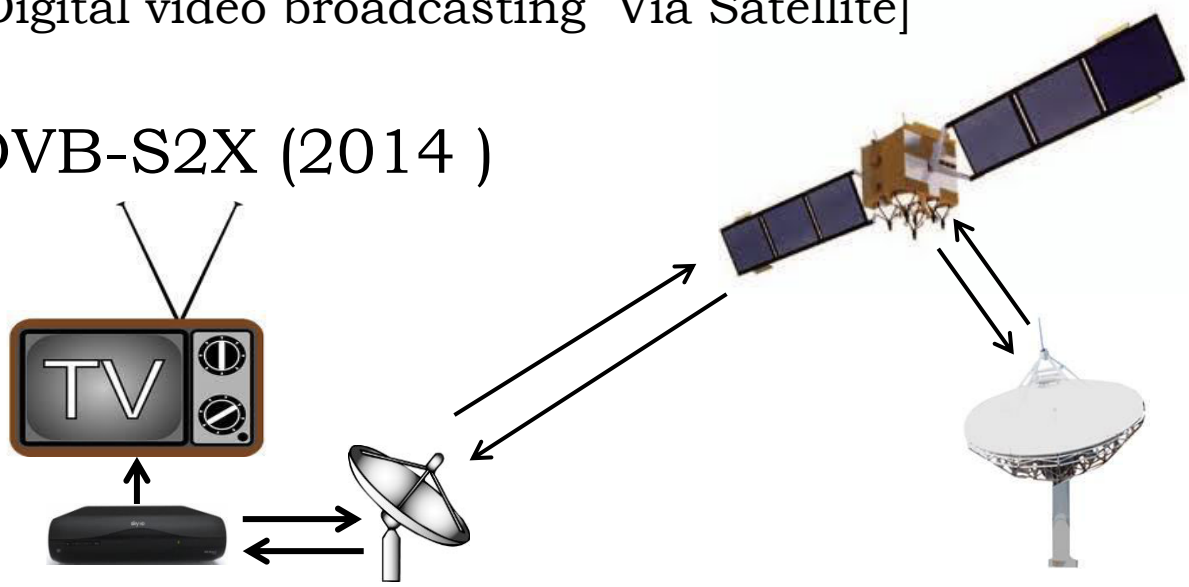
The Latest video broadcast via Satellite ??

DVB-S2 (2003)

[2nd Generation of Digital video broadcasting Via Satellite]

DVB-S2X (2014)



Four modulation modes
1. QPSK
2. 8PSK
3. 16APSK
4. 32APSK

Powerful Forward Error Correction scheme (FEC)- Combination of BCH (Bose-Chaudhuri-Hcquengham) with LDPC (Low Density Parity Check)

Can operate at carrier-to-noise ratios from -2dB with QPSK, through to +16dB using 32APSK.

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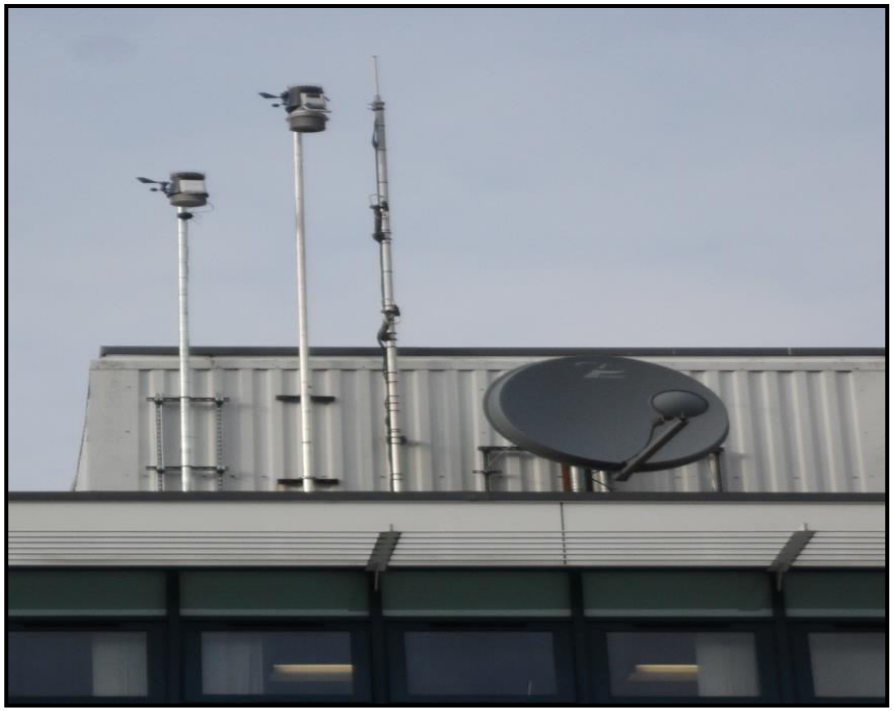
Beacon Satellite Link Experiment - Glamorgan

The Mobile & Satellite Communications Group at **University of South Wales** is operating **Two receiving Earth stations** measuring signals of the beacon carried on **Eutelsat Hot Bird 6** since **May 2010**. Alongside the beacon receivers a variety of meteorological instruments are operating at both sites in order to measure temperature, humidity, pressure, rainfall etc.



