



White Paper:

6WINDGate™

eXtensible Management System

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1 INTRODUCTION: NETWORK PRODUCT DEVELOPMENT ISSUES

One of the most costly and time-consuming challenges facing equipment vendors today is managing software integration and interface across their various products and sub-systems.

For better time-to-market to overcome competition, equipment vendors and system integrators are increasingly buying off-the-shelf networking software. As end-customers accept with difficulty to use several discrete management applications to configure different features within the same device, management consolidation across home-grown and third-party features is a clear issue. It is a tedious development task if this issue has not been considered carefully at the beginning.

Indeed, the market demand for rich and advanced IP services creates the need to support an ever-increasing number of IP features in equipment and systems. As networks become more intelligent, the complexity of networking protocols multiplies. By integrating these protocols together in a ready-to-run software, 6WIND has proven the superiority of its solution. Compared to protocol stacks vendors, 6WIND goes a step further by placing configuration and management at the heart of its 6WINDGate™ software to solve real business issues of time and cost savings associated with software integration, interface, configuration and network management.

2 NEED FOR CHANGE IN NETWORK MANAGEMENT

Original network management was focused on fault detection and recovery. Failure rates were high and diagnostic tools immature. Today, the situation has changed.

Hardware is more reliable and fails much less often. Network devices are indeed designed using fewer components and they consume less power and generate less heat. They embed intelligent microprocessors and benefit from better manufacturing quality. They are also more reliable due to the use of redundant components and redundant power.

Software quality has also improved. There are less development errors, more reliable code with current developer tools, testing techniques and reusable component technology. Another reliability factor is the ability of operating systems to dynamically reload software components after fault identification.

The bottom line is that hardware fault management is no more the primary concern of management systems. And as software reaches an almost equal-to-hardware reliability, the real focus of management has shifted to monitoring performance measurement, configuration and provisioning.

2.1 SNMP ISSUES

Network management does not keep up with the evolution of other technologies supporting IP-based networks. While network control mechanisms, protocols, technologies and applications are proliferating, IP network management is still relying on the Simple Network Management Protocol (SNMP) created in the late 80's. SNMP is widely used both in enterprise IP networks and in the internet because it is a simple solution that benefits from a large installed base.

However SNMP has several limitations. It can't flexibly support complex configuration management operations for new, state of the art, networking infrastructure. It is also not well suited for bulk data transfers. Like MIB implementation, application development with SNMP is tedious since developers must cope with low level tasks. SNMP-based management applications lack interoperability and often they cannot be reused.

2.2 XML FOR NETWORK MANAGEMENT

XML is increasingly being adopted for network management as it delivers open, flexible, interoperable and standardized management interfaces. It is expected to boost flexibility and cost-effectiveness for IP network management. Accessing, transforming, processing and presenting management information with XML provides the following benefits:

- XML provides standardized and sophisticated data structuring, while being easy to generate, parse and process,
- XML data structures can be flexibly defined, generated, extended and validated with XML schemes,

- XML comes with a wide range of technologies (XSLT, XML databases, XPath/XQuery) and with a rich set of tools, libraries and components. Those tools can facilitate development and deployment of network management applications,
- XML can overcome SNMP limitations in configuration management applications as it features higher-level semantics than SNMP. Indeed, it is easier to implement an XML service than a MIB. Also a MIB is not reusable to configure other network services.

As a result, XML is expected to boost flexible and cost effective network management, simply because network management applications can be developed in the form of simple XML documents. Application development becomes a simple matter of XML authoring.

2.3 XML MARKET ADOPTION

The potential of XML for network management has led to the creation of a specific working group at IETF, named netconf. This working group is currently standardizing network configuration mechanisms for routers and other network devices using XML.

Additionally, several network equipment vendors, including market leaders like Cisco and Juniper have implemented some XML-based configuration mechanisms for their equipment.

6WIND discovered the value of using XML for network configuration several years ago, and since migrated its network features configuration system onto an XML-based system.

3 6WINDGATE™ XMS

3.1 6WIND'S UNIQUE PROPOSITION

6WIND has migrated the configuration of 6WINDGate™ networking features onto an open and modular XML-based system. Leveraging the best of this standard and from our own hands-on experience in the domain, we have created and patented the market's first global software management framework based on XML, called 6WINDGate™ XMS for eXtensible Management System.

