Mobile Internet: The Drivers and Transition to IPv6 for Mobile Network Operators

Phil Roberts, Director of Mobile Network Architecture, Megisto Systems, Inc.

Introduction

As the penetration of mobile phones reach saturation levels in many markets, new revenue sources are required to drive increasing ARPUs (Average Revenues per Unit or Subscriber) and sustain growth. Key to many operator strategic plans is the addition of data services to mobile subscriber services targeted to both the business and the consumer subscriber.

Such services are expected to result in a proliferation in the kinds of devices attached to the Internet. The next generation Internet Protocol, IP v6, is one of the technologies being looked toward to enable mobile data services, not only for its abundance of address space which is certainly needed, but also for the opportunity for a restored level of architectural cleanliness that will both enhance and simplify the deployment of many new mobile data services.

This paper discusses some of these potential new mobile services, the kinds of devices that would enable such services, and details how IP v6 technologies are key to enabling many of the services and to simplifying the operation of the networks that provide them.

Drivers for IP Version 6

Data services have been available over mobile networks for some time. Although the uptake on these services have been weak so far, the synergy enabled by new devices, always-on networking technology, and optimized applications promises to create a boom in the use of data services over mobile networks.

Business users are already accustomed to accessing corporate services remotely through the use of dialup connectivity. As long as access to such services is restricted to the use of laptop computers, the widespread appeal of accessing such services in an untethered manner remains low. Mobile operators are looking to expand the business user market through the introduction of a spectrum of small handheld devices that are capable of delivering a large set of corporate data services without the use of a cumbersome laptop device. Handheld personal digital assistants are now available that allow the viewing and manipulation of the most commonly used text files, spreadsheets, and electronic mail – and that will allow the deployment of a myriad of new applications including remote sales force management and enhanced personal information management. Offering wireless data interfaces over mobile networks that enable the use of these data services in a truly untethered manner holds out the promise of a boom of new data usage on mobile networks for customers who are willing to pay for the use of the data services they use daily to do their jobs.

Operators also hope to entice consumer users with an entirely different set of data services also enabled in easy-to-use handy to handle devices. Multimedia services include such promising new technologies as handheld digital cameras and videophones that allow users not only to see the people they are communicating with but the setting of the communication such as a child's soccer game or a hot tourist attraction. Appeal to a younger generation may also include downloadable music and interactive games. Innovative charging services including subsidized billing, reverse billing, toll free and premium access will drive both the uptake and the revenues associated with consumer services.

Success of services such as these will result in not only 10s of millions of connected laptops for high-end business users, but instead 100s of millions of connected handheld devices. Widespread deployment of these new services requires a technology that provides users with a stable and always reachable identity and that supports a rich mix of networking capabilities. The enormous number of new devices requires a large address space such as is provided with IP v6. The ability of these devices to be always on and the need to be reachable through a stable identity is also provided with IP v6. The sheer number of devices requires that they have little configuration overhead. IP v6 offers serverless autoconfiguration to help alleviate configuration issues. The obvious mobility of such devices requires solid protocol support for mobility that is also enabled with IP v6. And the operator and customer expectation that their sensitive data will not be exposed to the world or that their networks will not be compromised demand an integral support for secure network services which is another key feature of IP v6.

Interim Solutions

The most immediate felt need in the technology to enable such networks and services is the shortage of addresses remaining with IP v4. The number of remaining allocable addresses continues to decrease and the difficulty in obtaining new addresses continues to increase. Mobile network operators have chosen to use private addresses for a large number of devices when the use of a private address is appropriate.

Some vendors are building highly scalable NAPT (network address and port translation) devices to enable this operation. NAPT technology was introduced in the 90s as a way of extending the address space of IP v4 and quickly caught on. It is widely used in both

