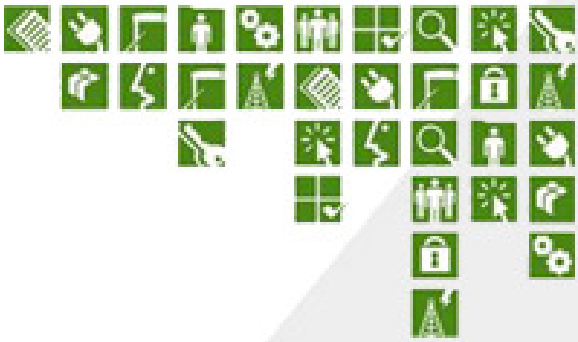


Proximetry AirSync 3.2

Practical User's Guide

Version 3.2.4

PROXIMETRY

Table of Contents

Preface

AirSync is a suite of network and device-management tools designed to manage wireless devices and traffic operating over multi-protocol wireless networks. With powerful support for service provisioning and reporting, AirSync simplifies your ability to manage service flows within the network, while reducing the operational costs associated with customer and server management.

Notice: The use of AirSync software and all other AirSync products is governed by the terms of your agreement(s) with Proximetry, Inc.

The use of Microsoft Virtual Earth software is governed by the terms of your agreement with Proximetry, Inc and Microsoft, Inc. By default this functionality is not enabled in AirSync software.

Intended Audience

This document is primarily intended for system administrators who will use AirSync to manage their wireless network environments. The document assumes that AirSync has already been successfully installed.

Product Version

The document corresponds to the AirSync version 3.2 product release.

Document Revision Level

Revision	Date	Description
Version 1.0.0	July 2008	Initial Release
Version 1.1.0	October 2008	The GUI Mechanics of Implementing QoS chapter updated
Version 1.1.1	November 2008	Using AirSync's Package Management System chapter updated. Appendix C added

Version 1.2.0	December 2008	Initial AirSync System Setup chapter updated. Screen Captures updated due to changes in GUI. Appendix A updated. Appendix D added
Version 1.3.0	January 2009	Appendix E and F added.
Version 2.0.0	January 2009	Update to 3.0 product release.
Version 2.0.1	March 2009	Appendix E updated
Version 2.0.2	March 2009	Understanding AdHoc Rules chapter updated
Version 3.1	April 2009	Update to 3.1 product release
Version 3.2	June 2009	Update to 3.2 product release
Version 3.2.1	June 2009	A few words about statuses chapter added
Version 3.2.2	June 2009	What is new in 3.2 release? chapter added. Appendix B updated
Version 3.2.3	July 2009	Associating the AirConsole with the AirSync Server chapter updated. GUI decorators chapter updated
Version 3.2.4	August 2009	Appendix E updated according to AirSync Server changes

Document Roadmap

The document begins with a brief overview of AirSync, then presents the main features of the AirSync graphical user interface. The next section describes some initial system setup tasks. The last three sections are task-oriented guides to the three primary functional areas in AirSync: Implementing QoS, Using Package Distribution, and Monitoring the network.

Chapter	Description
Introduction to the AirSync System	Provides an overview of the AirSync system, lists the AirSync features, and describes the AirSync system architecture and configurations.
Exploring the AirSync User Interface	Introduces the user interface and the basic skills needed to use and manipulate the system.
Initial AirSync System Setup	Provides instructions for AirSync to record and use the location for distributed components, for specifying preferences, and for defining confirmation messages and context-sensitive menus for third-party tools, and for registering devices.
Using AirSync to Implement Quality of Service (QoS)	Gives the details of implementing a traffic management system to maximize the QoS with AirSync.

Using AirSync's Package Management System	Gives instructions for system administrators to systematically define and distribute items to managed nodes.
Using AirSync to Monitor the Network	Describes AirSync's variety of network monitoring and mapping functions. The simplest way to invoke them is to right click on a device and select a monitoring function from the context-sensitive menu.
Appendix A. Item Descriptions for Tools – Options	Reference that describes AirSync tools.
Appendix B. Item Descriptions for Tools – System Configuration	Reference that describes system configuration tools.
Appendix C. AirSync Preinstallation Requirements	Reference that describes system preinstallation requirements.
Appendix D. Example AirSync configuration for Wireless ISP scenario	Reference that describes examples AirSync configuration for Wireless ISP scenarios.
Appendix E. AirSync tuning	Reference that describes possibility of AirSync tuning.
Appendix F. Setting AirSync Server Logging Options	Reference that describes setting logging options for AirSync Server.
Glossary	Defines terms used in AirSync.
Index	Reference to AirSync for finding information.

