Move Closer : The Benefits of A Flexible Approach to Display and Application Placement (Demo)

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ABSTRACT

Display appropriation provides a means by which mobile users can cyber-forage local display hardware to provide them with access to a high-quality output device. However, displays are of little use without applications to drive them and yet the nature of application support has been largely ignored in the field – with the prevailing assumption being that applications will be cloud-based and Web-centric. In this demonstration we show a system that presents an alternative vision in which users are able to cyber-forage for *both display and compute resources* in their local area – enabling them to execute high-performance applications that would not be possible using purely Web-centric technologies. The demonstration leverages a cohesive suite of existing systems, i.e. cloudlets, Internet Suspend/Resume (ISR), Yarely and Tacita, to deliver this vision.

Categories and Subject Descriptors

H.5 [**Information Interfaces and Presentation**]: Miscellaneous

Keywords

public displays, personalisation, cyber-foraging, cloud computing

1. INTRODUCTION

In this demonstration we show how public displays can be appropriated for resource-intensive end-user applications. Research has shown that there are a wide range of potential use cases for display personalisation [5]. Such use cases range from simple walk-by personalisation to facilitate tailored adverts through to longer-term interactive personalisation in which a user appropriates a public display for their own purposes. Our work focuses on supporting applications that demand access to high performance computational and display resources and are not amenable to purely Web-centric solutions.

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Previous work in the area of display personalisation (e.g. [9], [6], [3]) has focused on the choice of networking and location technologies to trigger personalisation and the nature of content that might be shown. These systems have tended to rely on Web technologies to deliver the personalised content. More specifically, most of the prototype systems adopt a thin-client approach in which the computer driving the public display is little more than a Web browser accessing cloud-based applications that supply the content.

Pure cloud-based approaches suffer from a number of significant shortcomings when looking to support resource-intensive end-user applications:

Inability to survive disconnection Pervasive displays that rely on a thin-client approach have a limited ability to survive network disconnection, despite recent advances in support for this in HTML5.

Limited access to native resources Browser-based applications have necessarily limited access to local resources.

High latency For highly interactive applications, research has shown that accessing cloud-based services may introduce unacceptable delays[2].

One approach to addressing these difficulties would be to situate application functionality on displays themselves – essentially supporting native applications running on pervasive displays. However, this approach also has drawbacks, not least that digital signs need to provide high levels of reliability as by definition their output is highly visible.

We believe one solution might be to leverage recent work on cloudlets [8] to provide well-resourced computation close to or even co-located with individual pervasive displays. In this demonstration we show the potential of this approach using a suite of established systems: cloudlets [8], ISR [7], Yarely [1] and Tacita [3].

2. TECHNOLOGY OVERVIEW

2.1 Cloudlets and Internet Suspend/Resume

Cloudlets [8] are a systems approach to providing flexible provisioning of cloud-based applications proximate to the end-user. In particular, cloudlets provide a hosting environment for user VMs that can be migrated between the cloud itself and different cloudlets in response to user mobility. This provides local computational resources that can be used both to off-load processing from resource-constrained mobile devices and to reduce the round-trip latency that

would be incurred if mobile applications were forced to communicate with the distant cloud when functionality was offloaded. Typical application scenarios involve tasks such as image and sound processing.

Internet Suspend/Resume (ISR) can be used as a technology to support the migration of cloud-based user VMs to cloudlets closer to the user themselves. ISR provides a range of features to make such VM migration both secure and efficient.

2.2 Tacita and Yarely

We support display personalisation using two pre-existing technologies: Tacita and Yarely. Tacita provides display personalisation capabilities while Yarely is responsible for scheduling and realising the display of content on the public display.

In more detail, Tacita is designed to enable viewers to personalise the content shown on public displays. Tacita supports personalisation by having displays publish their capabilities for personalisation to mobile devices. Viewers' mobile devices send customisation preferences directly to the (typically cloud-based) applications that produce the content for the display concerned and not to the display itself. Thus, Tacita builds on existing relationships between users and cloud-based applications rather than requiring the formation of new relationships between viewers and each display they encounter. Once a cloud-based application has prepared personalised content it contacts the target display to request screen real-estate. Tacita has been demonstrated at a wide range of venues including PerDis 2012, HotMobile 2012, MobiSys 2012 [3] and Digital Futures 2012 [4].

Requests from Tacita applications for screen real-estate are received by our custom signage player called Yarely. Yarely is a python-based player that currently runs on Mac OS and also on Debian Linux on the Raspberry Pi. Yarely has a flexible internal architecture that enables it to establish new renderers for different types of content and to respond to external triggers to pre-fetch and schedule content items. Thus while Yarely is able to show Web-based content it is equally able to invoke native applications if required. Yarely is in daily use in Lancaster University's digital signage network.

3. DEMONSTRATION

In this demonstration we show how cloudlets, ISR, Tacita and Yarely can be combined to enable viewers to effectively cyber-forage for both display and computational resources. More specifically, the system enables users to suspend and resume VMs in their local environment – redirecting the output of the VM to a near-by display. Crucially, we show VMs running on a range of cloudlets including one that is *co-located on the same physical hardware* as is being used to drive the public display. Physically co-locating cloudlets and displays enables hosted VMs to produce very high-quality output such as 1080p video that would not be possible using a browser-based VNC/SPICE client in combination with a headless VM situated at a remote cloudlet.

Our system maintains the same basic architecture as Tacita and uses a cloud-based service to respond to viewer display requests. This service is then responsible for coordinating VM location and (if necessary) resumption and then passes an appropriate request to the display. The performance gains of this approach over a browser-based solution will be demonstrated.

4. CONCLUSIONS

We believe that public displays will form an important component of future pervasive computing environments. However, these displays will not operate in isolation – rather they will work in tandem with a pervasive computational infrastructure based on cloudlets. In this demonstration we show the practical benefits in application performance that such an approach can deliver.

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