Could Ash Cloud or Deep-Sea Current Overwhelm the Internet?

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Abstract

In this paper, we are initially set out to evaluate how the ash cloud from the Eyjafjallajöekull volcano impacted the Internet traffic. Based on our path measurement for European websites, we observed significant congestion whose onset seems to coincide with the period of disrupted air traffic. However, after expanding the scope of investigation, the path congestion was in fact caused *indirectly* by a submarine cable fault which received far less attention than the ash-cloud news. The paths under our monitoring were overloaded by taking on additional traffic diverted from the faulty cable.

1 Introduction

The eruption of ashes from the Eyjafjallajöekull volcano in Iceland [1] seriously affected the air traffic to and from the UK and many European countries during 15-23 April. While the media attention was drawn to the impact on air travelers, there were also reports on its cascading effects on the Internet. For example, the traffic from Citrix' GoToMeeting web-conferencing service was doubled in the first week after the airspace was closed [3]. According to Akamai's report, the overall web traffic in the northern Europe was well above normal levels [4]. But France Telecom and Deutsche Telekom did not notice significant increases in mobile network usage [4].

In this paper, we are initially set out to measure the impact of the ash cloud on the Internet performance. Measuring the actual impact is very difficult, because there is a lack of effective monitoring infrastructure. Assessing relevant information and statistics from various network service providers is also a formidable task, as they are usually considered business secrets. The BGP routing information is not suitable, because the route for a congested path may still remain stable. The flow-based monitoring, on the other hand, cannot be used to measure arbitrary paths.

2 Unplanned measurement

As part of our ongoing network measurement project, we have been monitoring Internet paths using OneProbe [6] and Tcptraceroute. Each of the eight measurement probers at Hong Kong, referred to as UA, ..., UH, measures eight websites located in the UK and Europe: four of them are commercial sites and the other four academic sites. OneProbe measures each of the 64 paths continuously for one minute and then repeats the measurement after idling for nine minutes.

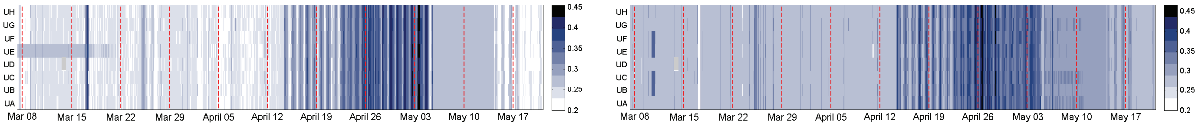
2.1 The overall results

We first summarize the overall measurement using heatmap time series for the period of 8 March–21 May 2010. We divide the measurement period into one-hour bins and calculate the median value for each bin for the six samples obtained during the hour. After computing the bin values, we divide the range from 0 to the maximum value into nine levels linearly and assign each level with a different gray level. A darker color refers to a higher value for the metric.

Figure 1 shows the time series for paths to two commercial sites in the UK and Finland, referred to as ENG and NOK, respectively. The RTTs surged on around 14 April for both paths and lasted till 3 May. The forward-path (FW) losses became very significant also around 14 April, but before that the paths did not see significant loss rates. The patterns for the reverse-path (RW) losses, however, are very different. There were heavy losses during 23-28 April for both paths. It is not difficult to see that the two paths suffered from RTT surge and heavy losses around the same time. Unlike the ENG and NOK paths, no surges on RTT and loss rates were observed for other paths, and interested readers could find other measurement results from [5].

