ASSOCIATE ARTICLES

Free association between operating systems and telephone applications

The operating system of a PBX is a key element because of its ability to incorporate quickly any new applications that customers require, while continuing to provide the same levels of performance in terms of response times and security of the corporate telecommunication system. The multiplicity of technologies has generated a multitude of applications to satisfy the market's constantly growing demands. Consequently, not even the most powerful manufacturer can develop a complete portfolio of products by itself. In order to remain successful in the market, it is necessary to seek recourse to external solutions.

The choice of Operating System (OS) is becoming a strategic factor in satisfying demands for open systems and switching compatibility in a totally controlled economic environment. The following two articles describe the solutions used to allow Alcatel OmniOffice software to be *fully* reused on Linux and the Alcatel OmniPCX 4400 software on Windows NT and Linux.

J.-L. Boulet, A. Marchesin

Systems for small enterprises: upgrades to the Alcatel OmniOffice platform and the use of Linux

The architecture of the Alcatel OmniOffice system has to change to satisfy the increasingly sophisticated needs of small businesses. A new platform based on a PC Linux architecture is ideal.

Introduction

The Alcatel Office range of products is aimed mainly at Small and Medium Enterprises (SME). It covers small digital communication systems with a capacity of between six and 200 terminals. Alcatel sells about 70 000 systems a year, totaling some two million lines.

To provide a better response to the emerging requirements of SMEs, the platform has to change: it now offers OmniOffice the openness that small companies require in the current environment. Convergence between voice and data communications, Internet access and the coupling of telephony and information technology are the cornerstones of this change.

Main Changes to the Platform

System management is fully centralized. Everything is handled by a single PC processor, together with an Application Specific Integrated Circuit (ASIC) and two Digital Signal Processors (DSP) which perform the switching, signal processing and remote maintenance (V.34 modem), as shown in *Figure 1*. The twin benefits of this approach are that interface cards with only minimal intelligence can be used, reducing the cost of the system and enabling new applications to be integrated. In addition, the CPU is dimensioned to cope with these applications.

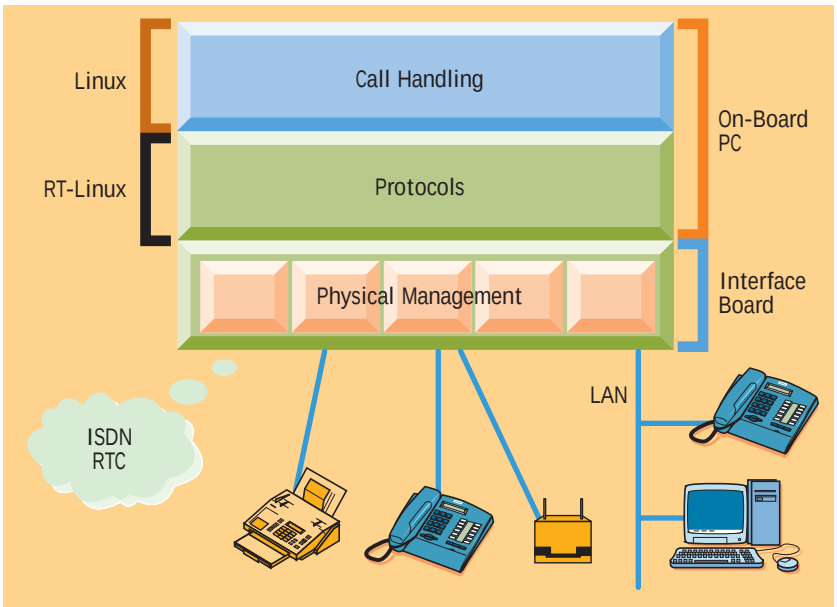

Figure 1 – Logicial architecture

Why Linux?