Facilities at Pontypridd South Wales

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Beacon Satellite Link Experiment - Chilbolton

Facilities at Chilbolton, Hampshire

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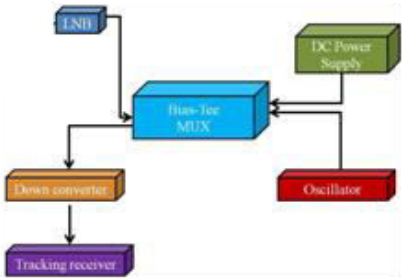
Physical connectivity of the entire system setup

Satellite Dish



Satellite Receiver Setup

Weather station Outdoor Unit (Wireless)

Weather station Indoor Unit (Wireless)

Weather station Outdoor Unit (Wired)

Weather station Indoor Unit (Wired)

Data Logging Server

User Interface

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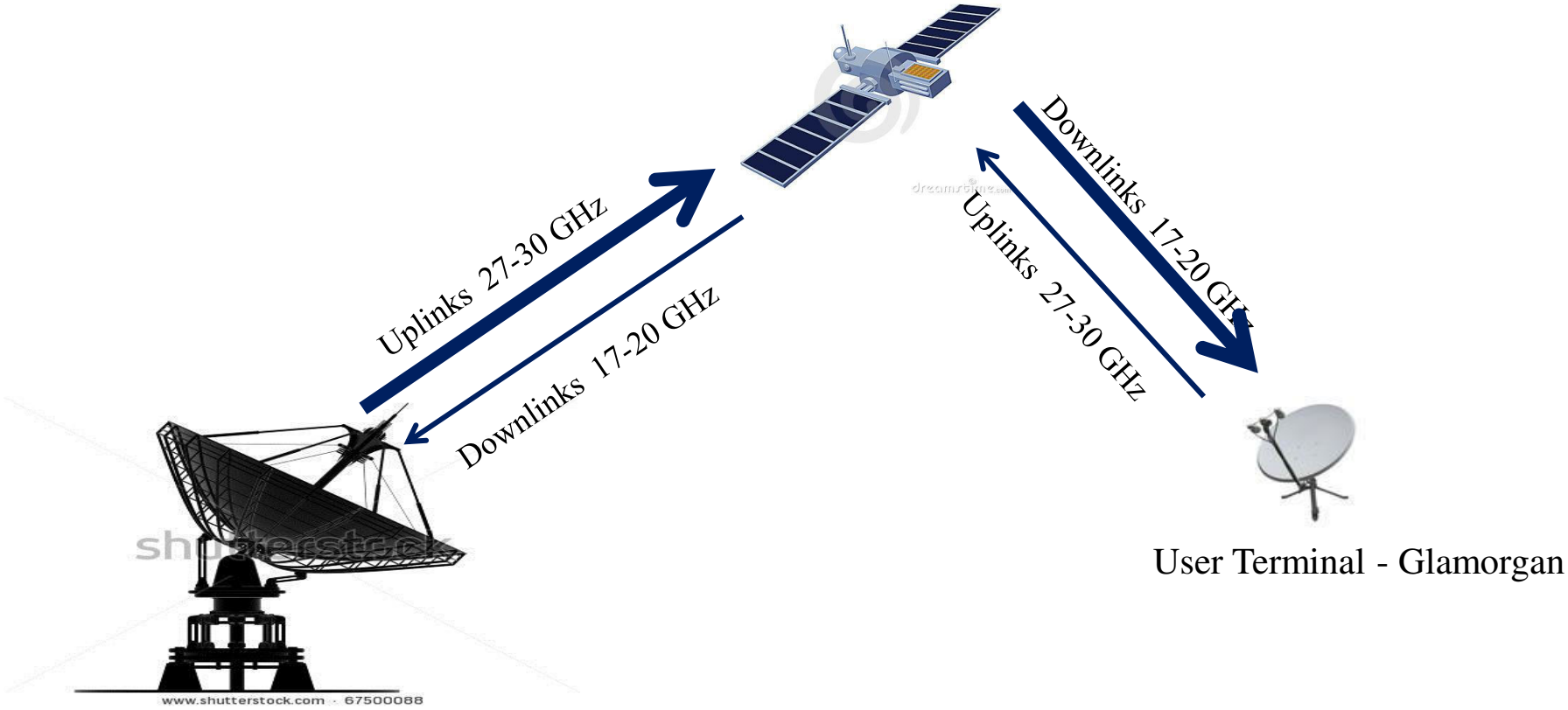
Initial Design of the hypothetical Network Structure



