I'm from the south, please leave a message: Spatial variation in network voicemail usage in the UK (BT Call Minder and Answer)

John Sweet-Escott

Unisys

Abstract: This paper describes the spatial variation of network voicemail usage in the UK. Voicemail usage is equated to the length of the message that a caller is willing to leave and the likelihood of a caller not hanging up before a message can be left. Data from BT's voicemail platforms was aggregated by telephone exchange and then used to shade thematic maps and cartograms. These maps show clear evidence of spatial variation in voicemail usage, with clear distinctions between urban and rural, south coast towns and inland towns, Scottish cities and even distinctive patterns within cities.

1 Network Voicemail in the UK.

BT provides its customers in the UK with a network based voicemail service that will take a message if they do not answer the phone or their line is busy. This consists of a premium service called BT Call Minder which is available for a monthly subscription as well as a simpler service called BT Answer 1571 which is free [1]. For reasons of brevity, both will be referred to as the 1571 service in this paper. BT currently uses voicemail platforms from Unisys to provide this service to around nine million, primarily residential, subscribers [2].

Voicemail is a type of messaging which is itself a form of communication. Voicemail can be contrasted with other modes of communication by its media and interactivity characteristics, as shown in Table 1.

Media/Interactivity	Real Time	Deferred
Written	Instant Messaging	Email & Text Message (SMS)
Spoken	Telephone Call	Voicemail & Voice SMS

Table 1 Typology of Communication.

What sets voicemail apart from other modes of communication is that the caller does not, typically, set out to have deferred communication. The session is initiated by the caller in the expectation that it will result in a real time telephone call, but it transitions to a deferred mode of communication when the call is not answered. Callers have only a few seconds to react to this transition, while they listen to the voicemail greeting, to decide whether they wish to leave a message and how to compose/articulate that message. This paper shows that how people react to this rapid transition does vary spatially as well as being influenced by whether the called party has recorded a personal greeting (which also varies spatially). It can therefore be seen that voicemail usage is in part determined by the called party (greeting usage) and the calling party (reaction to the transition from real time to deferred communication). Given that most calls are local (of calls diverted to voicemail, this study found that 70% were less than 20km), both the caller and the called party have a high probability of sharing similar geographical characteristics.

2. Study Methodology.

An analysis was conducted on a snapshot of data from the BT messaging platforms collected over 75 hours in March 2006. Each record contained the telephone numbers of the two parties, the duration of the call and a count which was used to determine whether a message was actually left. The telephone numbers were allocated to their telephone exchange using publicly available number range data [3]. Because 1571 is a fixed line service, nearly all called party telephone numbers could be allocated to exchanges. These exchanges were geo-coded using their postcode, with Thiessen polygons [4] constructed to estimate their catchment areas. Individual call durations, for the subset of calls where a message was left, were grouped by exchange and averaged to provide an analogue for message duration (it is an analogue because call duration includes the playing of the greeting as well as the message recording duration). In addition, the ratio of calls that left a message divided by all calls

placed was also calculated for each exchange. This ratio summarises the likelihood of a caller hanging up before a message can be left.

Using Thiessen polygons to map exchange data suffers from the perceptual effects of some exchanges having a small catchment and some having a larger one. Urban areas, because they are densely populated, have relatively high numbers of 1571 subscribers, but tend to contain small exchange polygons. In contrast, rural areas have fewer 1571 subscribers and larger exchange polygons. The impact of this is to visually over represent rural areas at the expense of urban areas. To mitigate this problem, a cartogram was constructed using Dorling's methodology [5] where each exchange was represented as a circle whose area was in proportion to the count of 1571 subscribers that belonged to it. Because this cartogram has to distort geographical space in order to prevent circles from overlapping, the cartograms are presented side by side with a corresponding geographical map to aid comprehension.

3. Who Calls who?

In addition to geo-coding the called party, the calling party was categorised and geo-coded where possible. Table 2, below, shows that on average, callers who were diverted to 1571 0.84 times per day during the study period (75 hours). This figure reflects both total number of calls made from a telephone number, each of which has a certain probability of diverting to 1571, and also a "persistence" factor. Human behaviour is such that on being connected to 1571, callers will frequently hang up and try again later. This may repeat several times before the caller either leaves a message or gives up.