OmniOffice is, first and foremost, a Private Branch Exchange (PBX): thus call handling remains the most important application on which the system is based. However, today's enterprise communication systems are required to provide increasingly sophisticated applications, so the plain old telephone system now has to be enriched not only with common optional features, such as voice mail or the Automated Attendant (AA) facility , but also applications, like e-mail, that are not normally supplied with this range of products.

These applications share the system's resources with the telephony function, hence the need for considerable computing power and large memory capacity. They can be sold without additional hardware, or be included from the outset in the communication system to make it a more attractive product.

In the case of services that are not directly integrated into the PBX, Computer Telephony Integration (CTI) protocols are provided to help corporate information systems to run applications like Automatic Call Distribution (ACD).

OmniOffice can also serve as an Internet gateway, enabling a company to arrange with an access provider to provide electronic mail and Internet access to employees using the same system they use for telephone calls. In addition, the Internet can be used to interconnect several OmniOffice systems, enabling a company to create a Virtual Private Network (VPN) for a modest outlay.

OmniOffice administration (configuring, downloading software updates, charging, etc) can be done remotely from anywhere with access to the Internet, thereby reducing the installer's system maintenance costs.

Finally, the OmniOffice system supports the transport of voice over corporate private data networks or over the Internet using Voice over IP (VoIP).

All these services naturally influence the choice of hardware and software platforms for a particular product. Apart from telephony, which remains separate, the other services (firewall, e-mail server, protocol stacks, etc) are available on "standard" platforms, normally on Windows NT or Unix/Linux servers. It is therefore natural to use such as platform to minimize costs and development times for new applications and add the telephone part that we control.

Both technically and functionally, the two types of platform mentioned above are entirely satisfactory. However, within the range of systems spanned by OmniOffice, the cost of the product and, in particular, of the platform, must be kept as low as possible. This led us to choose the Linux operating system as it is not subject to licenses and does not need vast resources to run a system like OmniOffice. Also, all the applications that are of interest to OmniOffice (in particular, those that are Internet-related) are available under Linux at minimal cost.

The free availability of Linux software means that the source files can be accessed, enabling the entire system to be better controlled.

Finally, the choice of a hardware platform based on an onboard PC architecture (i.e. all the components of a PC are on a single board integrated with the system) considerably reduces the workload needed for porting to Linux; only a few specific drivers remain to be developed.

Using Linux

The OmniOffice system belongs to the "real-time" category of onboard systems; this means that they can *always* respond to an event within a predefined time. For example, some network protocols demand responses to enquiries within very precise time limits, which are normally very short. Whatever the state of the system, it must be able to respond within the allotted time.

Linux cannot handle tasks in real-time; *on average*, it can respond to events within a predetermined time, but this *is not always the case*. In the technical literature, this is referred to as "soft real-time", as opposed to "hard real-time", which is what we need. There are a number of reasons for this, but the main one is that some kernel operations cannot be pre-empted. Consequently, when even a low priority process is performing this kind of operation, it cannot be interrupted in favor of a higher priority process. This is unacceptable, because the high priority process *must*, in all cases, be activated immediately. The consequences of this illogical behavior can sometimes be perceived by the user (e.g. wrong number, tone fails to stop).

To achieve the required level of determinism, an *extension* must be added to Linux. The two extensions currently available – Real-Time Application Interface (RTAI) and Real-Time Linux (RTLinux), are based on the same principle. For simplicity, think of it as a simple *real-time executive*, as opposed to a full operating system, in which the lowest priority task (in the executive sense) is Linux as a whole (see *Figure 2*); RTLinux (or RTAI) takes control