Hub Station - Chilbolton

User Terminal - Glamorgan

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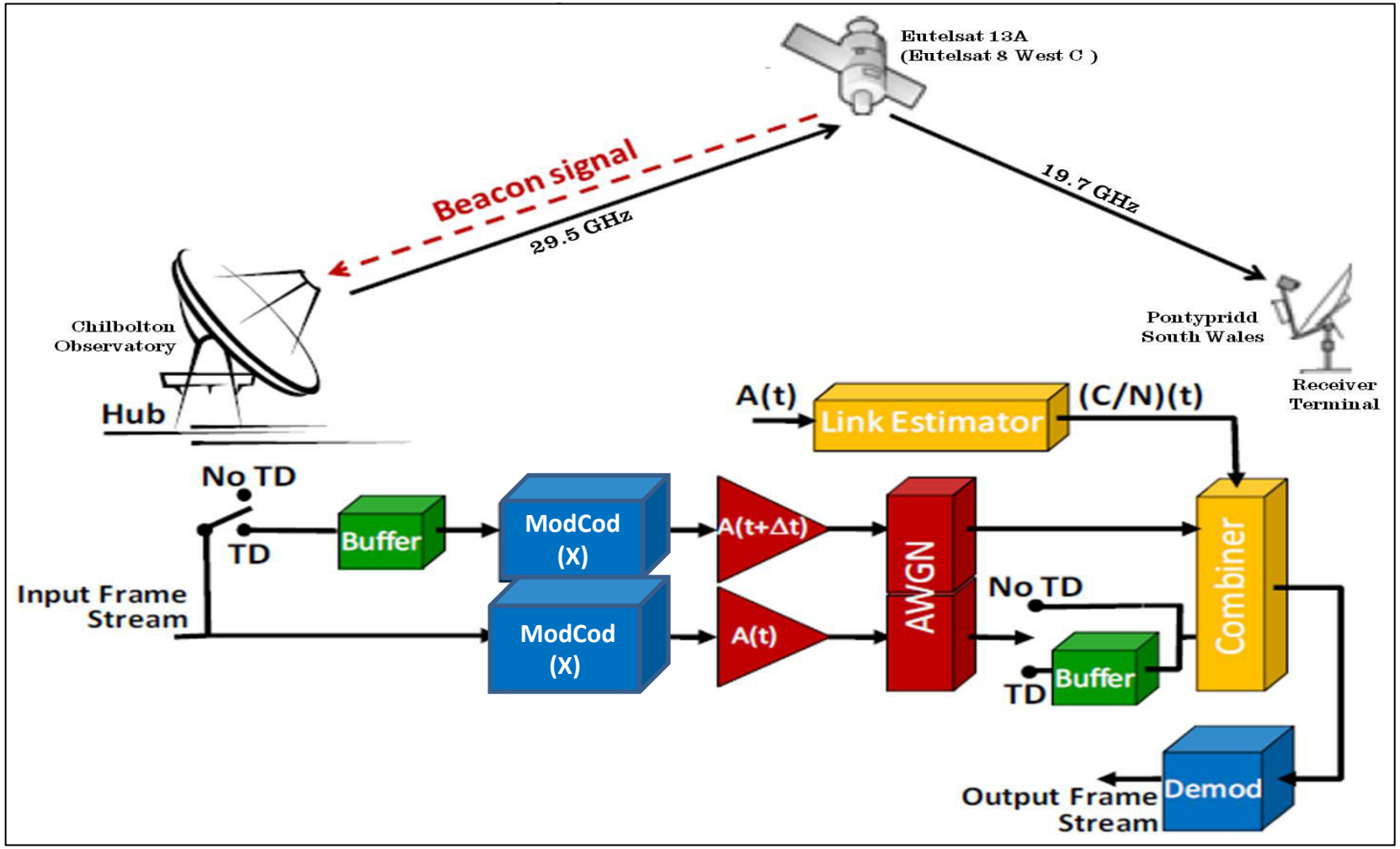
Initial Design of the hypothetical Network



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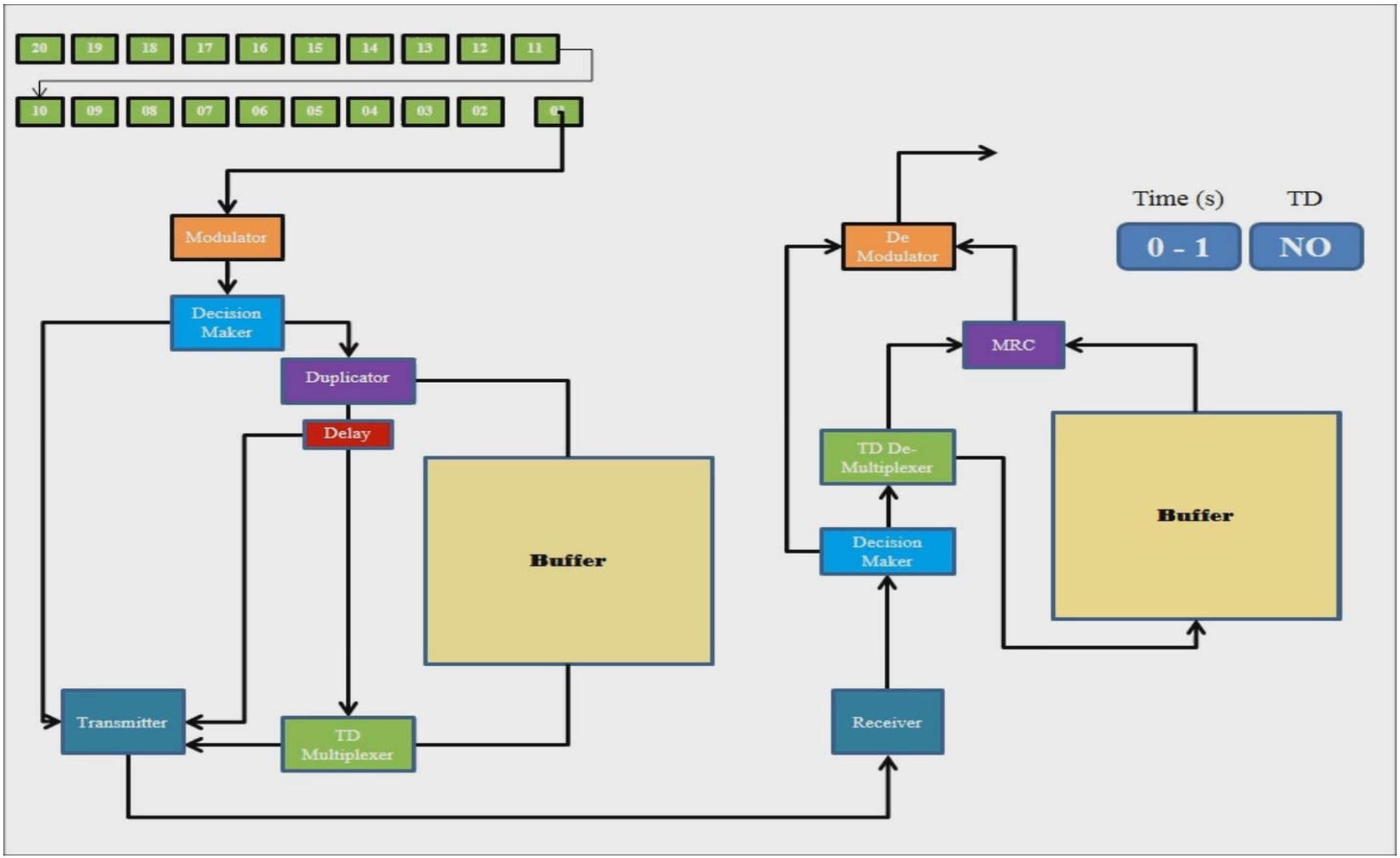
Maximal Ratio Combining Process



