PROPOSAL: Unicore

Roles		
Project Mentor:		<simon.kuenzer@neclab.eu> <felipe.huici@neclab.eu> <florian.schmidt@neclab.eu> <lars.kurth@citrix.com> <sstabellini@kernel.org> <wei.liu2@citrix.com></wei.liu2@citrix.com></sstabellini@kernel.org></lars.kurth@citrix.com></florian.schmidt@neclab.eu></felipe.huici@neclab.eu></simon.kuenzer@neclab.eu>
Background		
In recent years, unikernels have shown the imm have. By leveragin OSes, unikernels are ab instantiation timm footprints (a few Gb/s), and high c of instances on a sin attack surface and Unikernel projects worthy o Xen,	mense potential for ng specialization as le to yield impress es (tens of millise MBs or even KBs), onsolidation (e.g., ngle commodity serve d the potential for	projects dedicated to performance gains that these nd the use of minimalistic ive numbers, including fast conds or less), tiny memory high network throughput (10-40 being able to run thousands er), not to mention a reduced easier certification. irageOS, ClickOS, Erlang on ng others.
applications be m (e.g. having to p OSv); this require of time. In essen performance with unikernels, and decreased eff The goal of this providing	anually ported to the ort nginx, snort, my es both expert work ce, we need to pick or no porting effor iciency with standa proposal is to chang	<pre>ls is that they require that he underlying minimalistic OS ysql or memcached to MiniOS or and often considerable amount between either high t but decreased performance rd OS/VM images. ge this status quo by base; we call this base</pre>
		e the various efforts ity regarding minimalistic

OSes (essentially different variants of MiniOS). We think that splitting the community across these variants is counter-productive and hope that Unicore will provide a common place for all or most improvements and customizations of minimalistic OSes. The long term goal is to replace something like MiniOS with a tool that can automatically build such a minimalistic OS.

Unicore - The "Unikernel Core"

The high level goal of Unicore is to be able to build unikernels targeted at specific applications without requiring the time-consuming, expert work that building such a unikernel requires today. An additional goal (or hope) of Unicore is that all developers interested in unikernel development would contribute by supplying libraries rather than working on independent projects with different code bases as it is done now. The main idea behind Unicore is depicted in Figure 1 and consists of two basic components:

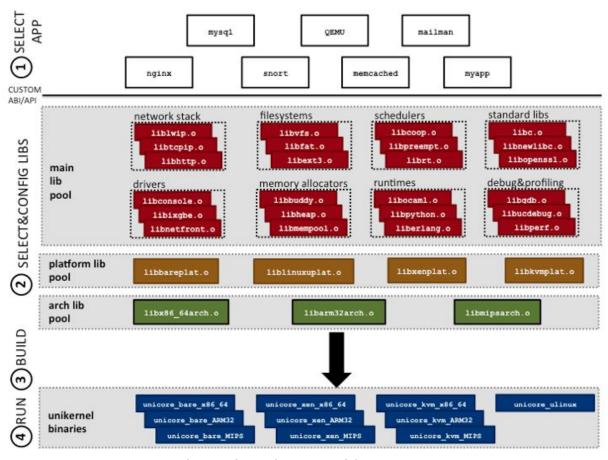


Figure 1. Unicore Architecture.

Library pools would contain libraries that the user of Unicore can select from to create the unikernel. From the bottom up, library pools are organized into (1) the architecture library tool, containing libraries specific to a computer architecture (e.g., x86 64, ARM32 or MIPS); (2) the platform tool, where target platforms can be Xen, KVM, bare metal (i.e. no virtualization) and user-space Linux; and (3) the main library pool, containing a rich set of functionality to build the unikernel from. This last library includes drivers (both virtual such as netback/netfront and physical such as ixgbe), filesystems, memory allocators, schedulers, network stacks, standard libs (e.g. libc, openssl, etc.), runtimes (e.g. a Python interpreter and debugging and profiling tools. These pools of libraries constitute a code base for creating unikernels. As shown, a library can be relatively large (e.g libc) or quite small (a scheduler), which should allow for a fair amount of customization for the unikernel.