Calling Party Category	Total Calls	Distinct Callers	Average number of calls to 1571 per day for each Caller
BT Exchanges	56%	58%	0.81
Mobile	22%	32%	0.58
Non Geographic	4%	0%	39.42
Unknown (incl Cable)	16%	8%	1.62
International	2%	2%	0.99
Total	100%	100%	0.84

Table 2 Calling Party Categories.

Callers from BT exchanges make up just over half the calls diverting to 1571 and place a number of calls that similar to the study average. The standout figure in this table is the non geographic category (i.e. caller's telephone number began with 03, 08 or 09) where each telephone number made, on average, nearly 40 calls per day. It is believed that this figure is driven by active outbound campaigns by call centres. The distinct caller and average number of calls for the category "Unknown (incl Cable)" should be ignored as it counts calls where the originating telephone number was not available as being originated from a single number.

4. Spatial Variation in Deposit Call Hold Time

A map of the average call hold time, by called party exchange, for those calls that were diverted to 1571 and a message left is shown in Figure 1. This figure has a geographic representation of the data on the left and a cartogram representation on the right. This side by side illustration shows the value of the cartogram in correcting the bias caused by exchange areas with different areas and subscriber counts. In order to aid interpretation, the outline of major UK towns and cities are also included on the map and cartogram. What is notable from the cartogram is the reduction of visual influence from the highlands of Scotland, the area south of Glasgow/ Edinburgh, the south west and west Wales.

Certain trends can be picked out from the data:

1. There does appear to be a broad "north/south" split, with subscribers in the south receiving longer messages than subscribers in the north, but there are significant variations within this pattern.

2. Midland and northern cities tend to have below average deposit lengths (with their rural hinterland tending more to the above average), whereas London has above average deposit lengths.
3. There are extremely low deposit durations in the south of Wales (with an exception for the city of Cardiff).
4. There is an interesting distinction between the cities of Glasgow (below average) and Edinburgh (above average).