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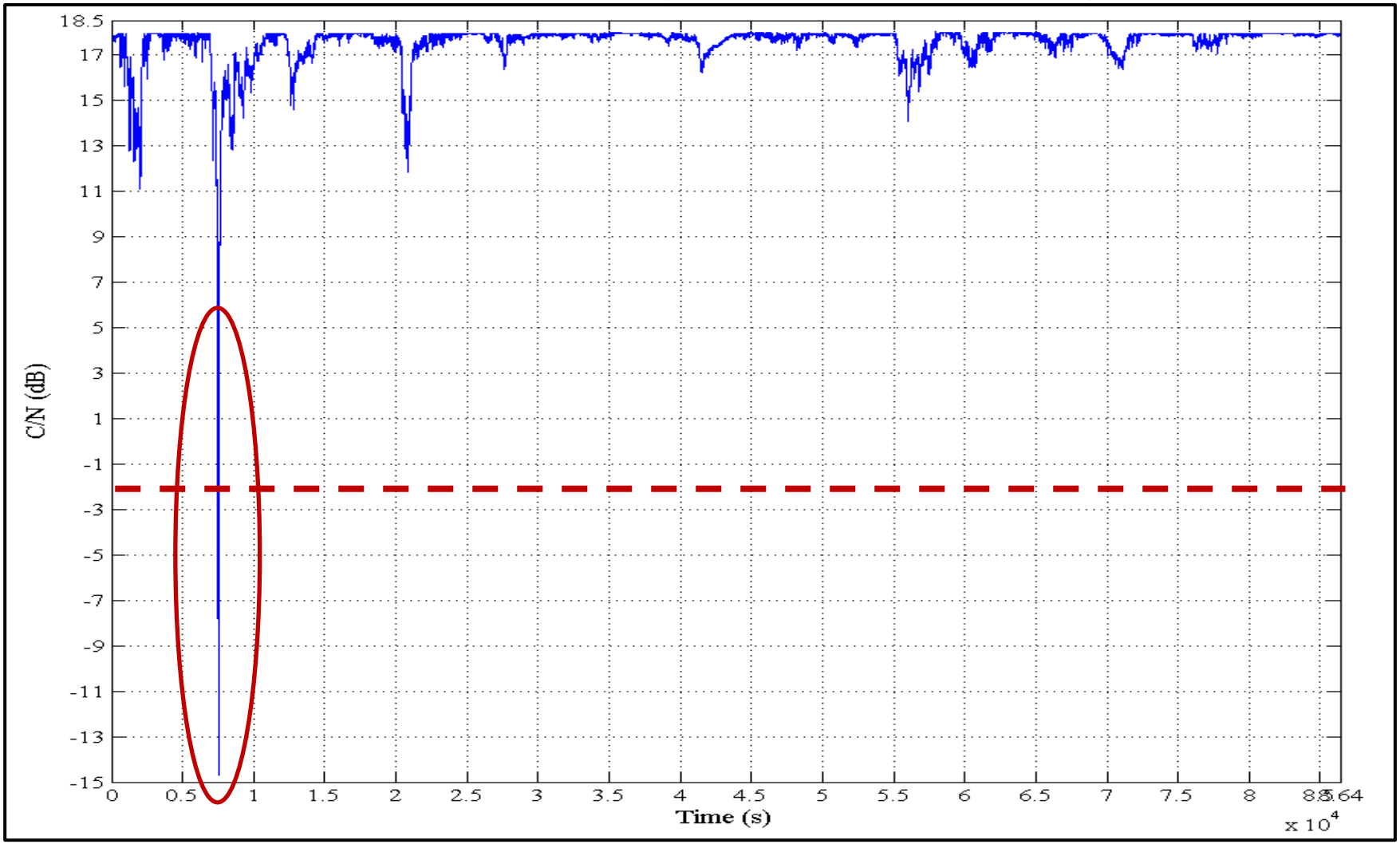
Rain Events (Fading Events)