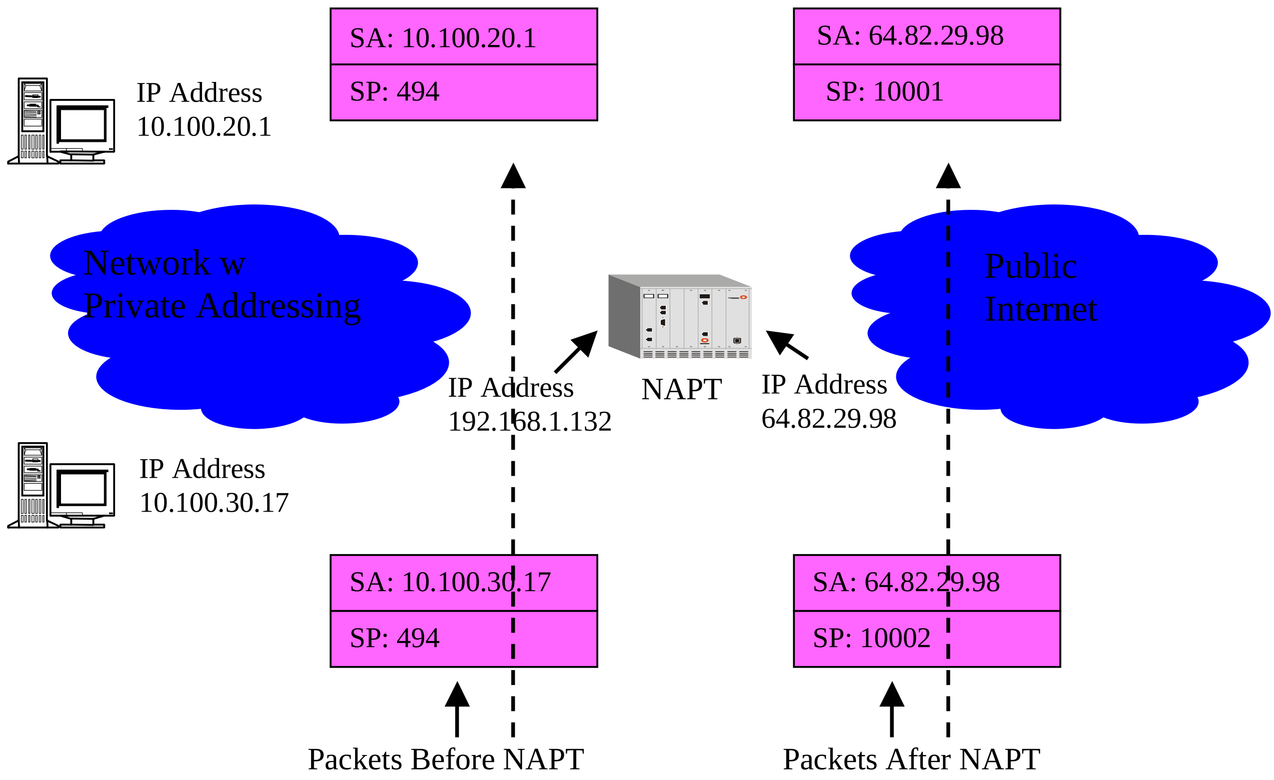

Figure 1: Simplified Representation of NAPT Operation

corporations and home settings and is a standard feature on many very inexpensive devices enabling high-speed data services in the home.

Network address and protocol translators work by mapping a potentially large set of private addresses into a smaller set of public addresses. This is possible because of the reuse of port numbers in the protocol on the public side of the translation – many IP addresses using potentially the same protocol port number are mapped to a smaller set of addresses using different protocol port numbers. The resulting address sharing allows for the addition of many more devices to the network without consuming precious addresses for each of the devices.

Although this may help alleviate the crunch that is being felt on address space in the short term, this technology does not come without its own problems. The authors of the original NAPT specifications realized that there would be limitations and difficulties with the use of NAPT technologies. Over time these concerns have been borne out. NAPT at its very core breaks the transparency of end-to-end communication and leads to the creation of special Application Level Gateway software to enable protocols to function that were not defined to function with NAPT between the endpoints. Enabling NAPT within a network requires significant state to be maintained within certain network elements which increases the processing burden of network elements which otherwise would not be so encumbered and the vulnerability of end users to the failures of the network elements that maintain that state. Perhaps most importantly the presence of NAPT technology makes it difficult to maintain a stable user identity that is reachable from the public side of the NAPT device. This severely limits the kind of applications that can be enabled on the devices in the private address space.