Document Conventions

This guide uses the following typographic conventions:

Convention	Description
Bold	Text on a window, other than the window title, including menus, menu options, buttons, and labels.
Italic	Variable.
`screen/code`	Text displayed or entered on screen or at the command prompt.
boldface screen font	Information you must enter is in boldface screen font.
< *italic screen* >	Variables appear in italic screen font between angle brackets.
[ ]	Default responses to system prompts are in square brackets.

This guide uses icons to draw your attention to certain information. Warnings are the most critical.

Icon	Meaning	Description
	Note	Notes call attention to important and/or additional information.
	Tip	Tips provide helpful information, guidelines, or suggestions for performing tasks more effectively.
	Caution	Cautions notify the user of adverse conditions and/or consequences (e.g., disruptive operations).
	WARNING	Warnings notify the user of severe conditions and/or consequences (e.g., destructive operations).

Getting Help

If technical support is needed, please gather as much information about the problem as possible, including:

- The circumstances surrounding the error or failure.
- The exact content of any error message(s) displayed.

The Proximetry Customer Service Department can be reached by email at support@proximetry.com Monday through Friday between the hours of 5:30 A.M. and 6:00 P.M. Pacific Time.

Customer Service can receive attachments as well as messages via email.

Introduction to the AirSync System

About AirSync

AirSync consists of a suite of tools that simplify the tasks of managing a complex wireless network and optimizing the traffic flows within the network. AirSync helps reduce the operational costs of customer and server management. In simple terms, AirSync is a tool suite that allows an organization to articulate business rules or policy governing the use of its managed wireless network in a manner that bests suits that organization's unique needs.

AirSync is a Distributed Software Product

AirSync consists of three types of software that work together to bring order and control to wireless networks:

- The front-end or **Graphical User Interface** (GUI). This is the piece system administrators interact with.
- A set of **server components**, responsible for storing the organization's business rules (policy), monitoring the managed network in near-real time, making adjustments based on organizational policy and in response to various trigger events as they occur on the managed network.
- A set of client components or **agents** that run on managed network devices. These agents ensure that the organizational policy is cohesively implemented in the managed network and report status back to the server components.

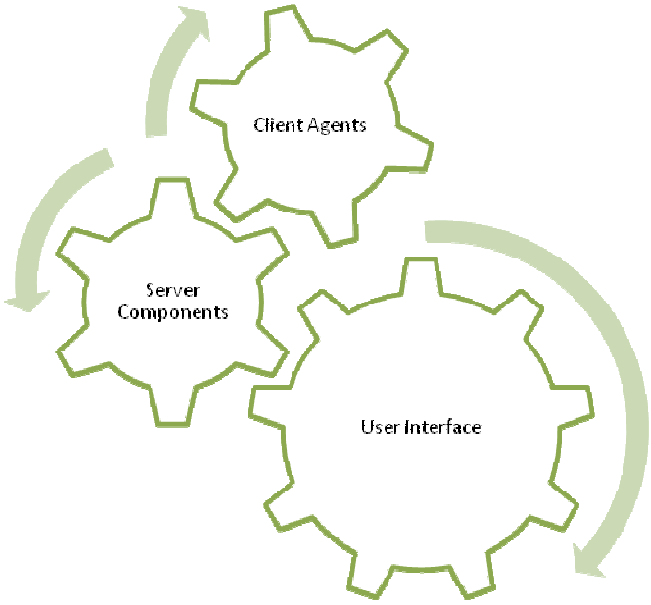


Figure 1. AirSync is composed of three types of software

What Does AirSync Do?

AirSync has many useful features, but they can be broken down into four main functional groups:

- **QoS or Traffic Shaping**. This means providing differentiated service to users that ensures the right traffic gets through the network at the right time according to the organization's business rules.
- **Package Management**. This is primarily a system management function for uploading new firmware and configuration files to managed devices, but it could be extended as a general content delivery system.
- **Network Monitoring and Feedback**. AirSync also provides visualization and reporting capabilities for showing network devices on a map, generating a logical topology diagram of network connectivity, and charting network statistics (such as signal quality and throughput).

