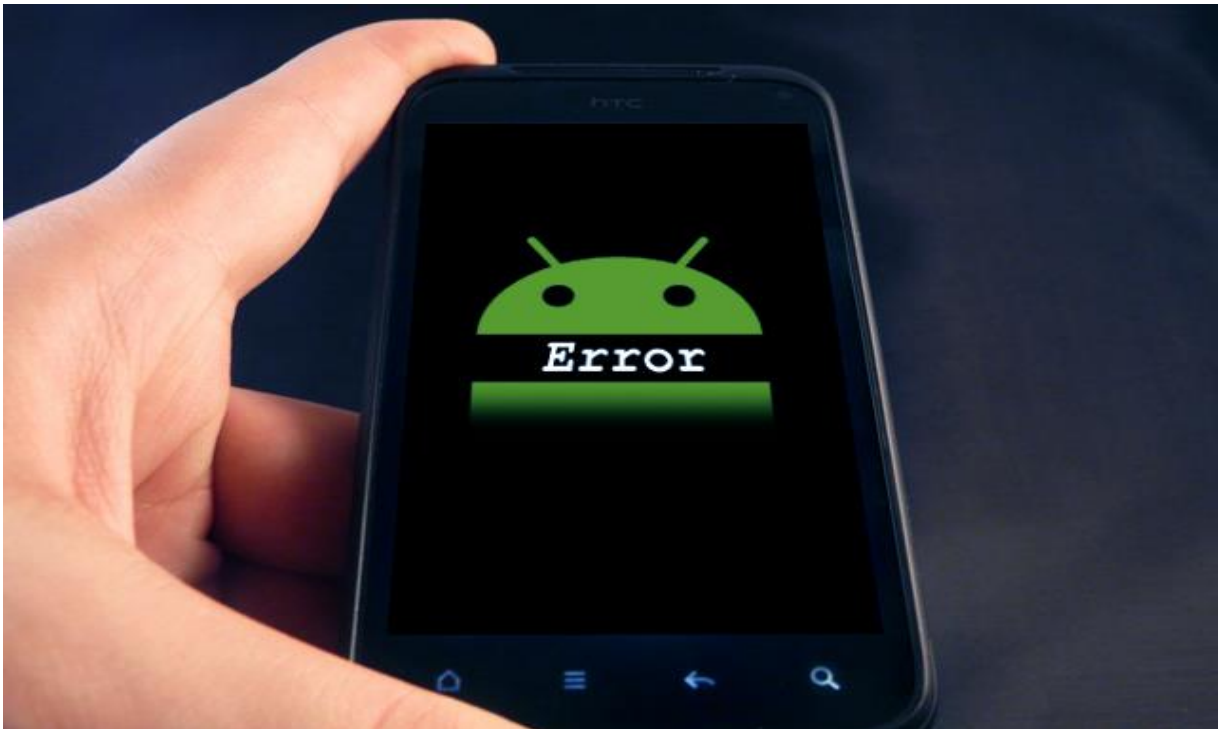

Executive Briefing

Lag Kills! How App Latency Wrecks Customer Experience

High latency events are a major cause of app errors, and therefore a major destroyer of the user experience on mobile networks.



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NOVEMBER 2015



Executive Summary

- STL Partners' analysis shows that while latency and app errors are only weakly correlated across the whole of Europe, once outlying operators (SFR, Wind and those in Germany) are removed, there is a strong positive correlation between the two: as latency increases so do app errors.
- Intuitively, this makes sense: apps 'time out' waiting for responses causing errors and crashes.
- Latency and app errors both negatively affect customer experience – customers are more likely to abandon apps as responsiveness and error rates increase:
 - 48% of users would uninstall or stop using an app if it regularly ran slowly.
 - 53% of users would uninstall or stop using an app if it regularly crashed, stopped responding or had errors.
- Historically, customers have tended to hold the app developer responsible for errors (55% of users blame the app for problems and only 22% the mobile operator) but mobile operators have a significant impact on how quickly an app runs and how likely it is to experience an error and, as understanding of the operators' role grows, users may well use this as a criterion when selecting their mobile service provider.
- Performance among Europe's operators for app latency and errors varies widely:
 - The worst-performing operator in Europe (3 Italy) experiences over three times the amount of requests with poor latency compared to the best-performer (Bouygues Telecom).
 - The worst-performing operator in Europe (O2 Germany) results in over twice the number of app errors than the best-performer (Bouygues Telecom again).
- Improving customer experience is rapidly becoming a mantra of operators globally and for several players (in Europe at least) improving latency performance and reducing app errors caused by latency and other factors should be a key priority. For without improvement, poor performing operators will find themselves at a disadvantage and may struggle to retain existing customers and recruit new ones.

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Introduction

Key objectives

Network latency is a key driver of user experience. In applications as diverse as e-commerce, VoIP, gaming, video or audio content delivery, search, online advertising, financial services, and the Internet of Things, increased latency has a direct and negative impact on customers. With higher latency, customers fail to complete tasks, leave applications, or experience application errors. This, in turn, results poorer core business KPIs for the application provider – lower ratings, fewer subscribers, or reduced advertising fees.

As we showed in a recent report titled [Mobile app latency in Europe: French operators lead; Italian & Spanish lag](#), with the modern Internet dominated by flows of small packets on fast networks, latency accounts for the biggest share of total load times and tends to determine the actual data transfer rates users see. And, as web and mobile applications increasingly consist of large numbers of requests to independent ‘microservices’, jitter – the variation in latency – becomes a more significant threat to the consumer experience. Furthermore, we benchmarked major European mobile network operators (MNOs) on average latency and the rate of unacceptably high-latency events (over 500ms).