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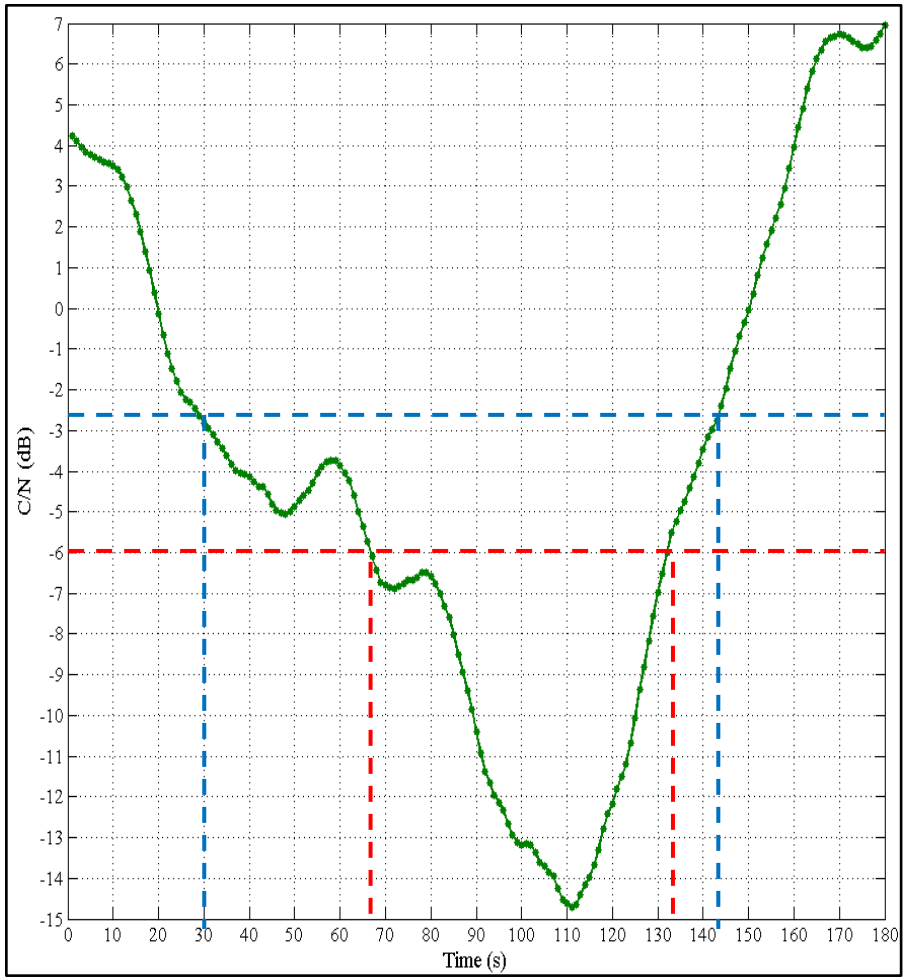
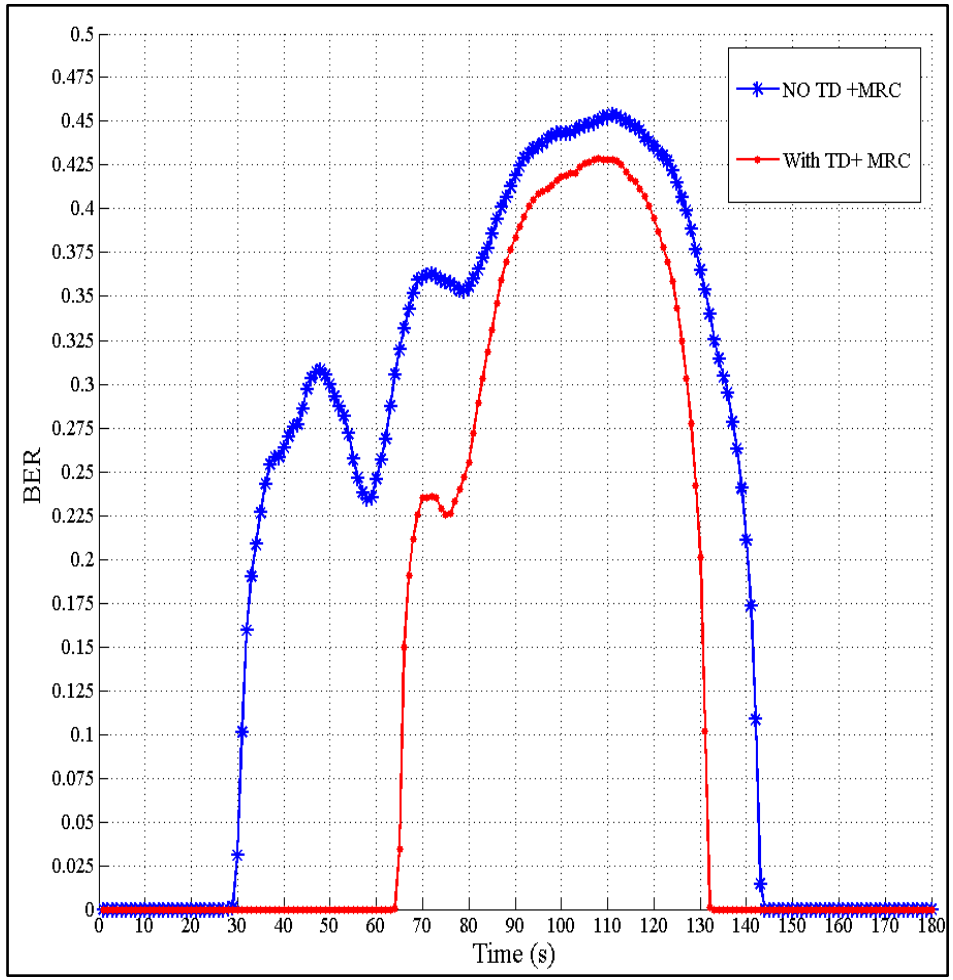
Performance analysis of MRC