6WINDGate™ XMS is the only comprehensive XML-based management of networking features required for a new generation multi-services IP gateway or communication system:

- IP configuration (DCHP, auto-configuration...)
- IP security (VPN, Filtering)
- IP mobility
- Quality of Service
- Layer 2 transport (PPP, PPPoE, VLAN...)
- IPv4 to IPv6 transition

More importantly, 6WINDGate™ XMS is open and extensible to enable management consolidation of the complex depth of 6WINDGate™ networking software, in addition to the integration with proprietary and open source software that are all embedded in new generation multi-services appliances. It removes the nightmare and endless task of developing coherent management across a multitude of software coming from different sources.

Considering that every equipment or system vendor provides value-add through an intelligent configuration system, sometimes customized for specific use or markets, this management extensibility provides maximum flexibility for adaptation to each vendor's specific requirements. OEMs can reuse the 6WINDGate™ XML configuration schemes to develop intelligent and differentiated management systems, like advanced security management, policy-based management, business-driven services management. Equipment and system vendors can easily integrate the configuration of 6WINDGate™ features within their existing device management application or within a higher-level system management application.

Furthermore, a significant value-add is that since 6WINDGate™ XMS has been entirely developed in C99 language; it provides an unrivalled memory footprint and performance optimization for small embedded applications. This is unheard of as many traditional XML implementations are based on heavy technologies like Java, TCL, Python or Pearl which do not fit into embedded systems. Indeed, unlike those technologies, C language does not require specific interpreters to be used, consumes less storage memory and RAM. Additionally, C language provides better processing performance.

3.2 ARCHITECTURE DESCRIPTION

6WINDGate™ XMS is based on a client/server architecture. Server part, named Configuration Manager, provides a system-level interface; It is where the system gets actually configured. XMS Clients are system-independent and provide an interface to allow service configuration description. An API, named XIPC, is defined for communication between Server and Clients.

Such architecture greatly reduces the time needed to build a management system. System configuration commands are defined once and are reused for as many user interfaces needed for the end product. Building configuration application is done via a simple interface and not a complete development. So, the more user interfaces required, the more returns are felt on time gained.

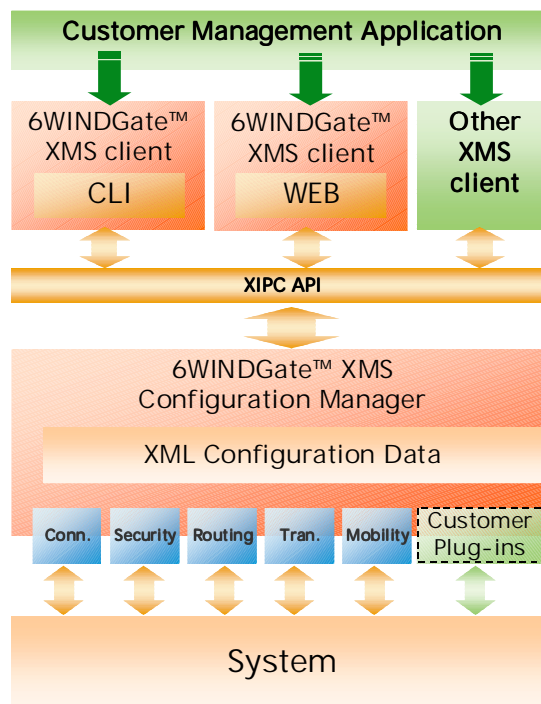


Figure 1: 6WINDGate™ XMS Architecture

XMS Configuration Manager contains network services configuration schemes defined in XML for all 6WINDGate™ features. Considering the wealth of IP features embedded in 6WINDGate™, 6WIND provides more XML configuration schemes than anyone in the industry.

The main task of XMS Configuration Manager is to receive configuration from XMS clients and dispatch configuration to the relevant network services. Specifically tailored for networking, XMS Configuration Manager automatically manages feature dependencies and precedence. For example, when a 6WINDGate™-enabled gateway receives a packet, the following features must be, and are actually, activated in that order: filtering, QoS, routing, forwarding. XMS Configuration Manager also sends the current XML configuration to XMS clients.