In this second report on latency, which again uses data provided by app analytics specialist Aptelligent, we look at the rate of app errors – evidently, something that could not impact user experience more directly – and its correlation with both latency, and the rate of unacceptable high-latency events. We explore how often apps fail across the same set of MNOs, test if latency is a driver of app errors, and then conclude whether or not our theory that it is a real driver of consumer experience is correct.

Source data and methodology

Our partner, Aptelligent, collects a wide variety of analytics data from thousands of mobile apps used by hundreds of millions of people around the world in their every-day lives and work. To date, the primary purpose of the data has been to help app developers make better apps. We are now working with Aptelligent to produce further insights from the data to serve the global community of mobile operators.

This data-set includes the average network latency experienced at the application layer, the percentage of network requests above 500ms round-trip time, the 5th and 95th percentiles, and the rate of application errors. All of these data points are useful in trying to understand the overall experience of customers using their mobile apps, and in particular the delays and problems they’ve experienced such as long screen wait times and applications failing to work.

We showed in the previous report how the longest round-trip delays or ‘app-lags’ (i.e. those over 500ms) are the most important KPI to look at when trying to understand customer experience. This is firstly because people really notice individual delays of this length. For people used to high speed broadband, it’s like going back to narrowband internet – it seems incredibly slow!

Importantly though, in modern apps, the distribution of delays is even more significant, as each app or web page typically makes multiple requests over the internet before it can load fully – and each of these requests will suffer some form of delay or latency.

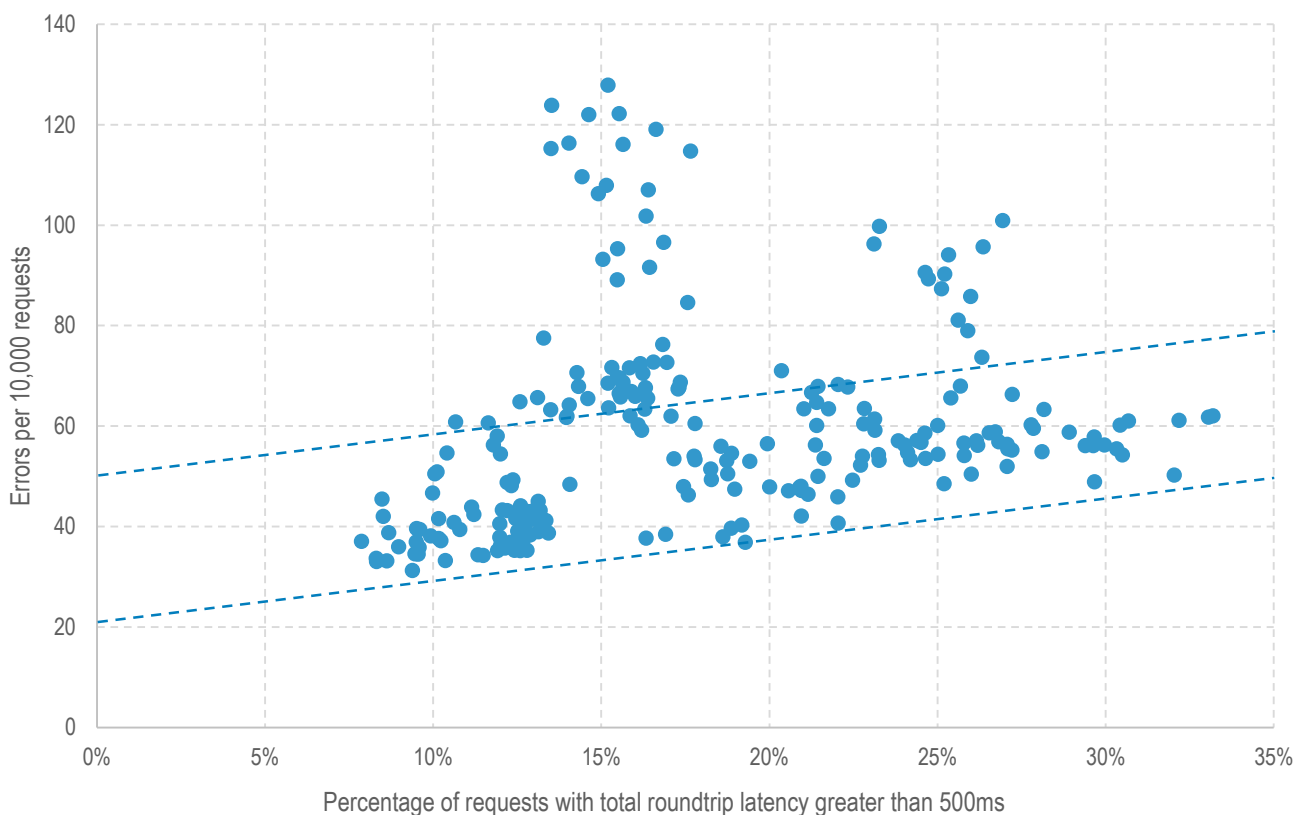
A detailed explanation of this and of the collection methodology is available in the first report.

The impact of latency on app errors

First glance: a positive correlation overall, but a weak one

The following chart shows the error rate per 10,000 app requests, plotted against the percentage of requests over 500ms round-trip time, by carrier. Each dot represents a week's performance and we've looked at 12 weeks of data from 20 operators, from the week of 03/08/15 to the week beginning 19/10/2015. The hypothesis being that the more requests with unacceptable latency there are, the more app errors, because apps 'time-out' or key requests are not fulfilled in time causing an app error or, worse, a crash.