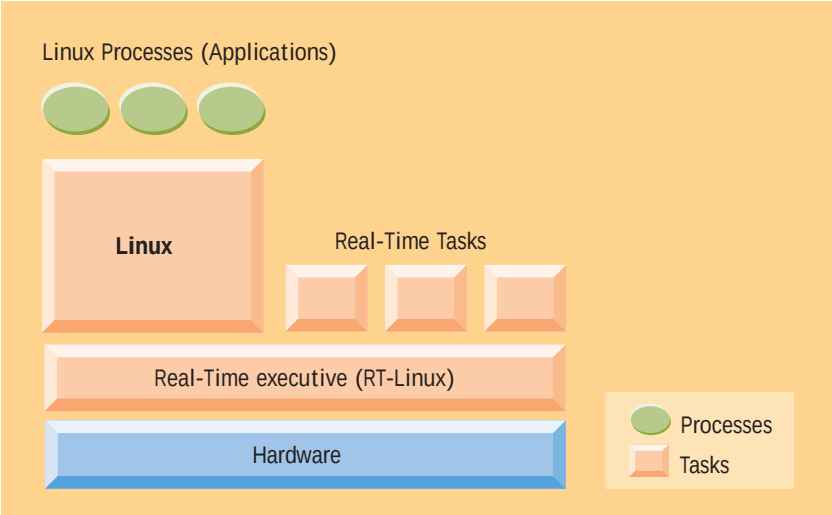

Figure 2 – Linux and its real-time extensions

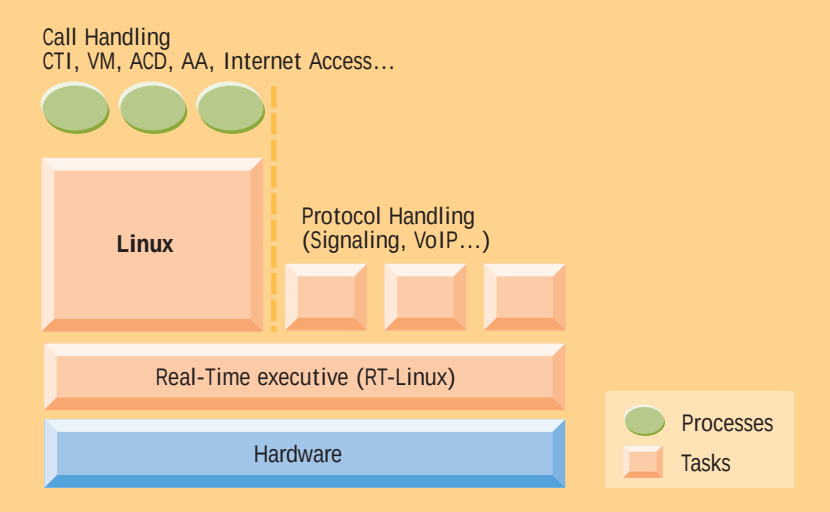

Figure 3 – Alcatel OmniOffice running under Linux

of the machine, mainly by intercepting all the interrupts normally addressed to Linux and reassigning them to Linux only when all the real-time tasks have been serviced. Moreover, interchanges between the Linux processes and the executive tasks are enabled via miscellaneous communication resources. In this way, applications requiring "real time" functionality (like telephone protocol management) can cohabit with other less demanding applications (such as voice mail or Internet access) on the same machine.

Real-time applications are developed using the Portable Operating System Interface (POSIX) available with RTLinux and RTAI. RTLinux, currently the most commonly used extension, was chosen for OmniOffice. If the more recent RTAI add-on were to become necessary, any adaptation work would be minimized by using POSIX. Lastly, if a future version of Linux were to provide native support for real-time requirements (i.e. without the use of an extension), porting effort would again be minimal as Linux also supports the POSIX interface.

The use of Linux/RTLinux in OmniOffice is illustrated in *Figure 3*. The software has been divided into a real-time part (based on RTLinux) and a non-real-time part (based on Linux) which collaborate with one another. This has been made possible thanks to the architecture of OmniOffice. The division already existed; the real-time part is small and the code mainly comprises state machines. For example, a Linux application provides Internet access; the application asks the call handling function to control the use of the telephone protocols (real-time) to set up a connection with the access provider (see *Figure 4*).

Development Environment

The existing development environment (TeamWare running on SUN/Solaris) uses a crossed GNU production line (C/C++ compiler: gcc) to generate both the Linux core and the applications. Debugging Linux programs is done using a standard gdb tool (*debugger*) which we have adapted to RTLinux to debug the real-time modules.