Effective use of AirSync involves the following steps:

1. First, **determine the organization's policy goals**. Which traffic is most important under what circumstances? How should the system arbitrate bandwidth allocation decisions during times of congestion? How should users and traffic flows be prioritized?
2. Next, use the AirSync GUI to **define the organization's usage policy in AirSync**. The policies will be stored and retrieved by the service components and propagated down to the managed devices.
3. Then, use the AirSync GUI tools to **monitor and adjust network behavior**. The reporting and visualization tools can help you verify how well the managed system is implementing the organization's traffic policies and identify adjustments and enhancements to improve network use. Over time, the reporting tools enable you to spot trends - proactively anticipate and solve network issues before they turn into bigger problems.
4. Periodically, use AirSync's package distribution functionality to **upload new firmware or configurations** onto the managed network devices.

A Few Words on the Architecture

At the core of its server components, AirSync uses JBoss, a Java-based, cross-platform application server. The system uses MySQL, a relational database, and Enterprise Java Beans (EJB) to store business logic. AirSync also has a server component, RMServer, that communicates with the software agents resident on managed client devices. While this is probably more detail than needed by most system administrators, a key characteristic is that AirSync uses a web-services-based architecture.

As a result, AirSync is highly customizable and scalable, especially with respect to:

- **The location of server components**. All the server components can run on the same machine. However, the database component can be moved to a separate machine, for example, to improve scalability or security.
- **The relational database used**. By default, MySQL is used, but another relational database product could potentially be used instead.
- **Custom User Interfaces or gateways to third party applications**. While AirSync's redesigned user interface is quite powerful, much of the AirSync functionality can be accessed via web-services-based interfaces to other systems. For example, one Proximetry customer has invested a significant amount of development, training, etc. implementing a custom management system. The web-services-based architecture allowed the existing management system to interface with AirSync.

Other Network Management Tools

AirSync is a sophisticated product that brings order and control to the wireless networks it manages, but there are some tools it does not replace. AirSync is not inherently an:

- Asset management and tracking system
- Incident management (trouble ticket) system, like Remedy
- SNMP network management framework, like HP Openview, although some devices are managed and monitored using SNMP in limited scope
- Firewall or intrusion detection system
- Network Sniffer or traffic analysis system

However, AirSync's web-services-based architecture gives it flexibility for integrating/interfacing with other third-party network management and control systems. It has been successfully integrated with other systems and it is easy to imagine useful functional pairings.

For example, pairing AirSync with an incident management (trouble ticket) system could be useful. AirSync could periodically report and store signal quality for one or more key network devices. If the signal degraded below a threshold value, AirSync could interface to the incident management system and automatically generate an incident ticket to dispatch a response team to investigate the issue.

If you can think of special interfaces that would be valuable for your organization, contact Proximetry and tell us about your ideas or special needs.

Mentally Decouple the User Interface from the Server Components

AirSync's user interface doesn't necessarily run on the same host machine as the other components. You can load AirConsole.exe on other management workstations as appropriate for organizational needs. In fact, if Linux is used on the platform(s) hosting the AirSync server components, the AirSync UI must run a separate machine, because it must be hosted on a Windows XP® platform running the Microsoft® .NET connection software framework.

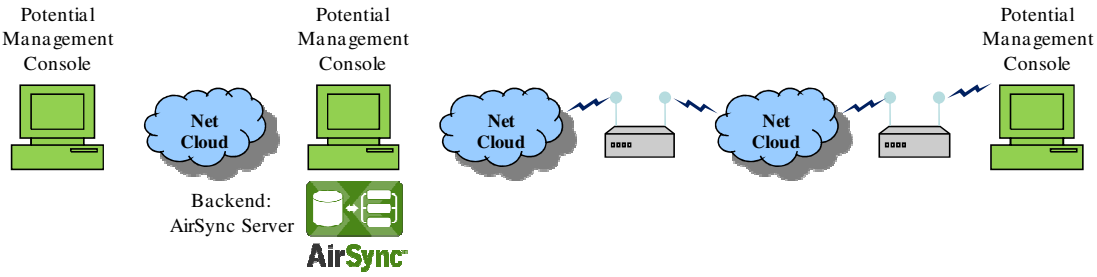


Figure 2. AirSync's Management GUI and Server components can run on different hosts

Develop and Use Consistent Naming Conventions

As you gain familiarity with AirSync, the need for consistent naming conventions will become apparent to you, but it is generally helpful to **implement a consistent naming convention** for objects created in the AirSync GUI. In general, it's easy to rename objects in the AirSync system, if you need to make adjustments.