Figure 1: Latency and errors for the top 20 European MNOs over the last 12-weeks appear correlated, but there are some important outliers



Source: STL Partners, Aptelligent

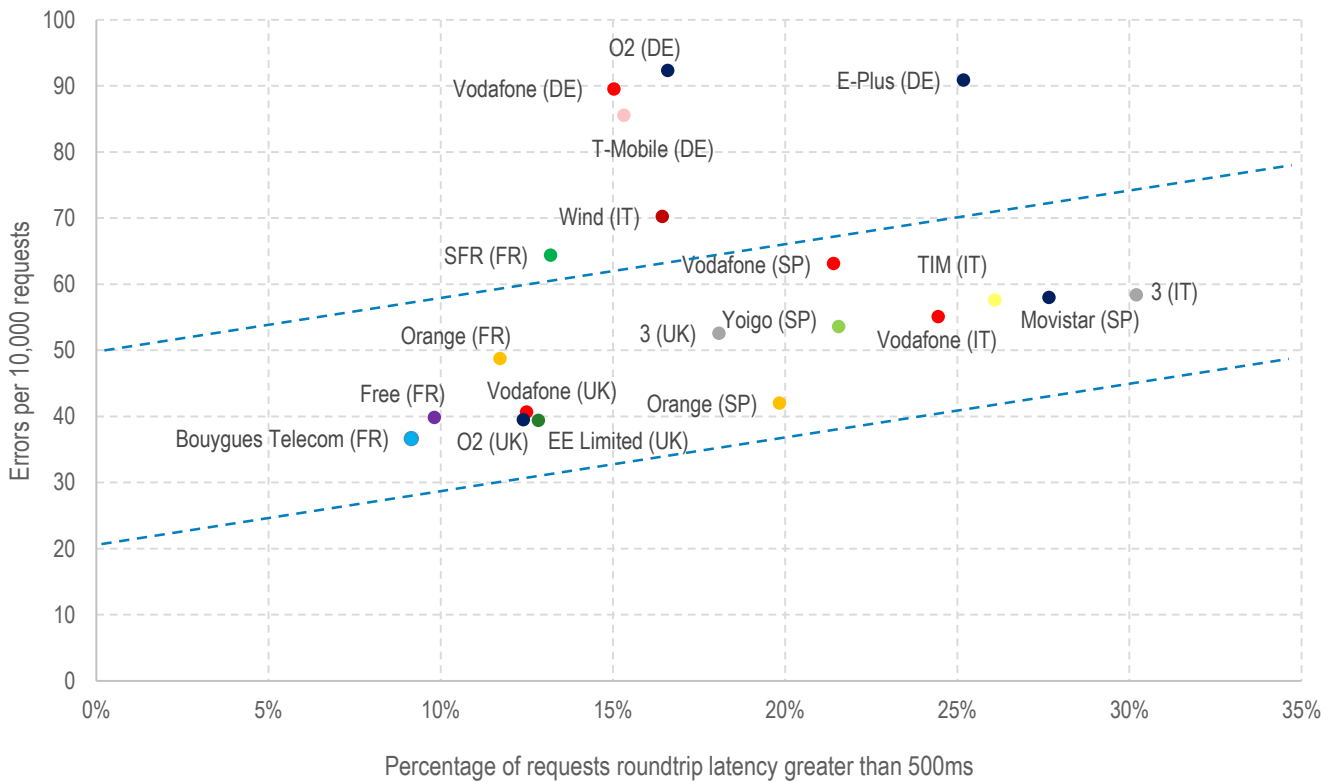
At first glance, there appears to be only a weak positive relationship between latency and error rates but there does seem to be a natural grouping found between the two hand-drawn dotted lines on the chart with the weeks above the upper boundary (potentially) being outliers, in which at least one other factor is driving application errors up.

The lower boundary seems to represent the underlying rate of app-errors that occur when there are no latency issues (between 20 and 50 errors per ten thousand plus an increasing error rate as higher latency kicks in. For example, when 10% of requests experience latency above 500ms, the minimum error rate is around 30 per 10,000 requests, rising to 50 at the 35% mark.

Outliers are specific countries and operators

If we condense the 12-week performance down into a single average for each operator (see figure 2 below), we can see that the high outliers are in fact a country cluster – Germany – tougher with Wind in Italy and SFR in France. Within the ‘normative band’, the best performing operators are present in the UK and France, and the worst in Spain and Italy. These show a clear relationship between latency and errors. But Germany seems to have a much higher ‘baseline’ for errors, at approximately 85 per 10,000 requests, despite its latency performance, which is close to the European average at around 15% of requests with latency greater than 500ms.