The State of Standards

The Internet Engineering Task Force (IETF) has been working on the new Internet Protocol for some time. The IETF has three stages of standards: Proposed Standard, Draft Standard, and Standard. A Proposed Standard can be specified without any interoperable implementations, but a Draft Standard is only approved with multiple independently developed implementations. Most of the key protocol components have a demonstrated level of maturity by the recognition that they have attained a Draft Standard status. It is also important to keep in mind that this new set of protocols was designed with the insights obtained from the years of experience using the IP v4 protocols in universities, corporations, and the commercial Internet.

The European mobile community has shown eager interest in adopting the IP v6 protocol through the specification of its usage in the base specifications of the General Packet Radio Service. There are already specifications defined for the operation of IP v6 to the mobile handset. The 3gpp standards body took a significant step in its definition of the new Internet Multimedia Service (IMS) for UMTS Release 5 by mandating that all IMS protocols operate on IP v6 and on IP v6 only. Such a specification means that mobile devices using the Internet Multimedia Service and those network elements that enable it must be IP v6 enabled.

Smooth Transitions

Deploying a new protocol that enables new features and new services to billions of devices does not mean that the networks must be rebuilt from scratch. The designers of IP v6 realized that a smooth transition is key and made provisions for a transition strategy that sees devices with new capabilities attached and interconnected with existing networks. Mobile networks will be one of the crucial networks to see large-scale commercial deployment of the new technologies in the near future.

Many new components are needed to enable services based on IP v6 – the most obvious of which are end stations tjat communicate and offer applications on IP v6. Routing infrastructure is also needed capable of performing IP v6 forwarding and updating routing