on 01th December 2011





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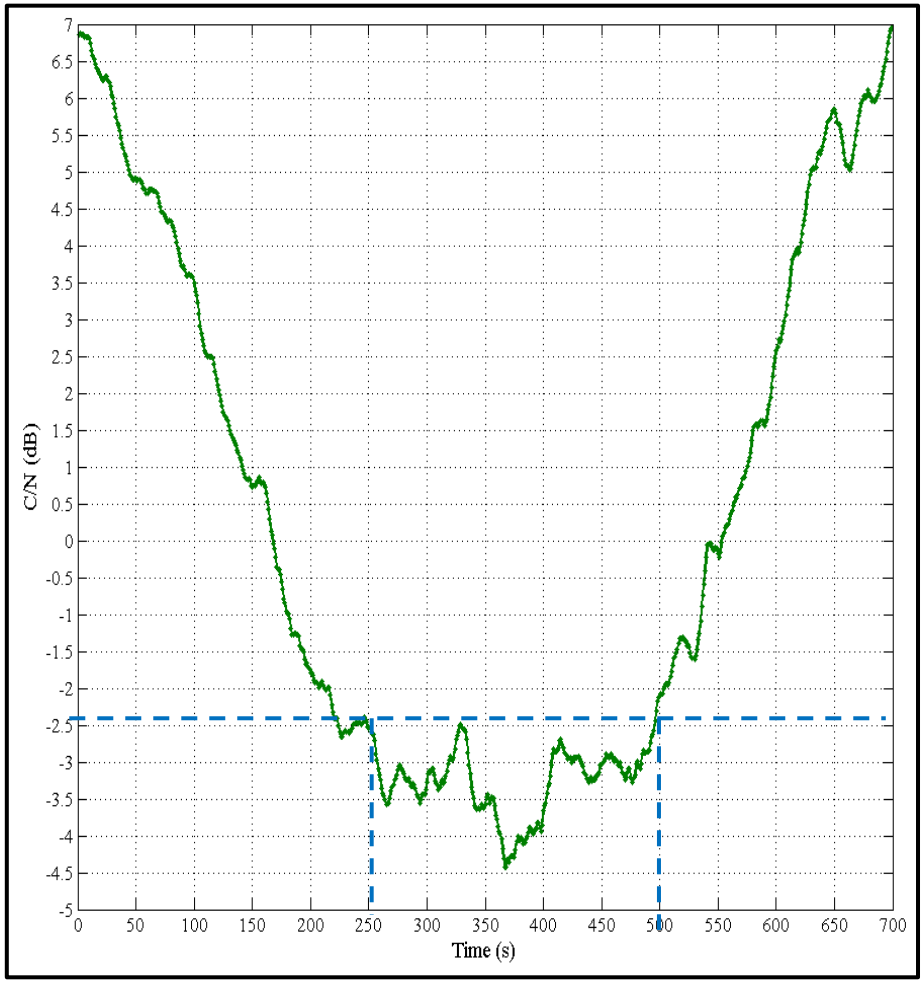
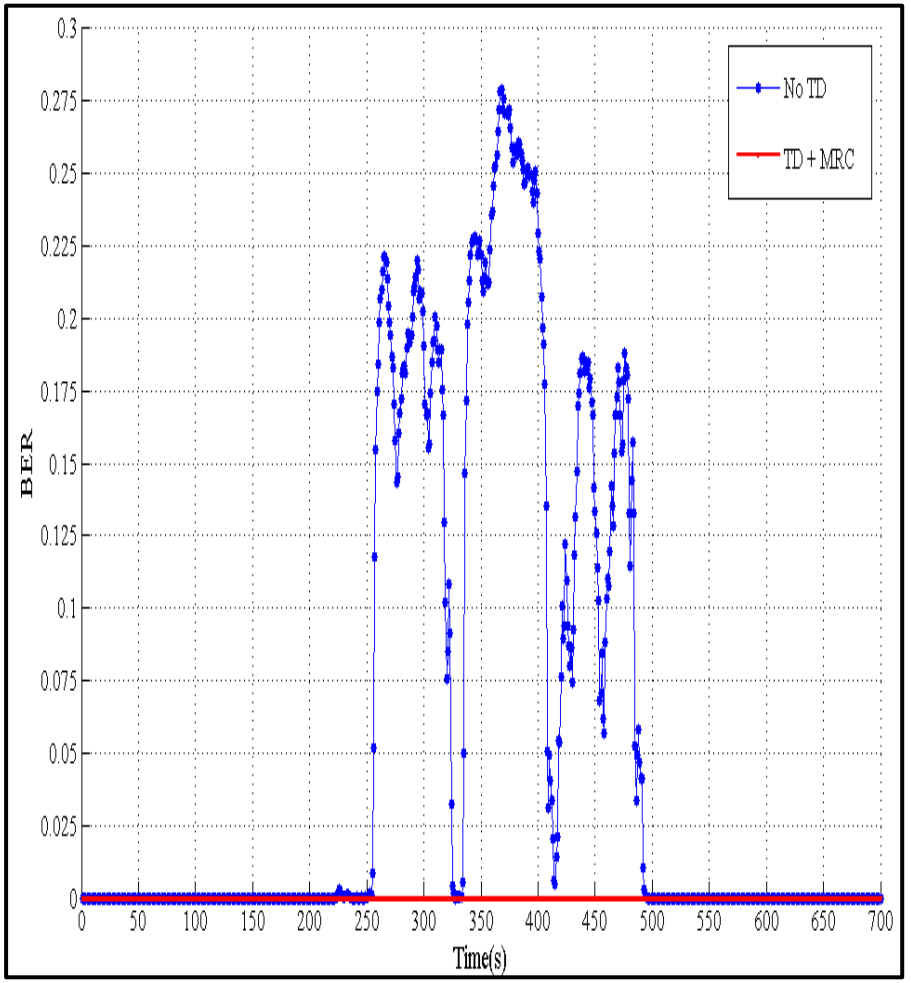
Performance analysis of MRC

on 12th April 2012





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Results and Analysis

Event's Date and Time (GMT) HH:MM:SS	Event Duration s	Outage Duration, s		Reduction in Outage, %
		No TD	TD + MRC	TD + MRC
2011-12-01 01:54:00–01:57:00	180	113	67	40.70 %
2012-04-12 13:30:30-13.42:09	700	260	0	100 %
2012-05-07 18:36:00-21:06:02	2874	2501	778	68.89 %
2011-10-05 18:40:00-19:05:00	1500	886	296	66.59 %
2011-08-06 22:35:00-23:00:00	1500	864	23	97.33 %
2012-05-01 03:11:20-03:23:00	700	498	158	68.27 %