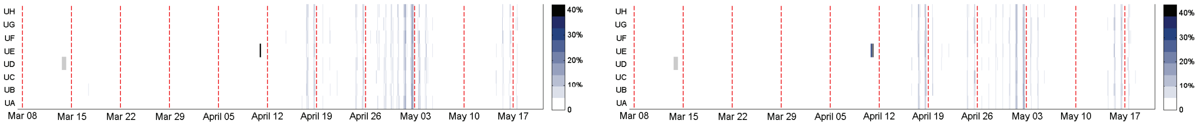
2.2 A root-cause analysis

Since the path performance for both NOK and ENG is similar, we choose only the NOK path for further analy-



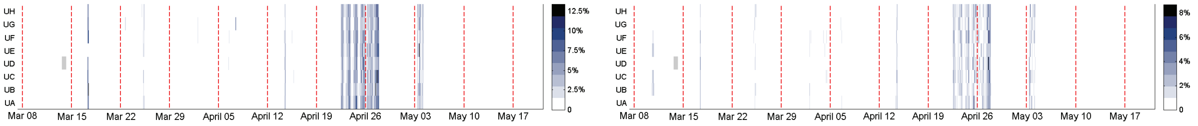
(a) The ENG path's RTT.

(b) The NOK path's RTT.



(c) The ENG path's forward-path loss.

(d) The NOK path's forward-path loss.



(e) The ENG path's reverse-path loss.

(f) The NOK path's reverse-path loss.

Figure 1: Heat-map time series for the ENG path's and NOK path's RTTs and packet loss rates.

sis. Besides the time series for UB→NOK in Figure 2(a), we also show that for UB→BBC in Figure 2(b), where BBC is another website in the UK. Figure 2(b) shows two loss peaks for UB→BBC starting on 14 April. A traceroute analysis reveals that at the onset of the path congestion observed on around 14 Apr 2010 07:18:00 GMT, the forward paths to ENG, NOK, and BBC went through the same provider FLAG (AS15412). However, on 16 Apr 2010 07:39:00 GMT, the BBC paths changed from FLAG to GLOBEINTERNET (AS6453). After the change, the BBC path saw very stable RTT and insignificant packet losses.

At the first glance, the onset of the path congestion matches quite well with the period of air traffic disruption. However, a careful analysis of their correlation reveals several problems:

1. The onsets of the path congestion and air traffic disruption do not entirely match. A travel warning due to the ash problem was announced on 14 April, but the announcement of shutting down the British airspace was first made in the morning of 15 April.
2. Some of the peak loss rate and RTT occurred on weekends, and these network traffic could not possibly be introduced by an increased usage of Internet for conducting business meetings.
3. Path congestion can still be observed at the end of the measurement period, but the air traffic basically returned to normal at the end of April. Although there were some intermittent airspace closures in May, their impact was much less than the prolonged closure in April.

Prompted by the three problems above, we expand the scope of our investigation. We first analyze where the forward-path congestion occurred by comparing the traceroutes of the 64 paths. Since only the ENG and NOK paths experienced the congestion, we perform "intersection" operations on the two sets of ASs on the paths. The only AS that was common to both sets of paths was the FLAG network which, however, did not appear in other paths (except for the BBC paths before 16 Apr 2010 07:39:00 GMT).

This new lead subsequently helps us to discover that the SeaMeWe-4 cable (owned by a consortium of 16 telecommunications companies), connecting Asia and Middle East, was damaged near Italy on 14 April (the exact time is usually not reported) [7]. This incident, which did not receive too much attention, caused limited Internet connectivity to and from Middle East and Asia, including Pakistan and India [8], and the cable was finally restored at the end of April [2].

The Internet traffic affected by the SeaMeWe-4 cable fault was shifted to satellite, land based networks, and two other submarine cables to Europe: the SeaMeWe-3 and FLAG Europe-Asia cables [8]. Therefore, a more plausible explanation is that the ENG and NOK paths were congested after taking on additional traffic from the SeaMeWe-4 cable [1]. There were also some major route changes for the two paths observed in early and middle of May.