XMS Clients are user interfaces that convert any configuration entered by the equipment administrator into an XML configuration. The XML schemes (taken from XMS Configuration Manager) are interfaced into user-friendly configuration commands.

XMS clients also comes with 6WIND-developped fully-automated Command Line Interface and Web-based configuration for 6WINDGate™ functionalities. These XMS Clients are fully modular in the sense that it is possible to use only one user interface (ex: CLI). The extra code associated with the other unused user interfaces won't be compiled and therefore won't unnecessarily weigh down the binary code. These XMS Clients can be customized and extended based on network equipment providers and system integrators specific needs. (See use cases in 3.3 and 3.4 on the given CLI and WEBGate).

XIPC (eXtensible Inter-Process Communication) is an open Application Programming Interface (API). This TCP or UNIX socket manages communication between XMS Configuration Manager and XMS Clients, following the enforce/verify concept. It enforces the configuration from XMS Client to Configuration Manager and verifies the configuration from Configuration Manager to XMS Client. XIPC supports all 6WINDGate™ feature configuration.

This documented API enables XMS Configuration Manager to receive XML-based configuration commands, regardless of the XML configuration generation mechanisms. XIPC offers 6WIND customers complete flexibility to choose their preferred user configuration interface or XMS clients. They can create a graphical user interface that generates compliant XML code and/or use 6WINDGate™ embedded configuration interfaces.

3.3 6WINDGATE™ XMS CLIENT: COMMAND LINE INTERFACE

6WIND provides a full-featured Command Line Interface. To provide an easy customization of this user interface, 6WINDGate™ XMS embeds an automatic CLI engine written in XML. The CLI system is generated automatically from XML code. Advanced tools like command completion and contextual help, are provided at the same time. The user documentation is also generated simultaneously. It is then easy to extend the CLI to provide more configuration options or configure third party or customer features.

The CLI development process is the following:

1. The CLI module has to be written in XML
2. C code of the CLI is automatically generated and then compiled
3. The HTML documentation and the CLI command reference guide is automatically generated

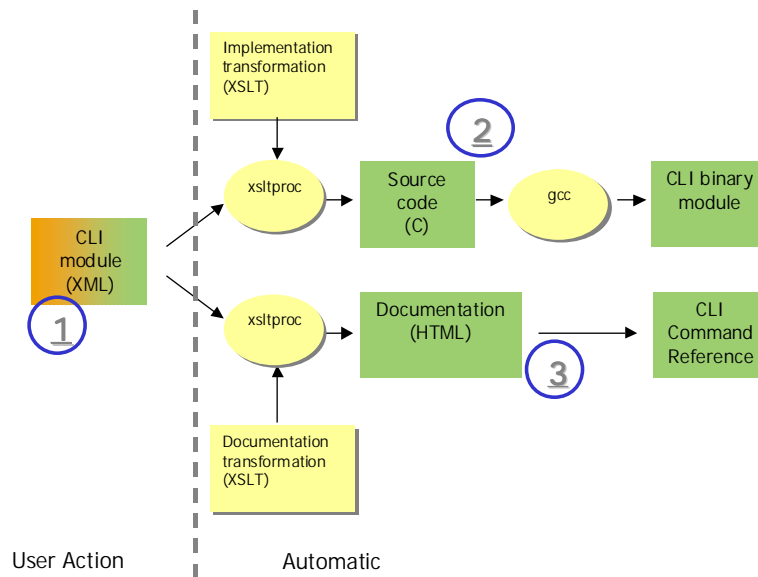


Figure 2: CLI development process

To transform XML code into C code (for the CLI) and HTML code (for the documentation), 6WINDGate™ XMS uses XSLT (eXtensible Stylesheet Language Transformations), which is a standard development language specialized in XML developments.

6WINDGate™ Command Line Interface performs multiple configuration file management.

3.4 6WINDGATE™ XMS CLIENT: WEBGATE

6WINDGate™ embeds a full-featured web-based configuration interface, named WEBGate. The web pages have been developed in standard PHP (version 4).