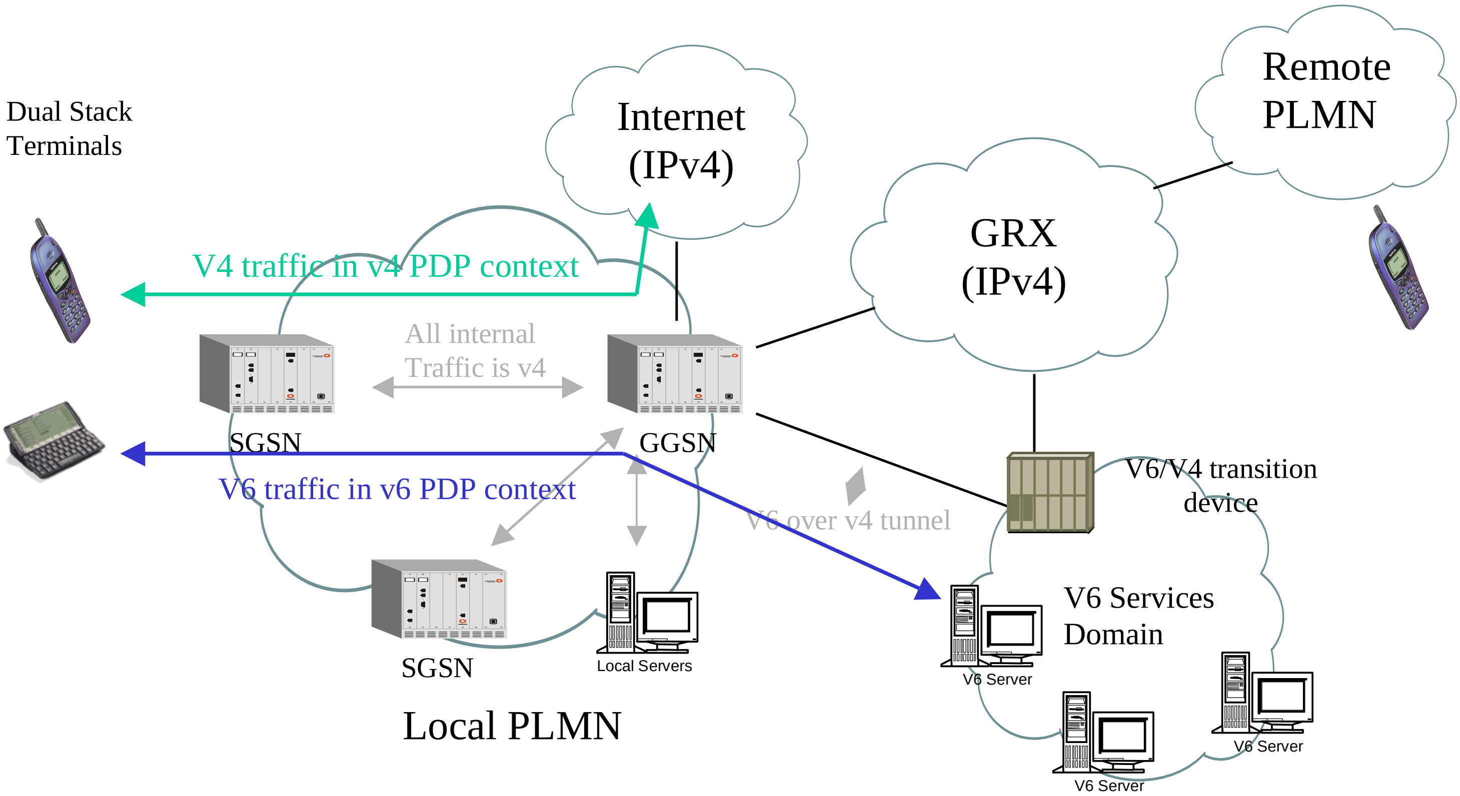

Figure 2: GPRS network in Transition towards IP v6

infrastructure to forward to the correct destinations. The standard support infrastructure also needs to have v6 capability – DNS, AAA, etc.

It is likely that end devices will operate in networks which have some v6 capability and some v4 capability, so dual protocol stack support is needed with the device having the ability to determine which protocol to use on which interface and for which applications. An example is mobile handsets that may use some services on v4 (such as general Internet access to legacy sites) and some services on v6 (such as IP multimedia services). Infrastructure to support this operation will also have some dual stack support. Gateways must exist that can forward IPv6 packets on IPv6 user contexts and I v4 packets on IPv4 user contexts.

The following diagrams show a possible evolution of GPRS networks to support IP v6 based services, beginning with GPRS and leading to full IMS support. The first diagram introduces the key components for data networking in a GPRS system. In this diagram the handset has the ability to open IPv4 PDP contexts and IP v6 PDP contexts. A Gateway terminates both of those contexts and forwards v4 traffic on its v4 interfaces. IP Version 6 traffic is forwarded into v6 over v4 tunnels to IPv6 enabled routers that have reachability to IPv6 service platforms. Notice that the radio access equipment is all legacy protocol connection