For example, when registering new devices in a municipal wireless network managed by AirSync, it may be helpful to name all devices mounted on lampposts with an "LP_" prefix followed by the intersection name, and all mobile devices with the prefix "MOB_" followed by the mobile unit number. This will make sorting and searching operations easier. The same goes for naming other objects in AirSync: Groups, Roles, Services and so on. Don't worry, these items will be introduced and discussed in more detail later in the document.

Can AirSync Manage Devices without AirSync Agents?

Yes. AirSync makes software agents that are part of the firmware for multiple wireless network devices, and these agents interact with the server components to implement the organizations business policy. However, the AirSync agents on some of the devices have enough intelligence to manage the characteristics of the other network devices connected to them on the network. For example, it is possible to shape traffic for a laptop PC connected to a network device managed by AirSync, even without an AirSync agent running on the PC host.

However, AirSync can manage devices with AirSync agents more intelligently than those that lack agents, and agents have been developed for a variety of devices ranging from small handheld devices to a variety of radio devices from different vendors.

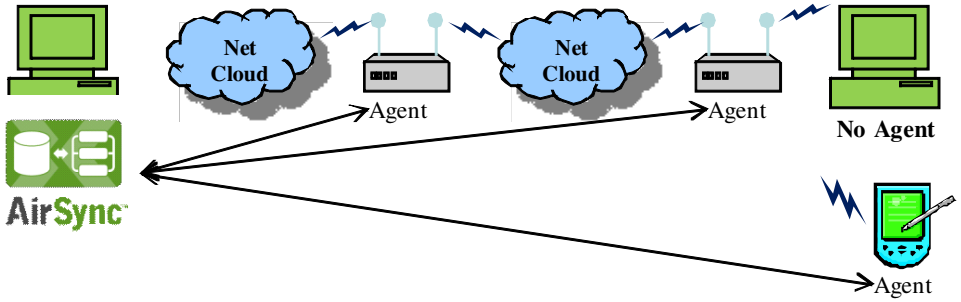


Figure 3. AirSync Manages Devices with agents and devices without agents

What is new in 3.2 Release?

The following new functionality introduced in the release:

- Advanced **Topology Manager** – starting with AirSync 3.2 former Network Diagram evolved to Topology Manager. This feature allows to display whole network topology in multiple layouts, or allows the operator to layout the topology according to his needs. With topology diagram operator may easily observe behavior of all the links, as in addition to state (active or inactive) and type (wifi, wimax, Ethernet) of the connection, extended status of the link is presented (like signal level, modulation, etc.). Additionally this feature introduced two types of connections, network neighborhood, which is result of network scanning and visualization of potential connections, and logical path, which reflects routing of packets in the network. With such an approach, dynamic nature of mesh network can be easily visualized.

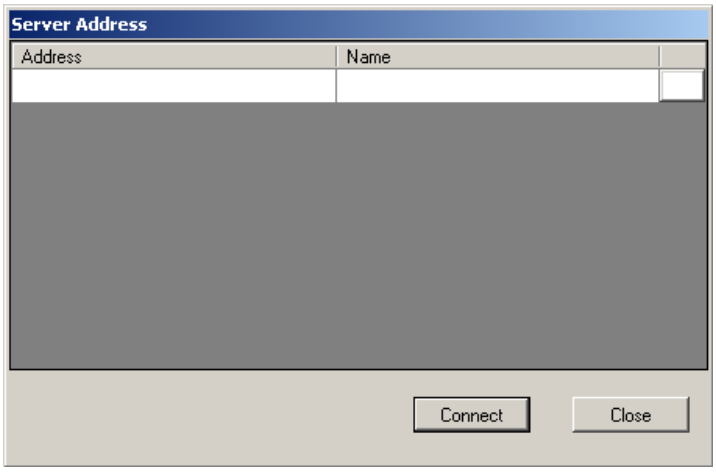
- **Device Profile** – having a possibility to configure multiple devices at a time with limited number of operations becomes crucial in large networks. AirSync 3.2 solves this problem by introducing Device Profiles. The profiles are snapshots of device configuration that can be easily distributed (by drag'n'drop) to multiple other devices. Profiles can be easily reused, while applying the profile operator may choose if all parameters should be applied or only a subset, etc. With this feature management of huge networks becomes an easy task.
- **Multicast Services** – bandwidth optimization is essential for increasing revenue, one of techniques that can be used for it is multicast services. Taking into account popularity of broadcasting applications (like IPTV or Radio Streaming), usage of multicast services can increase available bandwidth significantly. With AirSync 3.2 operator is able to define service as a multicast one, and system will handle the service in such a way to preserve resources and increase available bandwidth.
- **Device Management** – configuration of devices is mostly divided into configuration of device as a whole (e.g. hostname, management IP address, mode of operation, etc.) and configuration of each network interface of the device. With version 3.2., AirSync introduces and ability to configure parameters of whole device and each interface within the same user interface.
- **Enhanced Statistics** – statistics visualization in AirSync 3.2 is a huge step in comparison to previous releases. With this version, user is able to display charts of device health parameters (like CPU/Mem usage, temperature, etc.) as well as charts of multiple parameters from three ISO/OSI layers: Layer 1 (Physical), Layer 2 (Data Link layer, including MAC sublayer), Layer 3 (Network). With such an approach, operator can easily observe and analyze any network related problems that might appear.