PHP scripting language is widely used and has the advantage of enabling quick web page development. However, PHP is not tailored for embedded systems; therefore 6WIND has made a number of improvements. First, 6WIND encrypts its PHP pages with AES, to avoid the HTML/PHP pages source code to be read and stolen. Also, in order to reduce the pages memory footprint, the pages are compressed with a 60% ratio.

WEBGate handles configuration file management.

3.5 CONFIGURATION PROCESS AND EXAMPLE

The process of configuring a 6WINDGate™-based system using 6WINDGate™ CLI or WEBGate is shown on the following figure. The user gets the running configuration in XML format and this configuration is displayed in the CLI or on the PHP pages. The user modifies the configuration using the user interface of his choice which generates a new configuration. XMS Configuration Manager receives the updated configurations from the various user interfaces and compares those with the state of the system. Then XMS Configuration Manager only applies the parameters that have been changed by the user to the system. This process avoids any configuration conflict when administrators use several user interfaces at the same time.

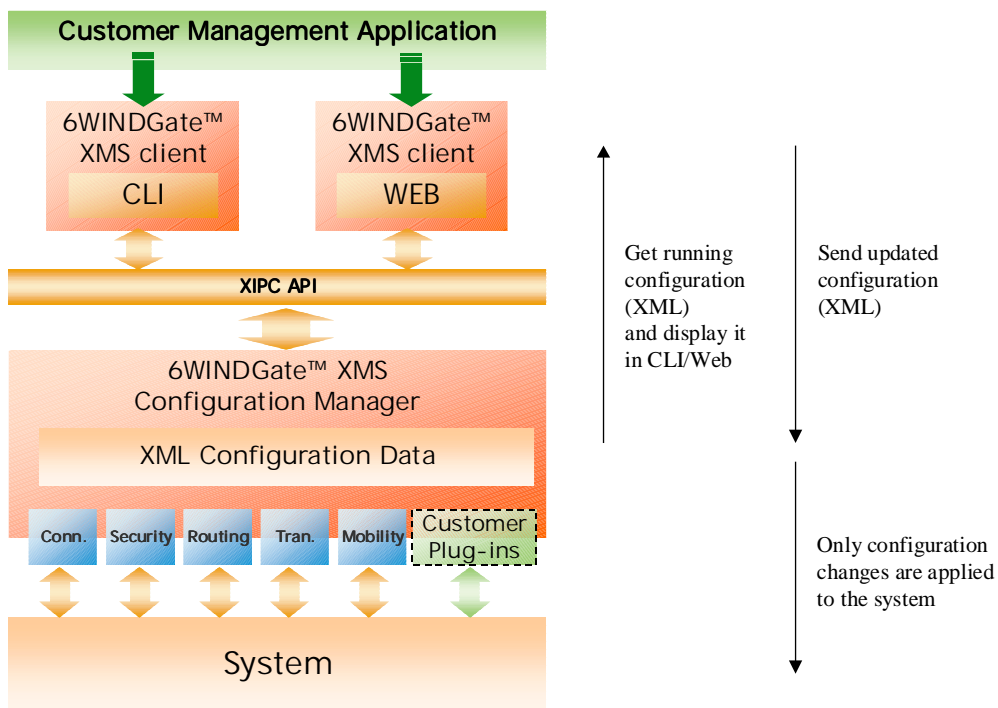


Figure 3: feature configuration process

The chosen example below is the configuration of an IPv4 DHCP server configuration. Of course, the CLI and web configurations will generate the same XML configuration file, sent to XMS Configuration Manager through XIPC API.

WEBGate configuration:

6WINDGate™ WEBGate Configuration admin Logout

Services: IPv4 DHCP Server

Enable DHCP server

Subnet /

Available range 192.168.0.0 - 192.168.0.255

Range to

Excluded addresses

| IP address |
|--------------|
| 192.168.0.64 |
| 192.168.0.65 |

Default lease time seconds
This is the default lease time if clients do not ask for a specific expiration time. The default is 600 seconds.

Maximum lease time seconds
This is the maximum lease time for clients that ask for a specific expiration time. The default is 7200 seconds.

Minimum lease time seconds
This is the minimum lease time for clients that ask for a specific expiration time. The default is 60 seconds.

Domain name
Domain Name for clients.

Default gateway
Default gateway for clients.