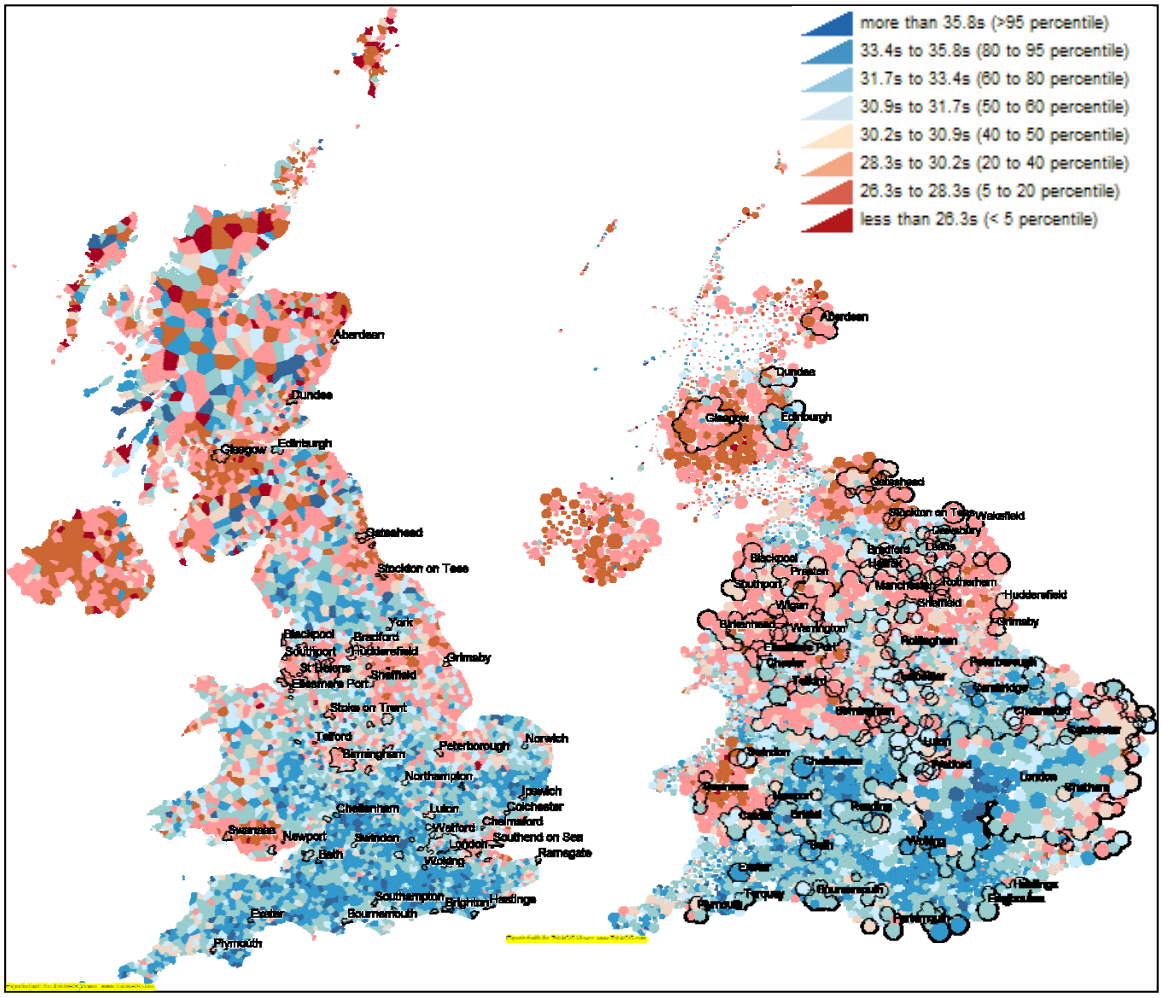

Figure 1 Average Deposit Call Hold Time by Called Party Exchange

A zoom of the same data on London and the M6 corridor is shown is shown in Figure 2. This shows a zone of above average deposit call hold times running from south west London to the city and shows more clearly the data for cities in the north of England.

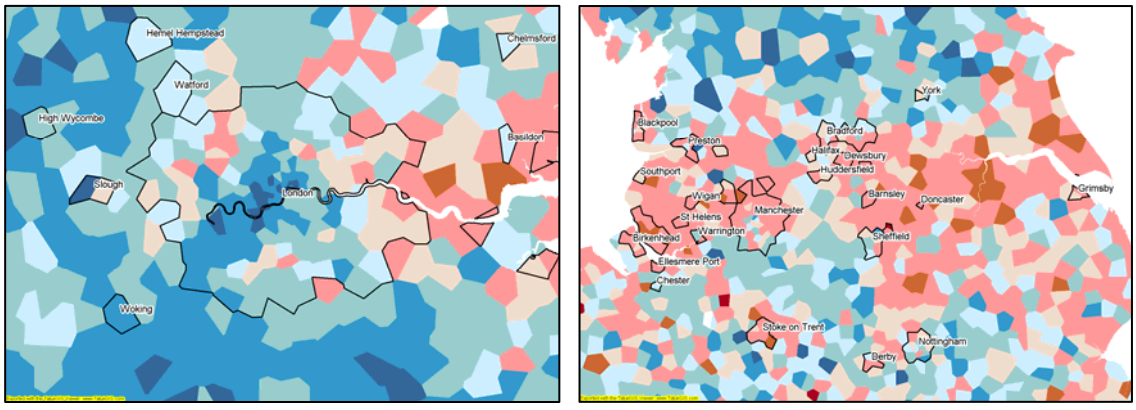

Figure 2 Average Deposit Call Hold Time by Called Party Exchange (London and M6 Corridor Zoom)

There are clear spatial patterns in the length of the average deposit call hold time. Spatial patterns are indicative of an underlying process that is giving rise to these variations. One factor that has been found to influence the length of a message being left is whether the subscriber has recorded a personal greeting (which is only available on the Call Minder classes of service (COS)). The relationship between deposit call hold time and the percentage of mailboxes that belong to the Call Minder COS in each exchange is plotted in Figure 3. Like a cartogram, size of each circle is proportional to the number of 1571 subscribers in the exchange.

