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# A Network of Noise: Designing with a Decade of Data to Sonify JANET<sup>1</sup>

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**ABSTRACT**

The existing sonification of networks mainly focuses on security. Our novel approach is framed by the ways in which network traffic changes over the national JANET network. Using a variety of sonification techniques, we examine the user context, how this sonification leads to system design considerations, and feeds back into the user experience.

**CCS CONCEPTS**

• **Human Centred Computing** → **Interaction Techniques** → Auditory Feedback; **Networks**

**KEYWORDS**

Sonification, networks, infographics

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The first demo is a modem and white noise sonifying two streams of JANET data over a decade using a dial-up modem as frame. The second is the same data with a voice over providing context with events.

The third demo is a quartet of instruments reflecting the percentage of traffic that is research in JANET across the four regions.

The fourth demo is the same research traffic data but using WebAudio and electronic notes for the research traffic.

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## 1 INTRODUCTION

JANET is the academic Internet backbone for the UK, providing connectivity for research, Higher and Further educational institutions. As part of the tenth anniversary celebrations of the Web Science discipline, we questioned how research traffic had changed by the growth of the World Wide Web and how inter-networking and collaboration with other networks had changed over the same time period.

Due to the large amount of data, we chose a strategy that entailed the use of sonification in order to best represent and understand the network traffic uses and changes in useage, rather than visualisation, as we felt that the technique is more likely to illuminate the repetitions in the normal pattern over time and highlight anomalies. Sonification is referred to in the literature as “*the use of nonspeech audio to convey information. More specifically, sonification is the transformation of data relations into perceived relations in an acoustic signal for the purposes of facilitating communication or interpretation*” [5].

This paper presents and describes the methodology and offers two ‘views’ of the data are presented as sonifications. We then discuss the overall data before considering future work and concluding. Previous work on sonifying networks [1][3][4] has focused upon security and monitoring. In this paper, we *sound out* how the network relationships have changed across regions and interacting networks.

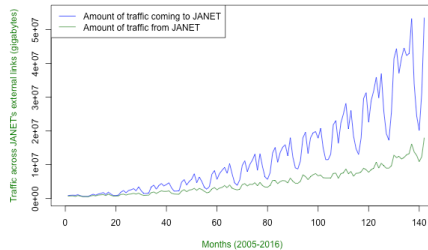
Our research questions are:

- How has research traffic changed over the decade of web science?
- Can Sonification provide insights into the data?

We then reflect on the Perceiving Patterns in Data pattern underlying both exploratory and explanatory sonifications, before considering other techniques that relate to the application of design guidelines for sonification to the re-use of the data.

## 2 RELATED WORK

Mynatt et al. [6] presents the concept of serendipitous information derived from background auditory clues. This



**Figure 1: Total traffic across JANET's external links used in the first sonification**

information may support the listener's actions but is not vital, or a notification to be acted upon. Vickers et al. [9] argues that this allows network traffic to be monitored as a peripheral task supporting situational awareness and the self-organised criticality of the network as a background task, in order that the sonification can be part of another task. Previous work on the sonification of network focused on monitoring tasks, such as Peep [4], SonNet [3] and [1].

Our novel approach focuses upon historical data, as a mechanism to review the changing patterns both within the network traffic and between the networks at a national level. We begin by considering the context of the listener and how this may affect the design of the display.

### 3. SONIFICATIONS

JISC Services and Collections, who maintain JANET, provided us aggregated data in CSV format and extracted into separate text files. The ChuckK language [8] is used to sonify them.

#### 3.1 An Overview of JANET traffic

The traffic data, shown in Figure 1, was split into two streams: incoming from outside of JANET and traffic within the network. Two versions of the sonification are presented: one focusing on the patterns within the data, and the other on placing the data in context as an audio info-graphic.

Our first sonification uses a sample of a modem to frame the experience with white noise presenting the data. The modem is a sonification of bits being transferred across a phone line. Using the data to affect both the frequency and the noise filter radius, we show the periodic nature of the transfer and its growth. As this presents time series data over 10 years, the time is split twice: each year is given one second time and then divided in 12 sections of 83 milliseconds length, each slice representing a month.

The second display uses a voice over to provide a timeline and context for the info-graphic. Word samples relating to events, such as the Large Hadron Collider or the London Olympics, are played over percussion. This invites a move from the rigorous matching of time slices to using 120 beats per minute, with the voice track using a separate timer based on a count of 12 to load the correct sample.

#### 3.2 Regional Research Traffic

Research traffic from the geographical regions – England, Scotland, Northern Ireland, and Wales – is used to look at how research has changed at a lower level, re-using the methodology. The data is normalised using the percentage of research traffic against the total regional traffic and represented as a quartet (with wind, string, organ and percussion). The quartet allows for the listening to the interactions of the four data streams. The data poses various issues for sonification: firstly, the ranges of the traffic are very different, and secondly the quieter aspects of the data may be easily lost.

### 3.3 Web Audio

As a final version, the simple electronica sonification was changed into a Web Audio piece. The web page has links to the data, the design document used, and the calculation to make the sound audible.<sup>2</sup>

## 4 DISCUSSION

The Perceiving Patterns in Data pattern [2] argues that time varying sonifications, where the data is high dimensional and hard to read in tabular form, can be used to perceptually group data together and show attributes. The aim is to create a perceptual soundscape of information. They were tested with five network analytics experts from JISC over a one hour session.

The first sonification allows listeners to hear the internal pattern of academic terms within the greater traffic growth. This reveals the patterns in the overall data but not its context. In the second version known events frame the data, justifying the violation the definition in [5]. The focus on historical points, such as network upgrades or large-scale events, directs the listener's focus. This version was viewed as a useful info-graphic: providing the context for the patterns heard in the earlier version.

The third sonification shows the decline as a percentage of research traffic against other forms - such as the Web, social media, and video telephony – as the Internet becomes more central to user lives and institutions accessing it change. The use of sonification for pattern recognition is heard when an anomaly appears in the Welsh traffic. The data sharply became more prominent than the Scottish, highlighting a decline of non-research traffic for short period before the normal pattern returned. Sonification makes this change quicker to identify across the number of data points required to simultaneously identify the regional interactions and the relationships within the data.

Web Audio shows possibilities for separating design and data to allow re-use and methods of achieving this is suggested but remains ongoing work. This may allow for alternative ways of linking the data and sonifications together for improved interaction.

## 5 CONCLUSION

This is the first audio project looking at the sonification of a national network. Changes to research traffic can be shown across the sonifications over a decade within the larger story of network growth. As other types of institutions, such as Further Education, join the network, their use of it changes the sonified traffic profile. We hope that the research discussed helps to support the ongoing work in the data sonification community and gives some insights into large scale network data sonifications.

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<sup>2</sup> <http://demeter.oerc.ox.ac.uk/Sound/janet/janet.html>

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