Nameservers

| IP address | Type |
|--------------|---------|
| 192.168.0.64 | primary |

NTP servers

| IP address | Type |
|-------------|---------|
| 192.168.0.1 | primary |

Hosts

| Name | MAC address | IP address |
|--------------|-------------------|--------------|
| myDNS | 00:01:02:03:04:05 | 192.168.0.64 |
| myHTTPserver | 06:07:08:09:0a:0b | 192.168.0.65 |

6WINDGate™ WEBGate. All rights reserved. [view license]

Equivalent CLI Configuration:

```
router{running-dhcpserver}display
# DHCPSEVER
enable dhcpserver
subnet 192.168.0.0/24
defaultlease 600
maxlease 7200
minlease 60
domainname auto
default-ipv4 192.168.0.1
# NAMESERVER
nameserver 192.168.0.64 primary
# RANGE
range 192.168.0.10 192.168.0.100
# EXCLUDE
exclude 192.168.0.64
exclude 192.168.0.65
# HOST
host myDNS 00:01:02:03:04:05 192.168.0.64
host myHTTPserver 06:07:08:09:0a:0b 192.168.0.65
# NTP SERVERS
ntp-server 192.168.0.1 primary
# LOG SERVICE
```

XML Configuration file sent to XMS Configuration Manager through XIPC API:

```
router{running-dhcpserver}display xml
<?xml version="1.0"?>
<ipv4-server>
  <pool>
    <enable-dhcpserver/>
    <subnet-netmask>
      <subnet>192.168.0.0</subnet>
      <length>24</length>
    </subnet-netmask>
    <lease>
      <default-lease>600</default-lease>
      <max-lease>7200</max-lease>
      <min-lease>60</min-lease>
    </lease>
    <default-gateway>192.168.0.1</default-gateway>
    <dns-server>
      <address>192.168.0.64</address>
      <type>primary</type>
    </dns-server>
    <range>
      <first-address>192.168.0.10</first-address>
      <last-address>192.168.0.100</last-address>
    </range>
    <excluded-address>192.168.0.64</excluded-address>
    <excluded-address>192.168.0.65</excluded-address>
    <host>
      <name>myDNS</name>
      <address>192.168.0.64</address>
      <mac-address>00:01:02:03:04:05</mac-address>
    </host>
  </pool>
</ipv4-server>
```

```
<host>
  <name>myHTTPserver</name>
  <address>192.168.0.65</address>
  <mac-address>06:07:08:09:0a:0b</mac-address>
</host>
<ntp-server>
  <address>192.168.0.1</address>
  <type>primary</type>
</ntp-server>
</pool>
</ipv4-server>
```

3.6 6WINDGATE™ XMS AND SNMP

In addition to this XML-based network configuration system, 6WINDGate™ also supports widely-used SNMP protocol. SNMP is best suited for network monitoring and XML for network configuration. In that sense, it is important to synchronize both systems.

A 6WINDGate™-enabled gateway can get the state of a XML-generated configuration with SNMP. 6WINDGate™ XMS allows to perform monitoring using SNMP.

4 6WINDGATE™ XMS USE CASES

The flexibility of the 6WINDGate™ XMS architecture enables equipment providers and system integrators to propose full-featured and highly-customized configuration and management systems.

6WINDGate™ XMS addresses the most common management consolidation and customization needs:

1. Integrate a new feature within 6WINDGate™ and consolidate management
2. Integrate 6WINDGate™ feature configuration in an existing management application of the customer
3. Customize 6WINDGate™ user interfaces to specific equipment provider or system integrator needs

4.1 INTEGRATING A NEW FEATURE WITHIN 6WINDGATE™

Sometimes it is useful to complete the 6WINDGate™ feature set with a couple of additional network protocols or applications to build an IP-centric gateway or system. In order to integrate a new customer or third-party feature within 6WINDGate™ and consolidate management, only the following actions have to be handled.

In XMS Configuration Manager, the system configuration commands have to be developed for the new feature. It means only the writing of the XML schemes for feature management as features dependencies and precedence are already handled in the system. This action is done once, regardless of the number of user interfaces used to configure this new feature. Again, the more user interfaces implemented, the more development time saved.