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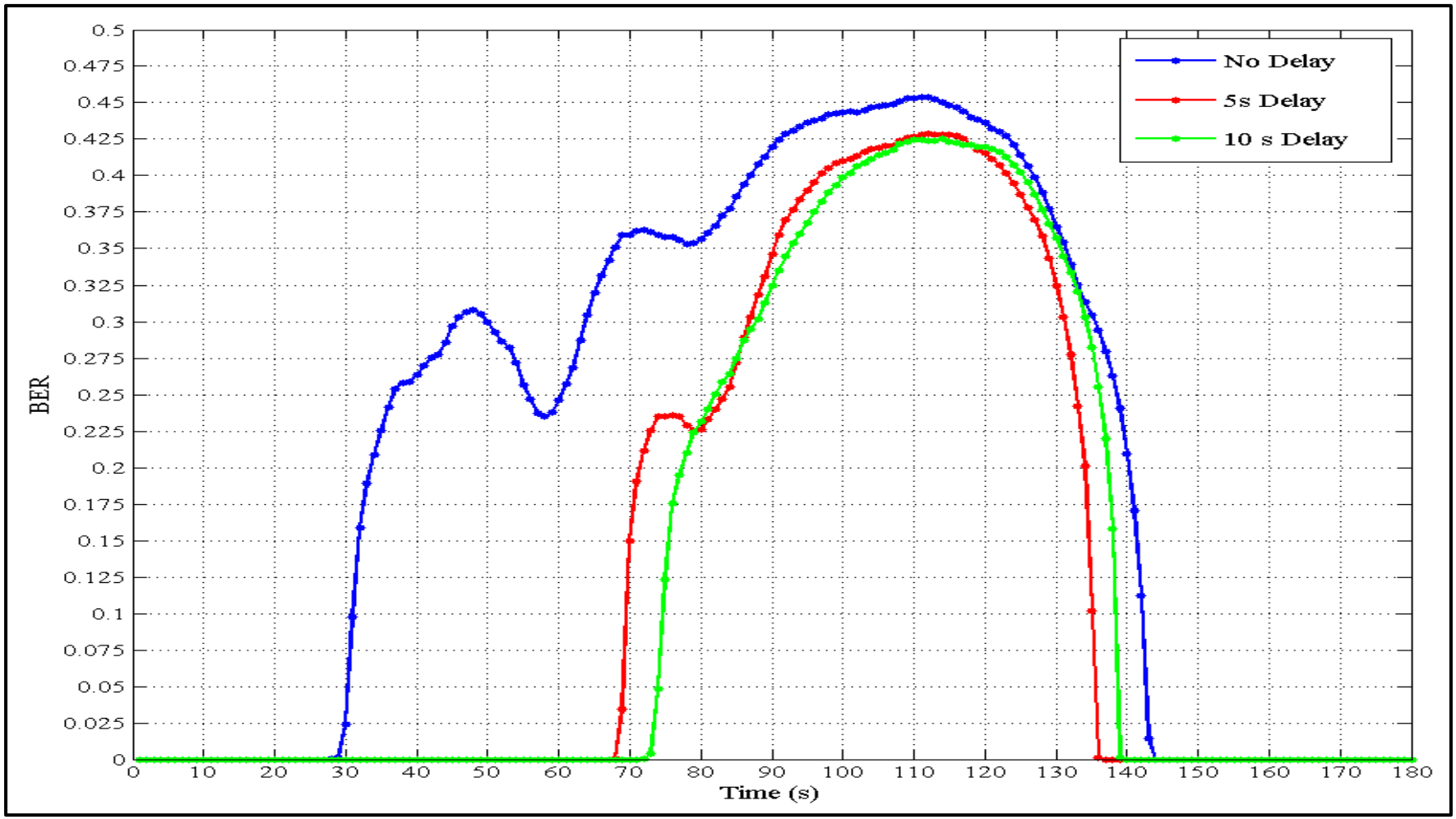
Effect on Different delay durations



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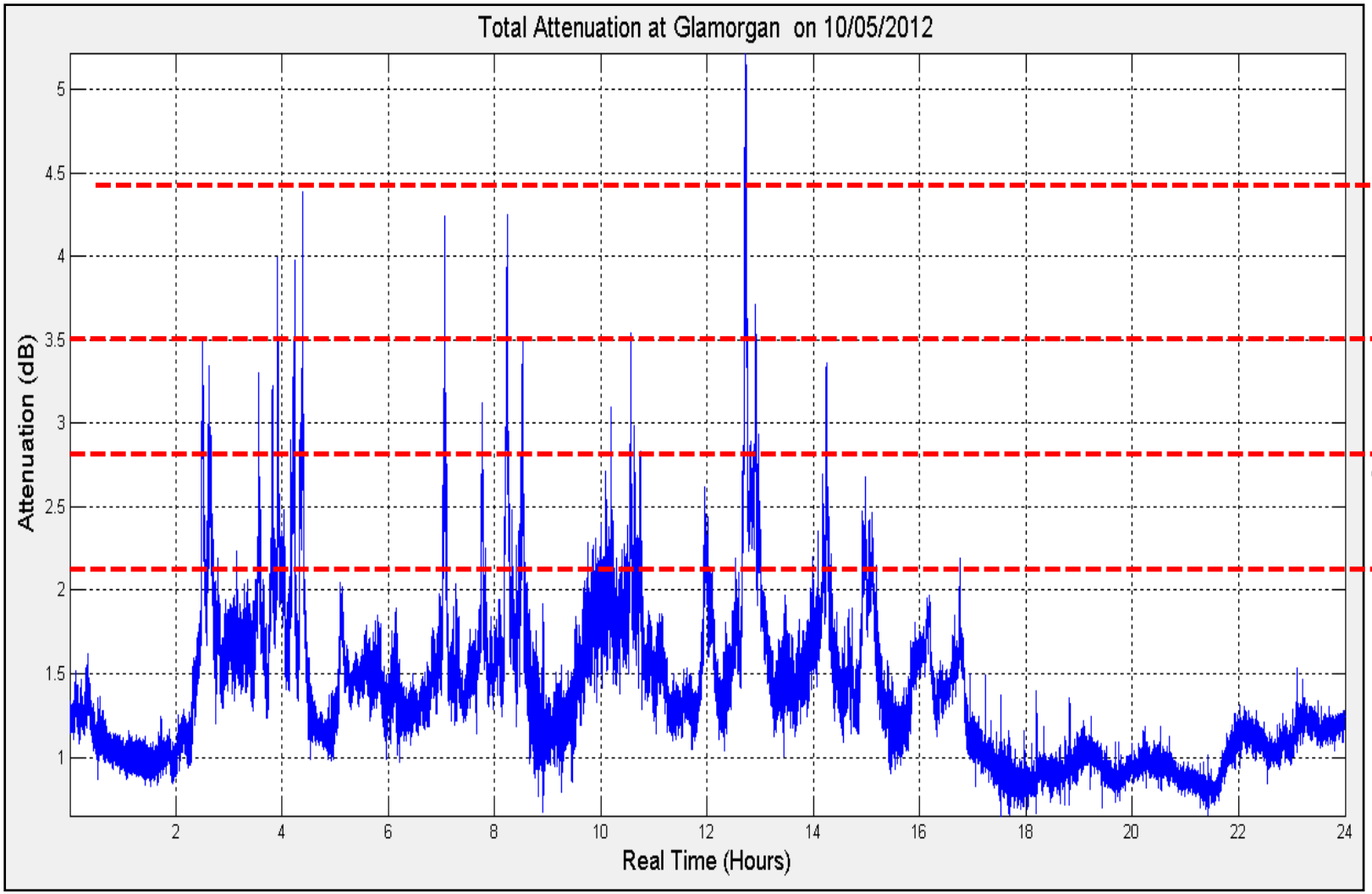
Switching between modulation schemes



