"Should a signaller look at Twitter?" The value of user data to transport control

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ABSTRACT
The present paper reports the outcome of a short feasibility study that critically evaluated the contribution user-sourced data in transport control through a process of using interviews and fieldwork to understand decision making in different modes/domains (road, rail, urban transit). We discuss what 'control' means in these modes, and how using this lens can aid the understanding of how data can be used in these contexts. We report key findings and resultant cases of use.

Keywords
Transport, Data, Social Media, Control, Joint Cognitive Systems

1. INTRODUCTION
It would appear intuitive that improved awareness of the state of a transport system and surrounding issues, such as the scheduling of a mass event, are critical in making effective decisions about transport operations [5]. Given the rise in Smartphone ownership and other new forms of sensor/communications technology, there is the potential to supplement existing information flows into transport control with new forms of data and information derived directly from transport users. Potential sources include incidentally present mobile device data (e.g., the presence of an open Bluetooth connection) and deliberately created information, such as that shared via social media. The question we asked was whether there is actually any value in these data for control within different transport modes as:

"The belief that more data or information automatically leads to better decisions is probably one of the most unfortunate mistakes of the information society". (Hollnagel & Woods, 2005, p. 7 [1])

Therefore, underpinning this question is the needs to understand what information gaps currently exist, and whether they can be mapped to new forms of user data. Thus, rather than ask how data can be used (bottom up/data driven), we asked first what uncertainties impact upon decision making and how new forms of data can reduce them (top down/decision driven). To meet this aim we adopted the lens of Cognitive Systems Engineering theory [1,2], prompting us to ask in the settings studied: *what does it mean to be in control?*

2. APPROACH
It is our observation that many 'harnessing data' use cases in the transport domain tend not to be about informing controllers, but rather dictating *new forms of control* and infrastructures that while valuable for their potentially bold transformative impacts, seldom respect the wider constraints of existing infrastructure, organization, business case and safety case. These concerns are particularly acute given the complex industrial fabrics created by privatization and regulation within transport in the UK (e.g., statutory obligations upon providers). For example, control in such contexts may be constrained by the infrastructure in which the travel takes place and by the technology for mediating control, much of both being legacy-based [6]. In the present work we eschewed the option seeing control as a blank slate and instead focused on understanding the key problems in different transport control domains sensitized by looking for how new 'data products' could be integrated within them; an approach we have termed 'decision making as a point of enquiry'. The aim of this was to limit the scope of future work to high-impact situations realizable within the relatively short-term.

2.1 Domains investigated
Visits were carried out to a range of partners across transport modes. This included urban transit, rail signaling, rail control, rail ergonomics, relevant information engineering contractors, consultants and a large multinational with interests in both transport infrastructure and consumer electronics. All were interviewed and where possible this was supplemented with observations of control room operations and in some cases, verbal protocols from controllers themselves where they described their control activity and decision making in real time.

3. FINDINGS
3.1 Opportunities
The initial finding is that there are indeed gaps in awareness required for control that could benefit from user-sourced data. Some of these gaps lie *outside* of the immediate area of control, but have an influence on events *within* the operator's control. For example, understanding what is happening in other modes on the periphery of a control region can inform real time decision making – eg disruption on the roads leading to a spike in rail use. However, another source of gaps is incomplete knowledge of what is happening *within* the region of control. While major events are usually well understood and present 'on the radar', minor events are not necessarily, and by their very scale are difficult to detect particularly in areas where sensing of the network by other means is not cost-effective. The key issue is that with transport networks nearing capacity, these events can soon escalate to have a severe impact across large geographical areas and across modes. Variations in user-derived travel patterns, and comment via social media, can support the awareness of such events and conditions.

Even at the level where an event may not cause significant disruption, it may still cause user dissatisfaction – an important

factor when encouraging mode shift to public transport, or in a market place of multiple transport providers, as is the case with urban transit. Already, such providers are seeing the value of Facebook and Twitter as a tool to stay abreast of minor disruptions and to allay user concerns.

While we initially drew a distinction between user-sourced information for control, and transport providers using channels such as social media for impression management, we found that the two are intertwined. Managing 'misinformation' through sources such as twitter has an important operational role as well as a customer relations role: on the roads this could be discouraging more traffic from coming to an already congested area; on public transport, informing people of when disrupted services will return to normal can prevent crowds, a potential safety risk, from building up at stations.

3.2 Constraints

Despite the potential of user-sourced data, there are significant constraints on how it could be used, and by whom. One factor is span of control – in practice, controllers on the front-line have to make tactical decisions within short windows of opportunity and limited latitude for intervention. However, sitting above this is often a strategic function (eg the rail 'controller' in the UK rail network [7]). This role tends to have a wider view of the network, more (though still limited) scope for strategic decision-making and, importantly, an information dissemination role.

Regulatory and organizational constraints also limit the amount of latitude operators have for real-time decision-making – for example, changes to the bus timetable need to go through regulatory approval taking weeks.

A further finding was that social media, in particular, needs to be treated with a degree of caution. The view was that it provides an additional, potentially valuable input into decision-making, but not without further verification from other more formal sources. In order not to add significant additional latency to the decision making-process, technology employing user-sourced data must be embedded effectively with other sources of data, and within appropriate processes.

4. SOCIAL MEDIA VS. THE ARCHITECTED SYSTEM

A common finding across domains was that we are entering an era where social media, without intervention, may be actively antagonistic, particularly under conditions of disruption. Controllers prefer to keep disruptions within the 'pocket' of control while measures are taken to relieve a problem. On the road this might include 'stacking' of cars on the motorway, in rail this might mean keeping passengers on a train or station platform. The reasons for this are two-fold, to restrict a given problem's impact on the wider network and given limited information availability, to keep the issue within a visible operational space. When social media (such as Twitter) are overlaid onto this, problems develop particularly where information shared by travelers is not accurate leading to a maladaptive response. The sum effect of this is to escalate a disruption that already pushing the network towards the margins of its capability to handle, well out of the envelope of control to a state where controllers and the system as a whole are unable to contain/react. Examples described included small villages clogged with motorway-level queued cars and the movement of large numbers of passengers to low capacity lines/stations in the rail network with further knock-on effects. Similar imbalances may start to occur even in relatively routine situations, where transport operators efforts at load spreading to optimize their network and relieve pressure, are undermined by social media and new forms of user-based journey recommender systems.

A further difficulty considered from a decision making for action perspective is that if we think of transport control as an Observe-Orient-Decide-Act loop (OODA, [3]), all four stages of this process are substantially slower within a formal 'architected' system than in the decentralized system created amongst passengers via social media (see [4] for an analogous account of a mismatch within military command and control), ultimately rendering many control measures at best inefficient or at worst counterproductive. Within the rubric of Human Factors, we would consider that a new variety of situation awareness is required relating to traveler information exchange and activity (see [5]).

5. CONCLUSIONS

Adopting a specific focus in understanding the place of new varieties of user data in transport control, we generate two potential use cases for taking on further, both of which concern social media. The first is its use in what me might term 'off-grid sensing', that is gaining SA of the transport network surrounding and therefore potentially impinging upon the controlled network. A second concerns giving visibility of 'buzz' on social media to rail controllers in a way that allows integration with existing decision making processes. This is currently being followed up through a short series of industry-specific workshops.

6. ACKNOWLEDGMENTS

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