On the user interface side, it is possible to extend 6WINDGate™ XMS Clients by simply adding new commands to the CLI and/or creating new Web pages. User interfaces facilities, like CLI completion and help are already available. Configuration coherency between WEBGate and CLI is also already managed by the XMS system. It is also possible to configure the new network service within a customer-specific intelligent or simplified network management system.

All in all, 6WIND customers enjoy a management development cycle reduction of at least half when they integrate a new feature within the 6WINDGate™ software.

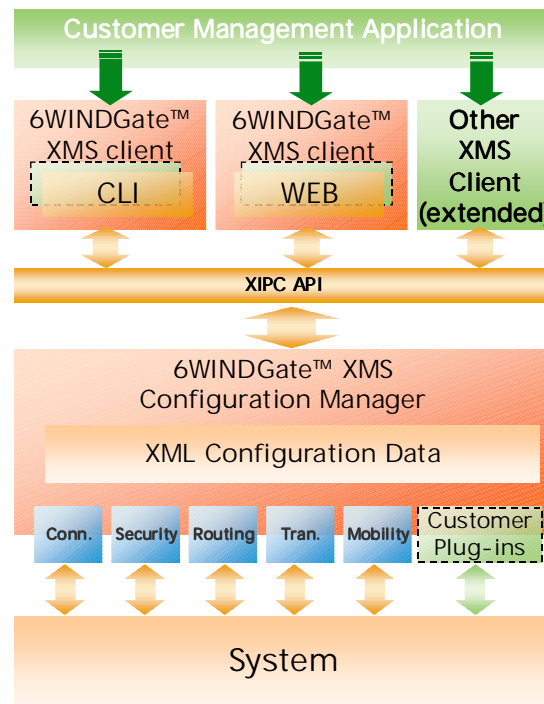


Figure 4: New feature within 6WINDGate™

To help its customers integrate its specific features along with the management integration enabled by XMS, 6WIND provides a set of guiding documents (including Software Design Documentation).

4.2 6WINDGATE™ INTEGRATION WITHIN CUSTOMER MANAGEMENT APPLICATION

When an equipment or system vendor integrates the 6WINDGate™ software with an existing equipment/system software, to enrich an existing product design with new networking functionalities, it is often mandatory to integrate the configuration of the new features within the existing management application.

In this case, 6WIND proves its superiority over protocol stack vendors by providing an integrated solution. As the system configuration commands for the 6WINDGate™ features are already available in XMS Configuration Manager, the only task to handle is to interface those system commands with the existing management application. For equipment/system provider, using protocol stacks means building the complete management solution.

It is useful to consider that, in a management system building, the most time consuming task is about developing the system commands. This figure gives a clear idea about the huge development time saved when those system commands are already available. Of course, the network services dependencies and precedence are already handled by 6WINDGate™ XMS, which removes another tedious development task for 6WIND customers.

With 6WINDGate™ XMS, management integration is a matter of re-using the 6WINDGate™ feature configuration XML schemes available in the XMS Configuration Manager. Then the equipment/system vendor has to interface those XML schemes with its management application, which is either a Graphical User Interface or a specific user environment. This is done by building a XMS Client which is a simple XML generation mechanism that will be able to exchange XML configuration commands with XMS Configuration Manager through XIPC API.

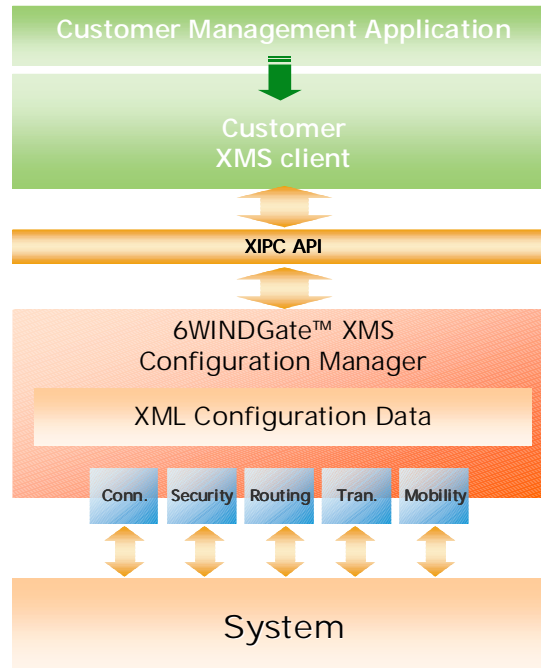


Figure 5: 6WINDGate™ integration in customer management

4.3 ADAPT 6WINDGATE™ USER INTERFACES TO SPECIFIC REQUIREMENTS

Even if 6WIND provides user interfaces (Web, CLI) to configure all 6WINDGate™ features, equipment or system vendors might want to adapt the user interface(s) to specific requirements. In this case, the management development task equals zero and customization is done very quickly. Indeed, the system commands are already available, such as the user commands.