Figure 2: 12-week average latency and app error performance by operator

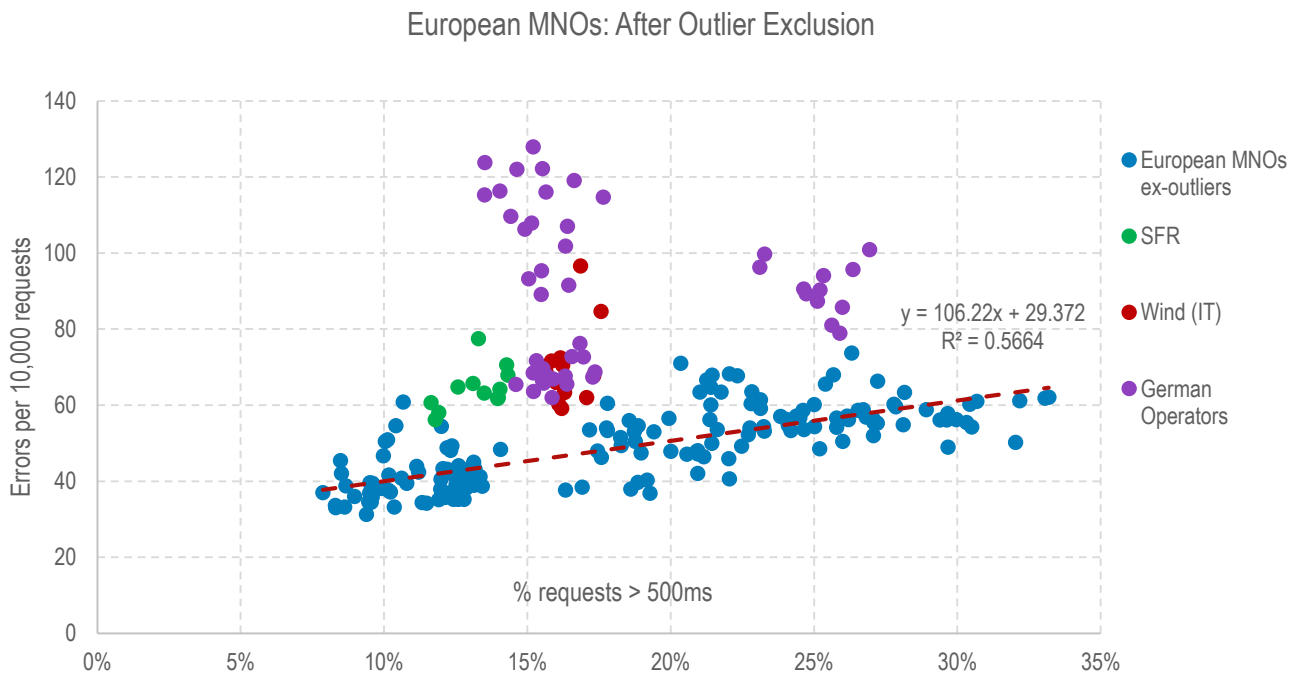


Source: Aptelligent, STL Partners

Strong positive correlation between latency and app errors once outliers are excluded

If we exclude Wind, SFR and the German operators and focus on the operators within our normative band, it is clear that there is a strong correlation between app error rates and latency performance – see Figure 3 below.

Figure 3: After excluding the key outliers, high-latency events explain 75% of the app error rate across Europe’s top 20 operators



Source: STL Partners, Aptelligent

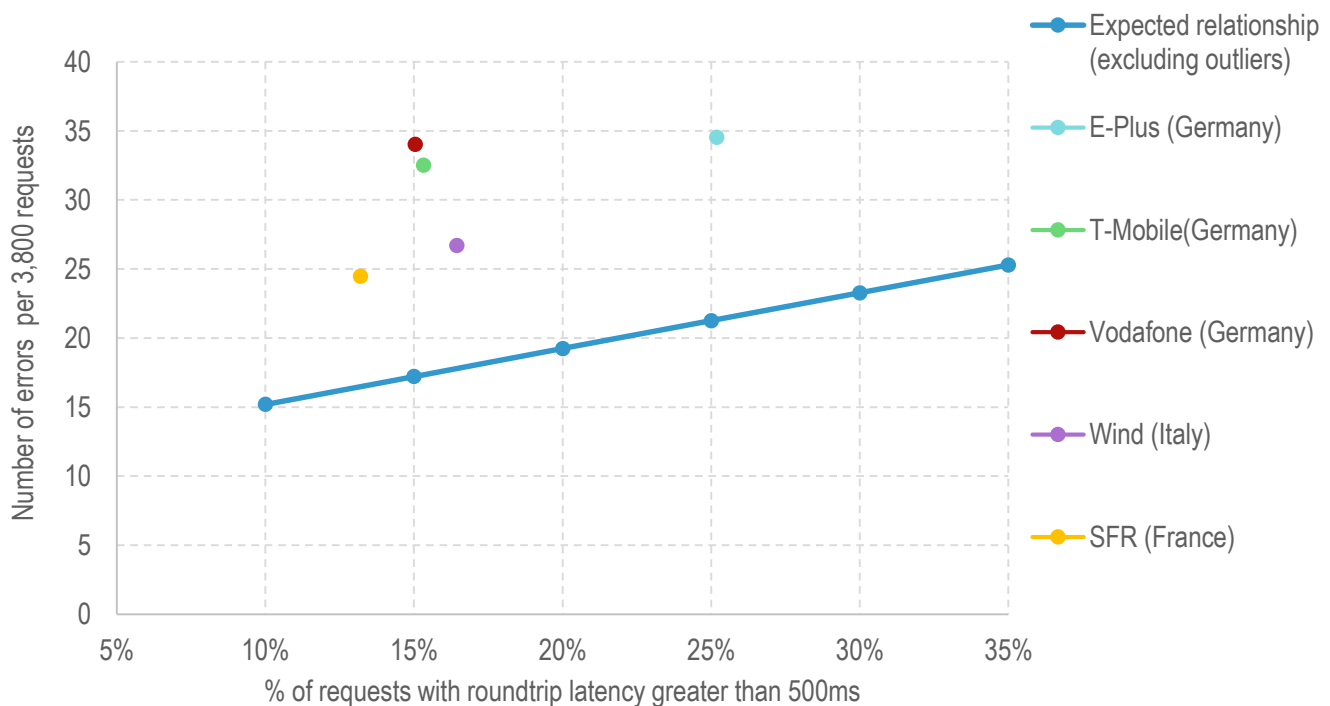
App Errors: The Impact on Customer Experience

Latency and errors – both bad for the customer

Each app or page load contains many requests, and therefore even a small percentage of high-latency events can lead to a large impact on the customer experience in terms of application errors. As an example, take a consumer that when browsing over a certain period of time loads the Amazon homepage 20 times (with 190 requests each time), based on the data within our normative band, users can expect to experience 16 errors even when the % of requests with latency greater than 500ms is only 10% (see Figure 4 below). This rises to 25 errors when 35% of requests are above 500ms (such as 3 Italy and Movistar Spain).

Not all of these errors will necessarily affect the customer (some might be for an inconsequential part of the webpage or app and go unnoticed) but clearly the higher the error rate, the more likely customers will have a poor experience. In other words, driving the error rate down is important for both the customer and the app developer (who is likely to experience poor ratings, lower usage and lower advertising revenues).