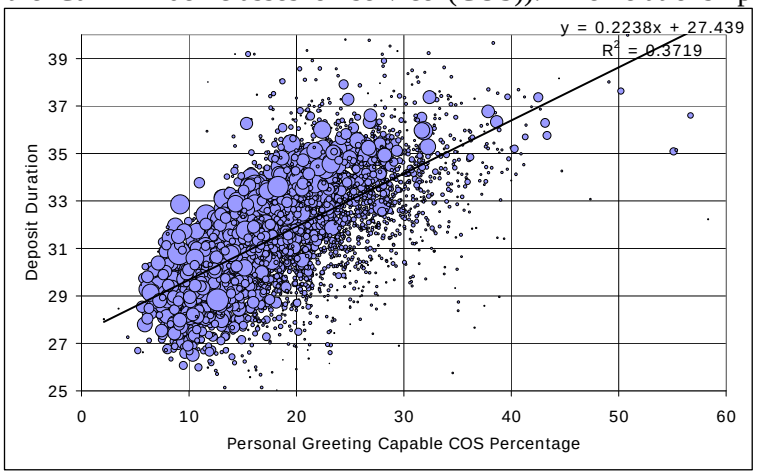

Figure 3 Deposit Call Hold Time and Personal Greeting COS

Not all subscribers who belong to the Call Minder COS actually record a personal greeting, so the X axis should be seen as an analogue for whether a greeting as been set. The graph shows that there is a strong positive relationship between mailboxes that belong to a personal greeting capable COS and message duration. Using linear regression it can be shown that this accounts for 37% of the variation (significant at the 0.001 level). It is believed that this is in part due to the caller being more certain that they have not misdialled, and therefore they are more certain that they are leaving a message for the correct person, resulting in a longer, more detailed message.

5. Spatial Variation in Leaving a Message

This study found that, on average, 24% of calls that are diverted to voicemail (which are the only calls plotted in the previous section) result in a message being left. For the remaining 76% of calls, the caller hangs up during the greeting or before a message of a certain length (3 seconds) can be recorded. The ratio of messages to the total number of calls is shown in Figure 5. It can be seen that there are strong similarities between Figure 1 and Figure 5. This relationship is shown in Figure 4. The conclusion from this data is that exchanges whose subscribers are, on average, left longer messages are also more likely to be left a message, rather than having the caller hang up before a message can be recorded. The maps that have been plotted are by called party exchange. This might seem like a questionable decision, because arguably it is the behaviour of the calling party that is determining whether a message is left and the duration of the message. However, a defining characteristic of voicemail is that it directly involves a calling and involves the called party by proxy. The behaviour of the called party has a significant influence on this data by whether they set a personal greeting. Since most calls that go to 1571 are local, this concern is less pressing because called and calling party are, at this scale of inquiry, likely to be neighbours.