Here are some examples where an adaptation of the 6WINDGate™ user interfaces would be useful:

- Need for an equipment provider to provide multi-lingual CLI, in Chinese or German for example. In that case, the only task to handle is to rename the user configuration commands.
- Need to simplify the CLI or to hide some configuration commands. Some deployment environments require a very simple user interface or some network administrators should not have access to some configuration commands. There are two ways to achieve this. First, it is possible to completely hide some configuration commands, which is a compilation option, and therefore the complete binary software footprint will be reduced. Second, it is possible to add conditions to activate a command, within the CLI code. Then this specific command will be accessible to the user only if the condition is met.

In the CLI generation process (see figure 2), only step 1 of the process has to be re-worked for CLI adaptation to specific needs.

5 CONCLUSION AND CUSTOMER BENEFITS

6WIND established market leadership in delivering embedded OEM networking software solutions, fully-integrated with comprehensive and complex networking protocols. However, 6WIND couldn't ignore the management and configuration issues of all those network features. Not providing a management solution means providing a partial solution, leaving unsolved issues to equipment and system vendors.

Considering XML is the go-forward technology for network configuration, enabling more intelligent and business-driven networking, 6WIND has built a complete XML-based management framework. The 6WINDGate™ eXtensible Management System provides XML configuration for all supported networking features. This makes 6WIND the only company to provide XML configuration for all networking features required in a multi-services gateway or IP system. This XMS framework is completed by full-featured and highly customizable user interfaces, e.g. CLI and web-based system.

As 6WINDGate™ XMS enables management development time and cost savings that grow exponentially with the number of features supported, 6WIND customers are increasingly using this framework to integrate together proprietary software, 6WINDGate™ functionalities and third-party software components. Instead of developing a complete management system, 6WIND customers can focus on management consolidation across those various sub-systems, management extension or restriction and management customization. In short, 6WINDGate™ XMS helps OEMs manage their software ecosystem.

6WINDGate™ XMS is fully embracing 6WIND's strategy to enable its customers to reduce development costs, optimize time-to-market and increase market differentiation.

5.1 MANAGEMENT CONSOLIDATION

As the 6WINDGate™ software is often completed with additional features, 6WINDGate™ XMS enables to greatly reduce time needed to create the management and configuration interfaces for the newly-added features.

When the 6WINDGate™ software is used to enrich an existing networking product, 6WIND facilitates management consolidation and provides the framework to quickly and easily integrate the configuration of the 6WINDGate™ features within an existing device or system application.

5.2 MANAGEMENT EXTENSION OR RESTRICTION

6WINDGate™ XMS enables an easy modification of the 6WINDGate™ embedded user interfaces according to specific requirements. When a new network protocol is added to the 6WINDGate™, additional configuration and management features, new CLI commands or new Web pages, can be added to the 6WINDGate™ user interfaces. On the opposite, when we want the end-device user to have access to a limited subset of configuration commands, hiding management features require very limited efforts.

To provide more configuration interfaces on top of CLI and Web, an equipment provider can develop a graphical user interface or a customer-specific configuration environment. This can be done by a simple interfacing and a reusing of the 6WINDGate™ features configuration XML scheme. In that case, development cycle and costs of new management application are reduced by at least a third.

5.3 MANAGEMENT CUSTOMIZATION

For the most optimized time-to-market and reduced development costs, equipment providers might just want to reuse 6WINDGate™ embedded user interfaces, CLI and Web. Those interfaces can however be simply customized. The CLI command syntax can be changed, to provide multi-lingual CLI for example. The Web pages look & feel can be changed too, for rebranding purpose for example.