Figure 4: Expected number of errors when loading 20 web pages of Amazon



Source: STL Partners, Aptelligent

Consumer research undertaken in February 2015 by Dimensional Research¹, sponsored by HP, suggests that both latency and app crashes and errors have a material impact on customer experience and the way that app developers and operators are perceived:

- 48% of users would uninstall or stop using an app if it regularly ran slowly.

¹ Failing To Meet Mobile App User Expectations: A Mobile App User Survey, February 2015; Dimensional Research

- 53% of users would uninstall or stop using an app if it regularly crashed, stopped responding or had errors.

According to the research, 55% of users blame the app for such problems and only 22% the mobile operator.

STL Partners' research here shows that mobile operators have a significant impact on how quickly an app runs and how likely it is to crash and that as understanding of the operators' role grows, users may well use this as a criterion when selecting their mobile service provider:

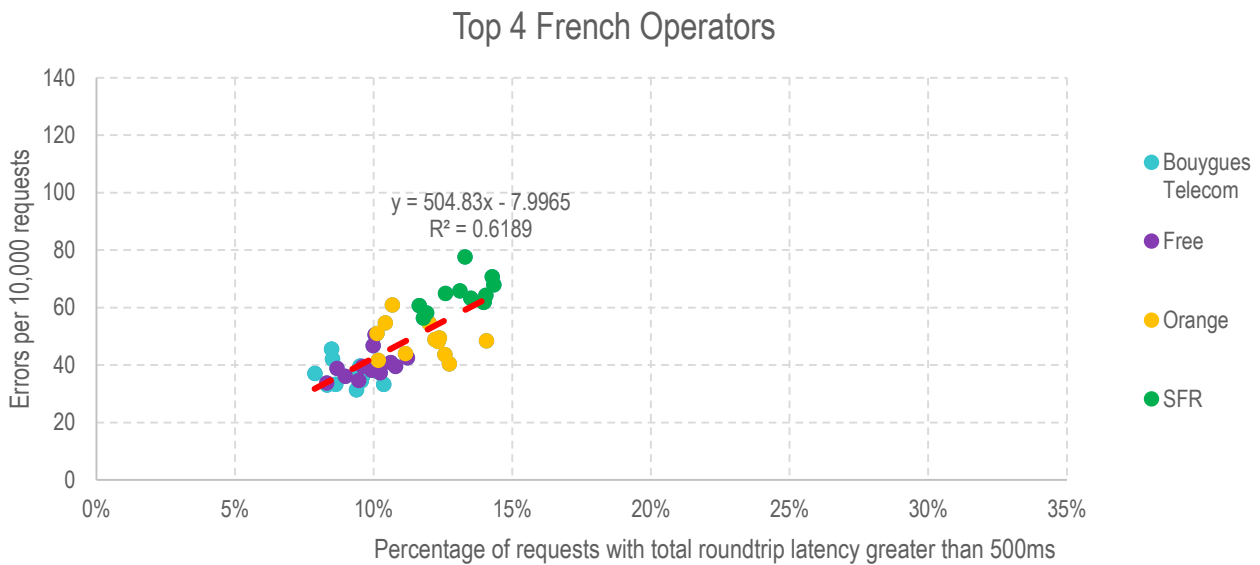
- The worst-performing operator in Europe (3 Italy) experiences over three times the amount of requests with poor latency compared to the best-performer (Bouygues Telecom).
- The worst-performing operator in Europe (O₂ Germany) results in over twice the number of app errors than the best-performer (Bouygues Telecom again).

Appendix: Country analysis

France: A Clear Relationship

We noted in our last report that the lowest latencies, and most consistent performances, were observed in France, and especially with the current joint champion operators, Bouygues and Free Mobile. In this case, we observed a very clear correlation between latency and app error rate with the relationship strongest for the best performers – this may be because the proportion of total load times accounted for by latency increases as network data rates get faster, or also because the best-performing networks attract power-users who are likely to use more apps and more demanding ones.

Figure 5: France shows both the best performers, and a very clear relationship between latency and app errors