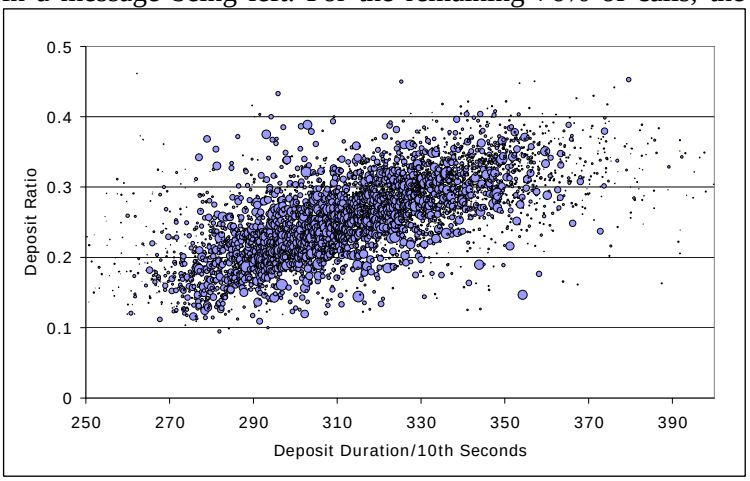

Figure 4 Calls leaving a message and deposit call hold time

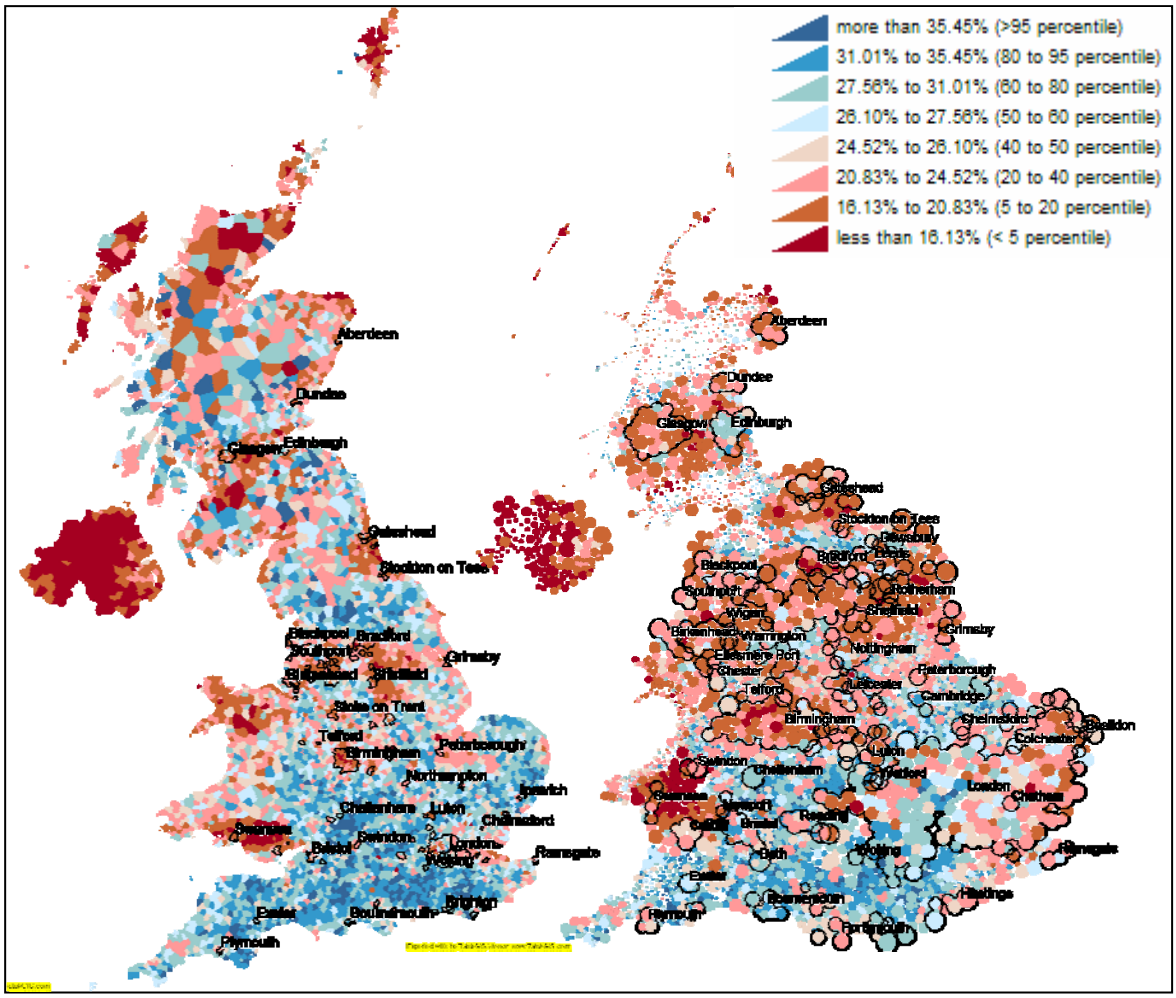

Figure 5 Calls that left a message to total call percentage

7. Conclusions.

The title of this paper started with the statement: "I'm from the south, please leave a message". The maps and cartograms shown illustrate that whilst there is a broad north/south split, this characterisation is too simple as it hides a wealth of spatial variation. This knowledge is interesting because it provokes intriguing questions as to what are the underlying processes that give rise to this spatial variation. It also forms an important element of a network operator's understanding of their customer.

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