Various Aspects of Using Linux

Linux is evolving along two different lines. Development versions, which are identified by their odd version numbers (currently 2.3.xx), are produced at frequent intervals; they are designed to be

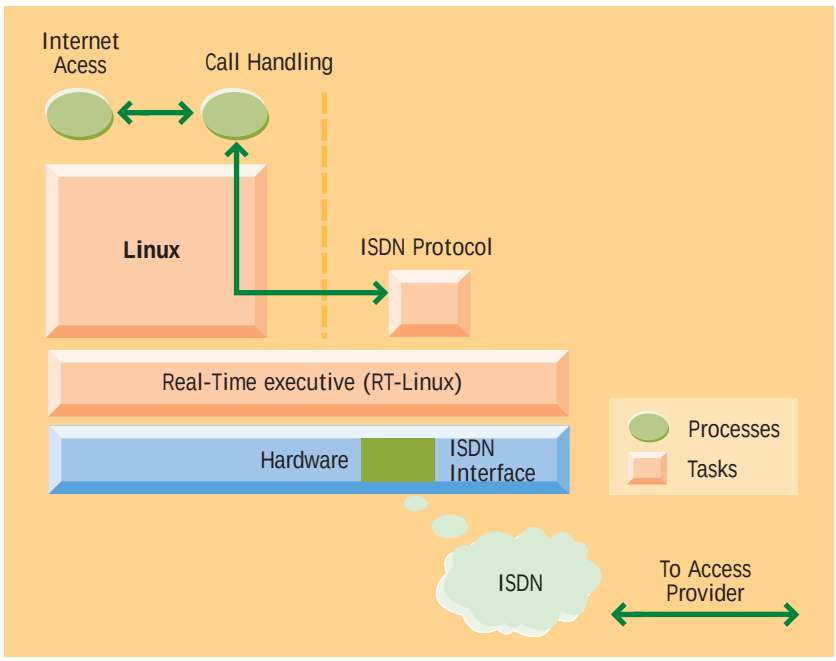

Figure 4 – Internet access with Alcatel OmniOffice

tested by the development community in order to improve quality. The stable versions, identified by even numbers (currently 2.2.xx), are development versions that have reached maturity; they are used in products and evolve more slowly (approximately two versions per year).

OmniOffice is using the current stable version; new versions will be installed only when justified (e.g. to introduce a major new feature).

Linux is "freeware", the fruit of collaboration between a community of developers. The right to use freeware is based on copyright. The author – the creator of the software – allows the user rights of use through a license agreement. Various types of free license exist, and Linux is governed by the GNU General Public License (GPL) which allows it to be used, even commercially, provided that any modifications made by the user are made available to the community. This means, for example, that any improvement to an algorithm used by Linux must be published. However, since our core business is not publishing operating systems, we will not normally find ourselves modifying those that we use. If, however, the situation were to arise, it would be only fair to comply with the rule, in return for the benefits that we obtain from using Linux.

Conclusion

Enterprise communication systems are requiring more advanced services that proprietary platforms can no longer provide without considerable effort. Consequently, it has become essential to use standard platforms. Linux provides an inexpensive way of building such platforms. ■

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Linux was developed by a Finn, Linus Torvalds, in the early 1990s at Helsinki University.
Linux is a UNIX type, multitasking and multi-user operating system for machines with 32 and 64 bit processors (in particular, PC and PowerMac machines), open to networks and other operating systems. Linux is compliant with the POSIX standard and market standards, particularly the Internet.
The main feature of Linux is that it is free, developed collaboratively, and mostly free of charge by thousands of programmers around the world. Independent analysts consider its quality equal to that of equivalent market-standard products.
Linux's «official» mascot is the penguin, which was selected by Linus himself to symbolize the image he wanted associated with his creation. (see http://www.linux.org/info/penguin.html)