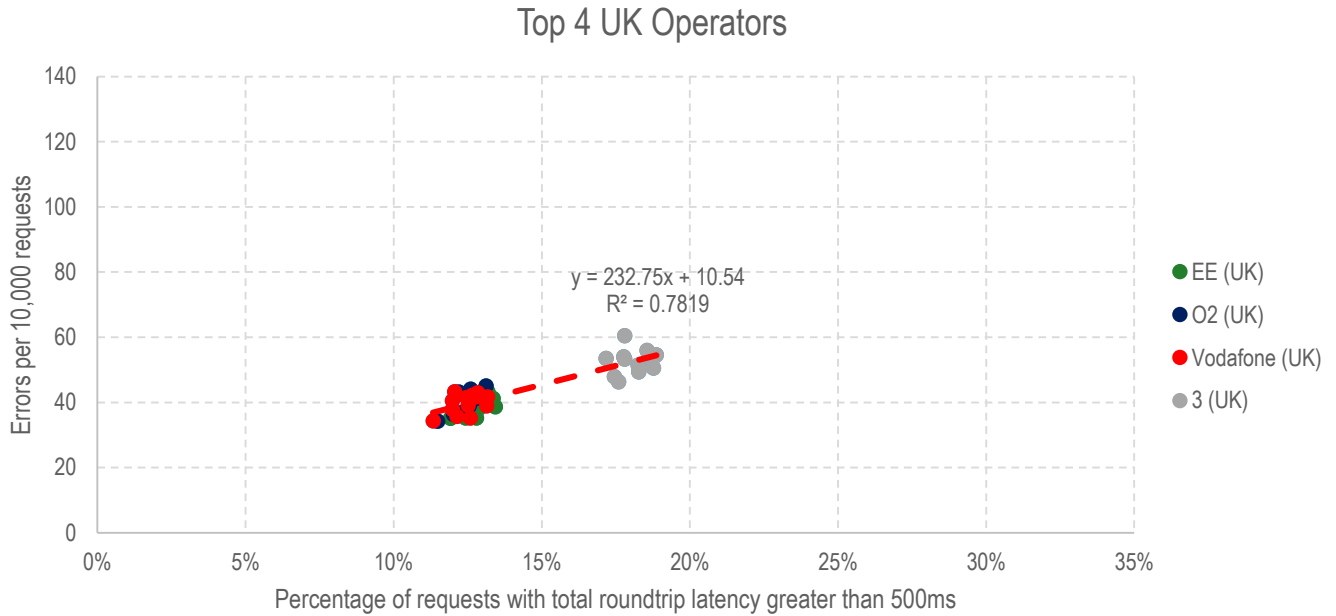


Source: STL Partners, Aptelligent

The UK: Strong Latency-Error Correlation

In the UK, the correlation is very strong, although this is largely down to something which came to light in our previous report, the unusually poor performance from 3UK.

Figure 6: The latency-error correlation is strongest in the UK

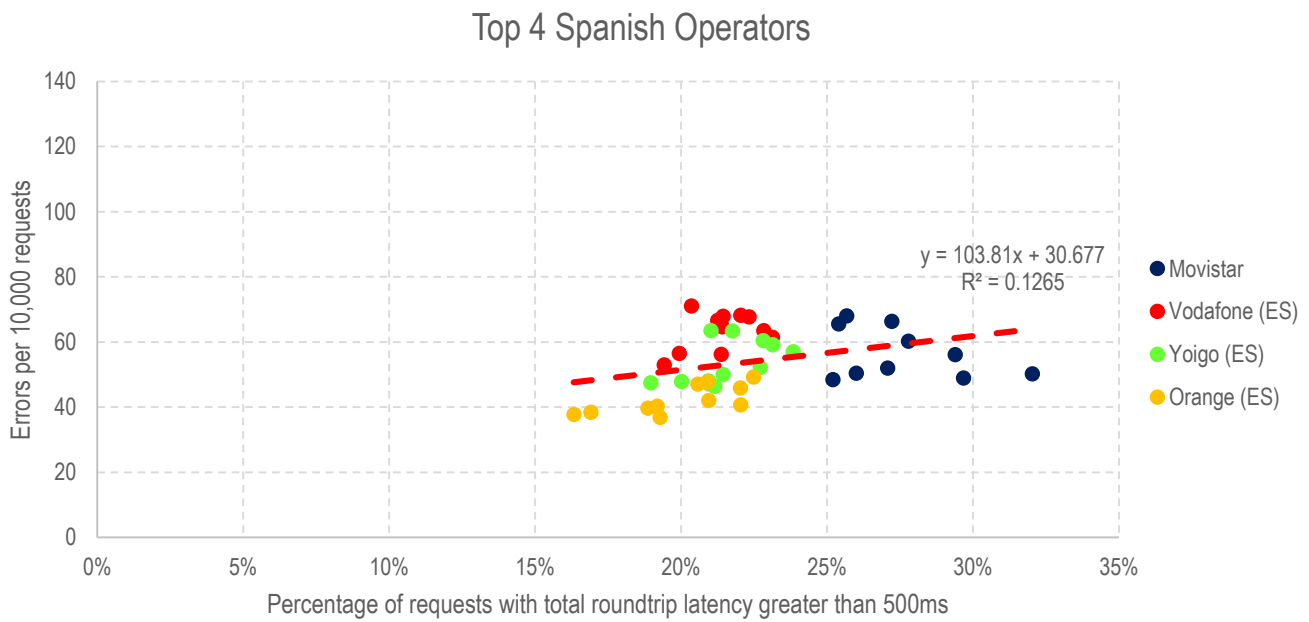


Source: STL Partners, Aptelligent

Spain: a mixed picture, but latency is still predictive of app errors

In Spain, the correlation is substantially weaker but still material. Error rates are relatively stable but latency performance is highly variable over the twelve week period, especially for the worst performer, the incumbent Movistar.

Figure 7: High variation in latency complicates the picture, but a third of app error variation is still driven by latency