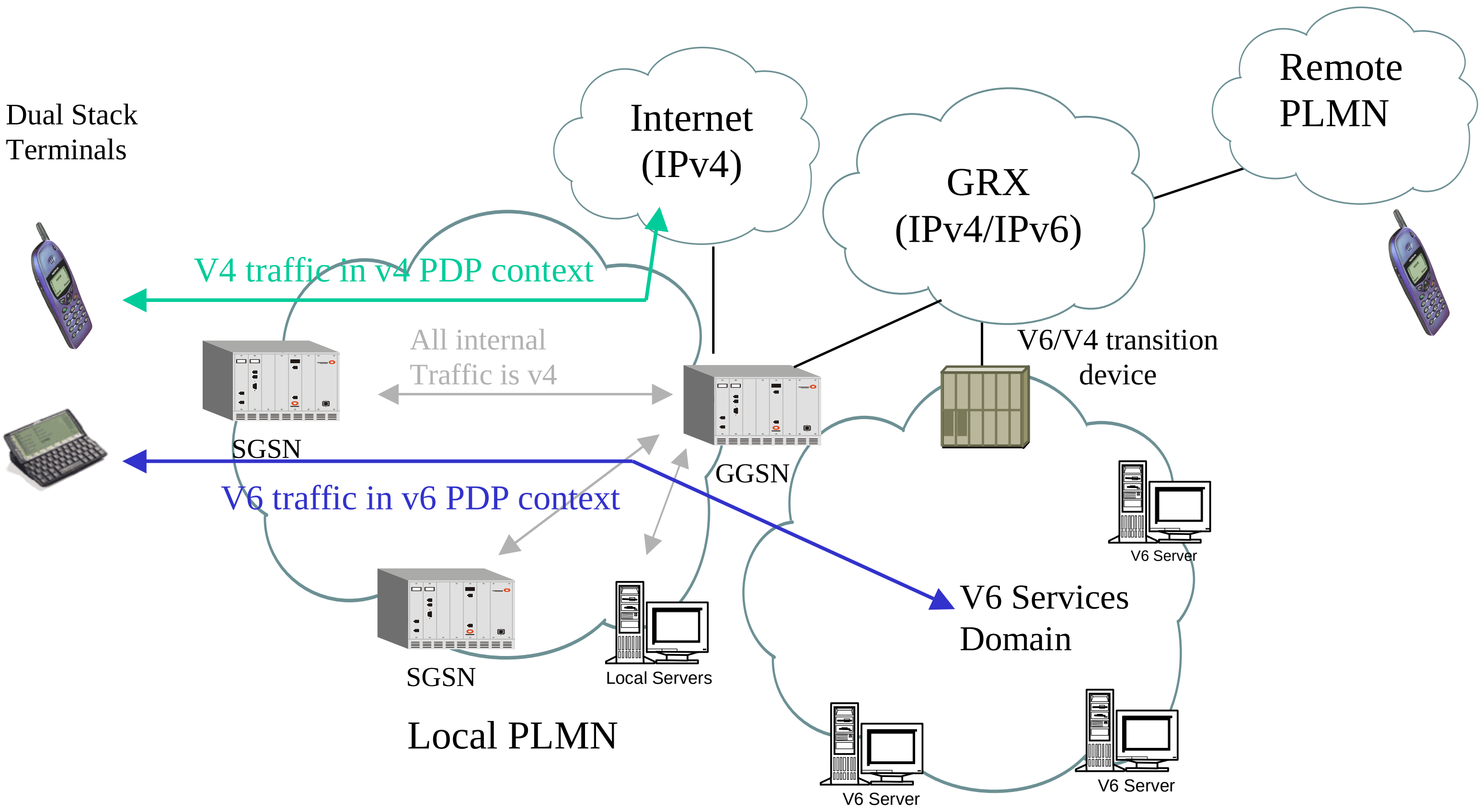

Figure 3: GPRS with Tighter v6 Integration

including IP v4. IP version 6 is not needed in this domain for some time. Although connections to support infrastructure are shown over v4 interfaces, they have v6 capabilities such as v6 AAA records. Such a network allows significant IP v6 service capabilities to and from user handsets including unique and stable user identity enabling push services to the mobile device or server type operation at the mobile node.

The second diagram is a simple upgrade of the first diagram but in which the Gateway supports native IPv6 interfaces to other network elements. Such a configuration may allow simpler and more efficient operation of network elements but does not necessarily add new or significant service capabilities for the mobile devices.

It is in the end possible to imagine IP v6 interfaces on every network element and native IP v6 used to connect everything. Such a network may be a long time in coming, but the earlier diagram shows how it is possible to get significant IP v6 capabilities without having to build a totally new network or upgrade very network element.

The Status of the Transition

Most of the network infrastructure elements have been defined in protocols and there are existing implementations. Many vendors now offer commercial products with full commercial support both for routers and end station software.

The 6Bone was established for testing interoperability of IP v6 services and has been around for some time. There are 100s of sites on the 6Bone consisting mostly of university and corporate research labs and vendors who are testing their v6 implementations. The 6ren is an example of production infrastructure support enabling transit services of v6 for support of research and education. But there is still limited commercial IP v6 deployment in ISPs.

For mobile network operators, as always, the key component for enabling service in their networks is the mobile handset, whether it is a phone or some sort of PDA. Such devices are expected to be available in the immediate future as are significant new applications making use of the rich feature set of the mobile network and of IP v6.

Conclusion

Until recently, IPv6 has been viewed as an interesting technology without a business case or much market momentum. However, it is now emerging as an important, if not essential, addressing option for the Mobile Internet. The Mobile Internet may provide the first real reason for IPv6 adoption, and many mobile operators are now focused on being at the leading edge of IPv6 deployment. Mobile network operators stand to gain much from the deployment of IPv6 and it is expected that they will step up and to lead the way.