3 Conclusions and lessons learnt

"Disappointedly" our measurement did not observe any correlation between the air traffic disruption due to the ash cloud and Internet performance. Instead, our results

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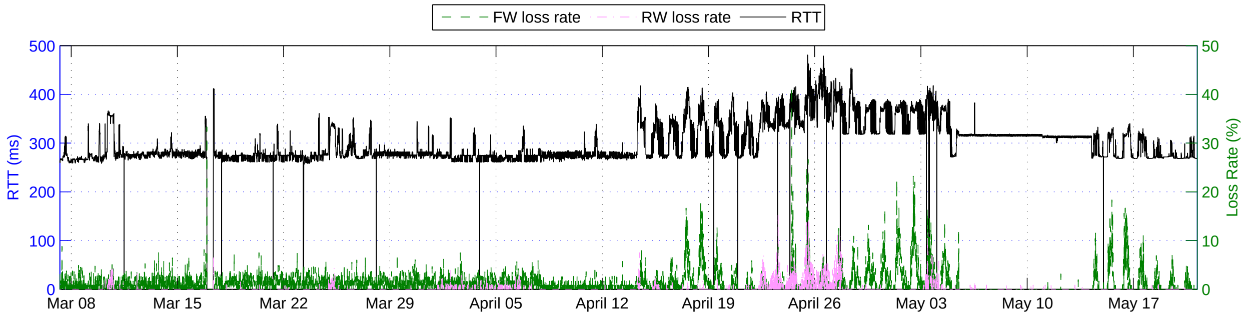
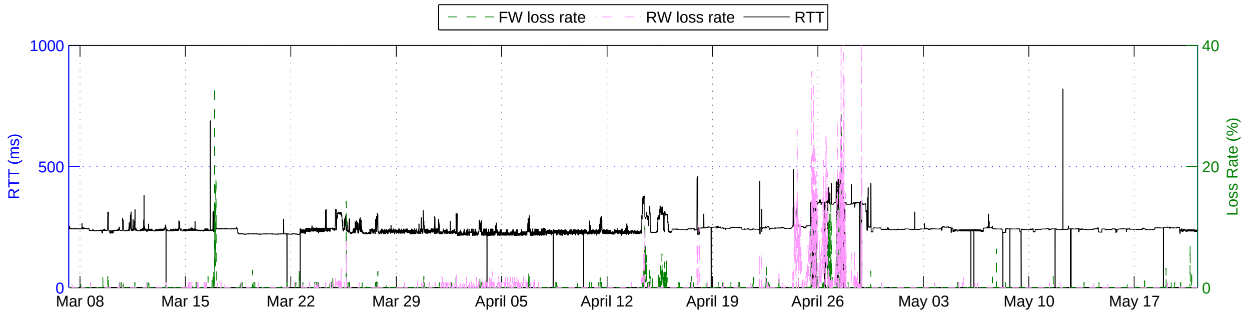
[1] In private communication, our explanation for the network path congestion was not rejected by our contact at FLAG.



(a) UB→NOK's RTT and loss rates.



(b) UB→BBC's RTT and loss rates.

Figure 2: Time series for UB→NOK's and UB→BBC's RTTs and loss rates.

revealed significant congestion for some paths to the UK and Finland which was the result of carrying additional traffic diverted from a faulty submarine cable. We have learnt the following lessons during this investigation.

1. Measuring end-to-end network paths actively is necessary for monitoring critical network infrastructure. The BGP information, though useful for detecting link outages, generally cannot reveal degradation of path performance. On the other hand, it is very difficult to diagnose the network problems in this paper using passive measurement.
2. Correlating the measurement of multiple paths for the same destination is very useful for locating the problematic AS. Although we have measured only eight websites in the UK and Europe, we were able to identify the AS in which the main congestion occurred. Using multiple probers located close to one another on the AS topology can effectively facilitate the cross-path correlation analysis.
3. Correlating IP routes with end-to-end path measurement is also necessary for diagnosing path problems. However, extra caution must be exercised in drawing sound conclusions from the analysis. For example, we observed some IP route changes inside the FLAG network close to the onset of path congestion, but it turns out that these route changes were not responsible for the path congestion.

Acknowledgments

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