The Unicore build tool is in charge of compiling the application and the selected libraries together to create a binary for a specific platform and architecture (e.g., Xen on x86_64). The tool is currently inspired by Linux's kconfig system and consists of a set of Makefiles. It allows users to select libraries, to configure them, and to warn them when library dependencies are not met. In addition, the tool can also simultaneously generate binaries for multiple platforms.

As an example, imagine a user wanting to generate a network driver domain unikernel. In this case, we would assume the "application" to be the netback driver. To select this application, the user would first run "make menuconfig" from within the netback application folder. The Makefile there would set a variable to indicate what the application is, and would include the main Unicore Makefiles so that the unikernel can be built (Step 1 in the figure). Using the menu-based system, the user chooses the relevant libraries; for a Xen driver domain this would include a physical network driver, the netback driver, the libxenplat library and a library from the architecture library pool such as libx86_64arch (Step 2 in the figure). With this in place, the user saves the configuration and types "make" to build the unikernel (Step 3) and "xl create" to run it (Step 4).

A note on the ABI/API exposed to the application: because Unicore allows for customization of the unikernels, the ABI (or API since there is no kernel) would be custom, that is, defined by the libraries the user selected. Having said that, it would be perfectly possible, for instance, to build POSIX-compliant unikernels with it (e.g. similar to Rump, but in principle with much more specialized OS layers).

Finally, it is worth pointing out that we use the term application loosely: another clear target for Unicore is the building of runtime-specific unikernels (e.g. a unikernel able to run Python or OCaml scripts as is the case with MirageOS).

Relevance to Xen and its Community

Unikernels are important to a number of areas relevant to the Xen community, including IoT, automotive, stub domains, and driver domain/dom0 disaggregation. Unicore could help boost the progress in all of these areas by quickly providing the necessary tools to create unikernels for them. For instance, for a driver domain, the user would include the "library" containing the relevant hardware driver and corresponding back-end driver, and in principle Unicore would take care of the rest.

In addition, Unicore could eventually replace Mini-OS, providing a cleaner, more stable and flexible base from which to build unikernels for projects (the modularization of Mini-OS is in fact already taking place).

Current Status

Unicore is at an early stage. For now it includes some base libraries with code extracted from Mini-OS as well as a build tool inspired by Linux's KConfig system. Unicore is currently able to build "hello world" unikernels for Xen and Linux user space on x86 64 and ARMv7.

Incubation

The reason behind making Unicore a Xen sub-project project is to (1) bring the existence of Unicore to the attention of the Xen community and to outside world; (2) to attempt to harness interest and potentially development cycles from people and companies interested in unikernels; (3) to concentrate maintenance resources from people interested in unikernels within the community; and (4) to have a legal entity behind the project. License _____ The main license of the run-time components of Unicore will be a 3-clause BSD license, unless there is a good reason not to use it (e.g. we may import 2-clause BSD licensed code from Mini-OS, which we would *not* anticipate to change). The Makefile system would be licensed under GPL v2 or later as we want to be able to use KConfig functionality from Buildroot/Linux. Required Infrastructure _____ The official repositories should be created on [http://xenbits.xenproject.org/] under `unicore.git`. There should be a main repository for the core unicore implementation and additional repositories for some more advanced extension libraries (e.g., lwIP, newlib). ### Main repository `unicore.git` ### Repositories for extension libraries Repositories for additional libraries that are supported by the Unicore project should exist under a separate directory: `unicore-libs/` For example: `unicore-libs/lwip.git` `unicore-libs/newlib.git` ### Mailing list In the beginning we would use the MiniOS mailing list (minios-devel@lists.xenproject.org). When we get traction with Unicore we could consider splitting that traffic onto a unicore

mailing list.