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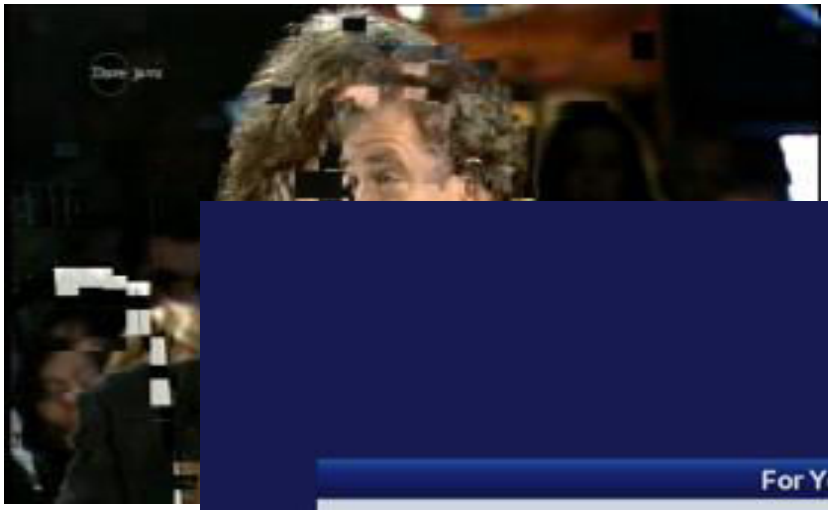
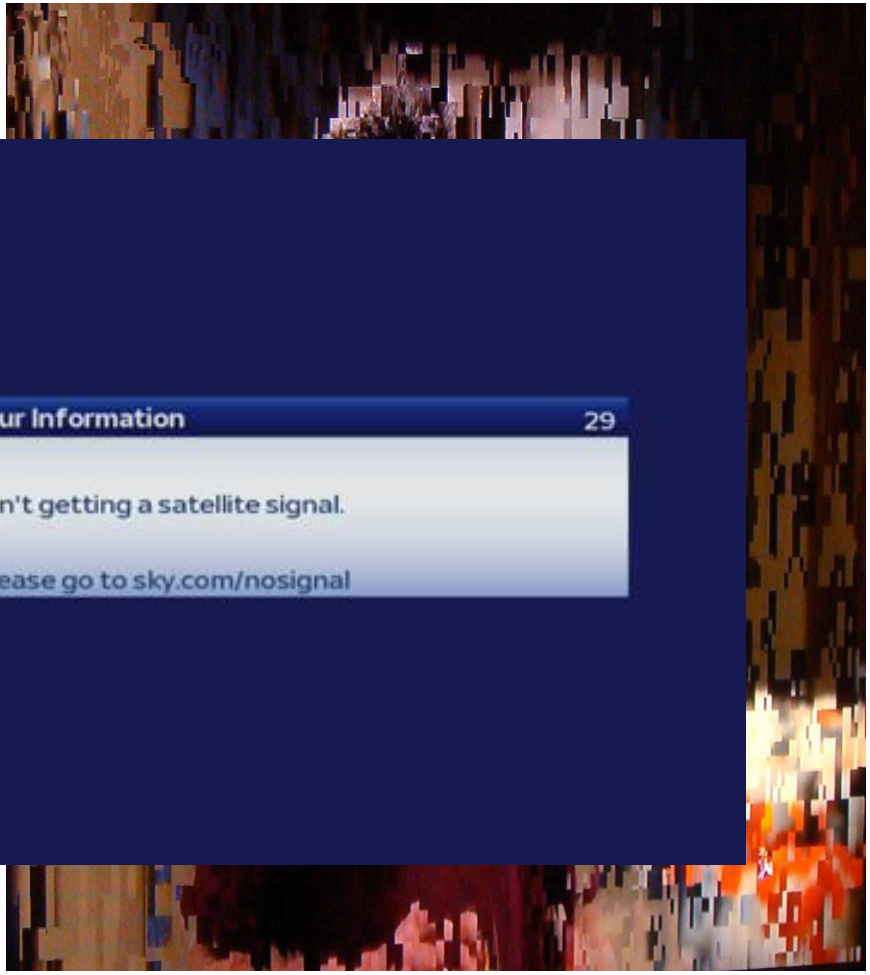
Examples of digital TV pixilation





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The existing broadcasting scenario - DVB-S2

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The proposed broadcasting scenario - DVB-S2TD

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Conclusions

It has been shown that short-delay TD+MRC can deliver significant improvement in link availability during rain fading events.

This technique is suitable for integration into real time applications, e.g. live broadcasting (DVBS2) and live streaming (DVB-DSNG).

Increasing the fixed time delay ΔT employed between duplicated packets in TD+MRC yields only a marginal improvement in performance (such as reduction in BER or link outage), unless very high levels of DT unsuitable for real time applications are chosen.

Finally, the lowest supported C/N level in the latest released DVB-S2X (Normal frames) is -2.45 dB, whereas integration of TD+MRC allows operation at C/N levels down to –6.00 dB.

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Thank you !

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