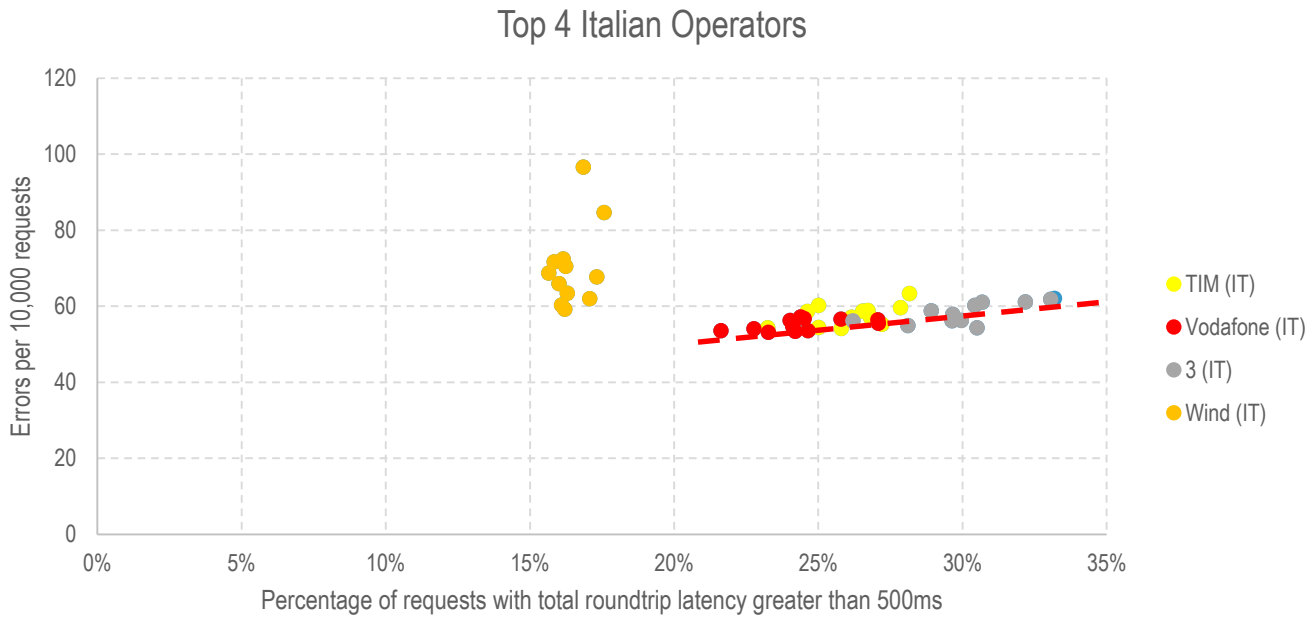


Source: STL Partners, Aptelligent

Italy: Wind is a super-outlier

In Italy the relationship breaks down owing to Wind, with its unusually strong latency performance and some very error-heavy weeks. Excluding Wind, we see a similar picture to what we've seen in Spain, the UK and France with 3 Italy the poorest performer on both latency and errors.

Figure 8: Wind complicates the picture, but the trend is still there

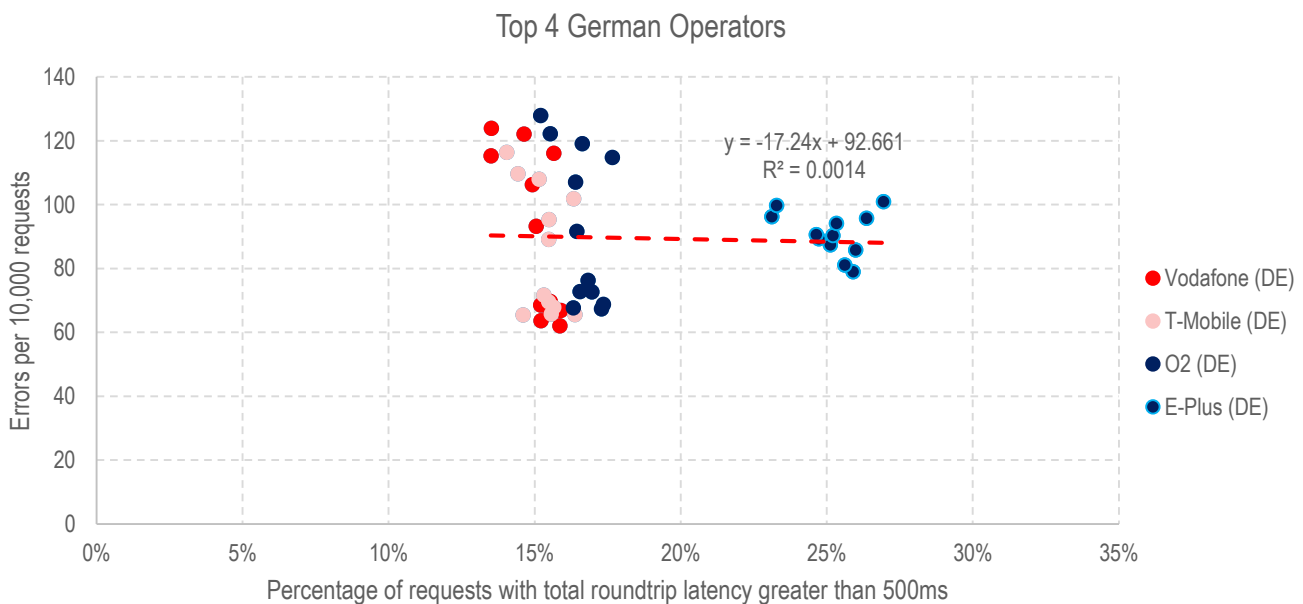


Germany: Nothing but Outliers?

Looking into the German data separately, we see a very anomalous picture. The weak correlation is negative. Results for Vodafone Germany, T-Mobile, and O2, are remarkably similar. Although O2 has acquired E-Plus, we continue to observe devices identifying themselves as E-Plus in the data. These tend to show both poor latency performance and a very high error rate, suggesting that they might be a population of old devices that aren't getting software updates and that may be 2G/3G only.

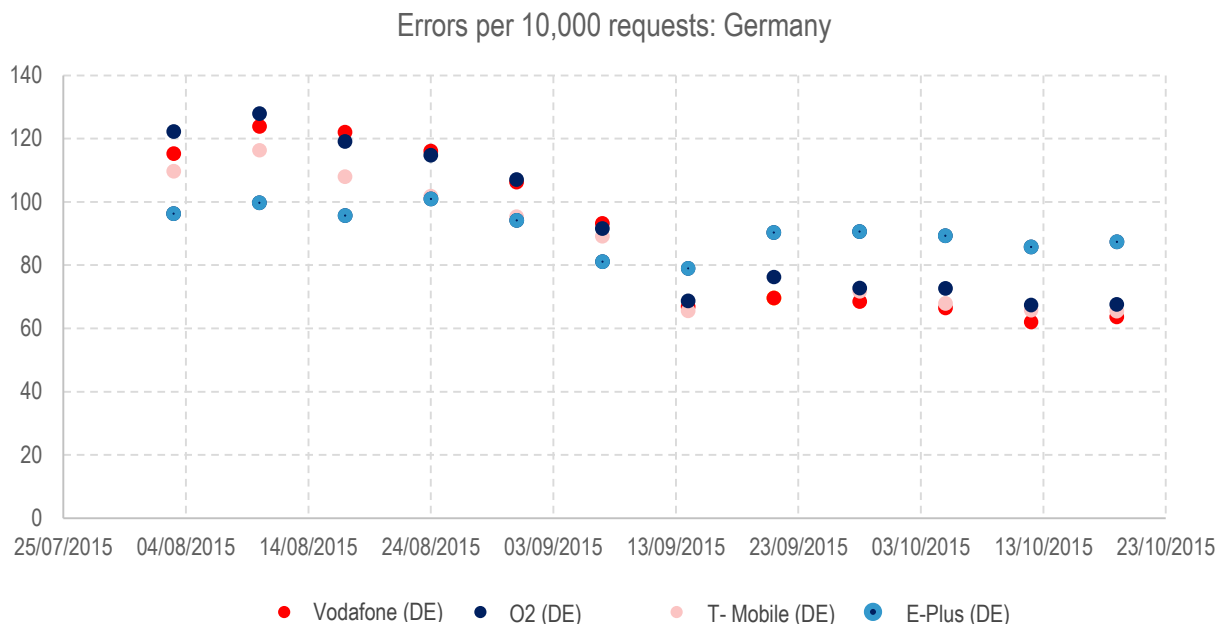
The fact that the operators in Germany (and notably Wind in Italy) fall outside the normative band suggests that there must be at least one other factor at work driving the differences between operators when it comes to app crashes. This could be to do with the device and app population, with the delivery of operating system updates, with the network infrastructure, or with the use of "middleboxes" within the mobile operators' networks that conduct deep packet inspection or try to optimise certain classes of traffic.

Figure 9: Germany – is there any trend at all?



Source: STL Partners, Aptelligent

The explanation may be that something unusual happened during August 2015. All the observations with an error rate above 100 errors per 10,000 occurred before the 6th of September. After that point, the error rate never rose above this level again. Figure 10 shows the change.

Figure 10: The source of the outliers – Germany in August

Source: STL Partners, Aptelligent

Between mid-August and mid-September, the app error rate fell dramatically for all three networks, until they were well within the Europe-wide norms. However, excluding the data points from before the 7th of September actually strengthens the negative correlation – suggesting at least one other factor is having a stronger influence on app errors than latency.

The timing strongly suggests that there is a common factor driving the change, which affected all operators equally. This might be:

- Spectrum
- Software – because 80-90% of smartphones come from only two operating system vendors, major version rollouts will tend to impact all networks at the same time
- Something else – it's possible that the operators did something coordinated, rather than being impacted by an external factor

The E-Plus users do not seem to be affected by the change, only those on the three major networks going forward. We therefore reason that these are non-4G users, and the change affected the 4G networks.

STL Partners and Telco 2.0: Change the Game

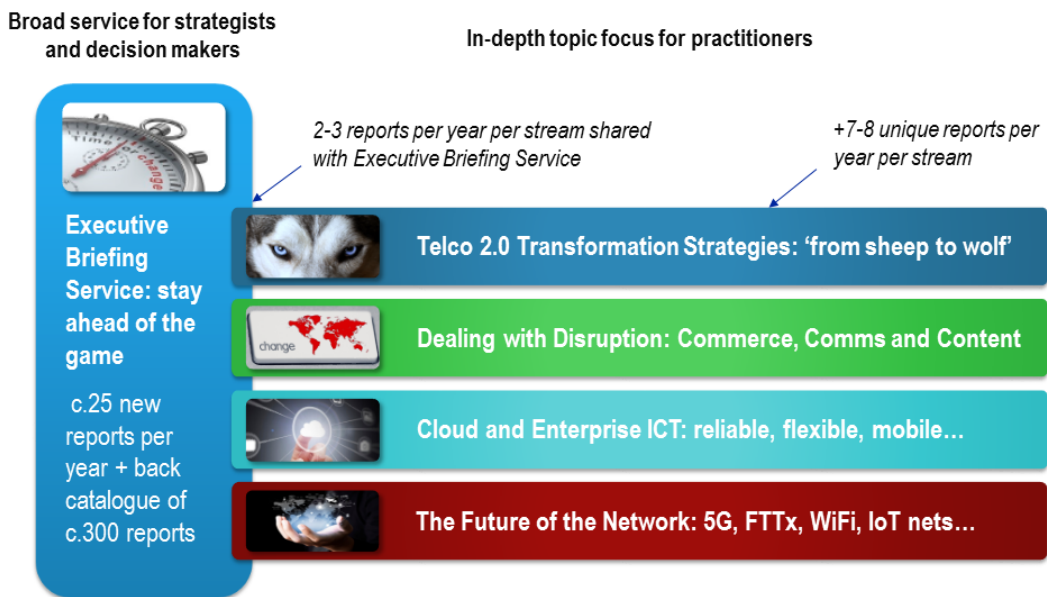
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Founded in 2011, Aptelligent helps organizations improve, optimize, and monetize their mobile apps – by delivering real Mobile App Intelligence. Delivering real-time insights from both operational and end-user behavioral data, Aptelligent is incorporated into >23,000 apps with over 100 billion monthly app launches across 120 countries, spanning industries and use cases. Trusted by 3 of the top 5 credit card issuers, 3 of the top 5 media companies, 3 of the top 5 retailers, and 2 of the top 3 hotel chains with the success of their strategic mobile app initiatives, Aptelligent fully supports iOS, Android, Windows 10, and Hybrid app platforms across all popular devices.

Aptelligent has become one of the primary sources for impartial, real-time statistical data on the mobile ecosystem including device performance, carrier network performance, OS/App crash and error rates and a wealth of additional data. Working with some of the leading analyst and media firms Aptelligent data has been cited in reports by Business Insider, CNN, Fox News, Le Figaro, and Yahoo News, among other notable news organizations. With Network Operations Centers in both the US and Germany (for EU subscribers), Aptelligent fully adheres to the strict EU privacy standards – all user data is kept fully anonymous and is never sold for advertising or other commercial use.

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