Exploring the AirSync User Interface

The purpose of this section is to introduce AirSync's redesigned user interface and develop the basic skills and techniques needed to use it effectively. The emphasis of this section is understanding how to manipulate the various GUI objects, rather than fully understanding what each particular item means or does.

Associating the AirConsole with the AirSync Server

After running the AirConsole, it is important to select **the correct AirSync server** it will be used to manage. While running first time after installation it will display server list window as shown in Screen Capture 1.

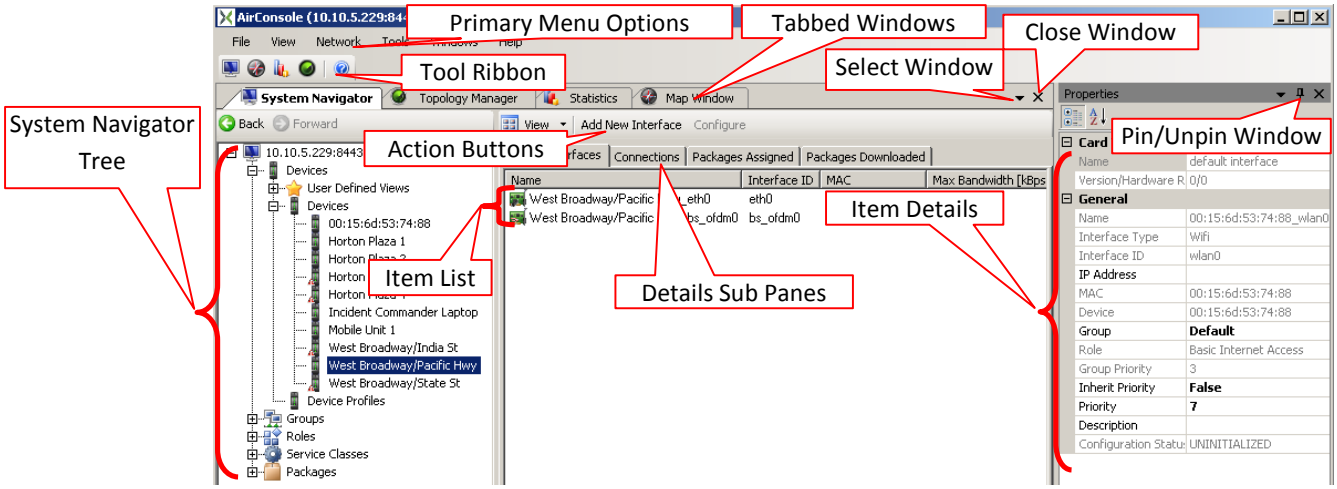


Screen Capture 1. Server Address list

To associate the GUI to a specific AirSync server, you must furnish the correct IP address of the AirSync server you intend to manage. When you set proper values to **Address** and **Name** just press **Connect** button to connect and manage selected AirSync server.

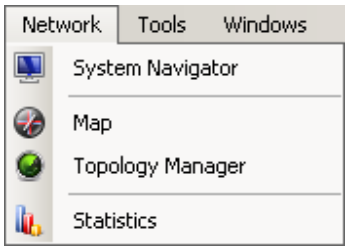
Basic GUI Layout

Screen Capture 2 shows the basic AirSync GUI layout.



Screen Capture 2. The Basic AirSync GUI layout

The GUI has six primary menu items, but administrators will frequently access the items available on the "Network" submenu shown in Screen Capture 3. Notice the tool ribbon immediately below the primary menu items in Screen Capture 2 contains quick access icons for all of the items also available from the Network menu.



Screen Capture 3. The AirSync Network menu

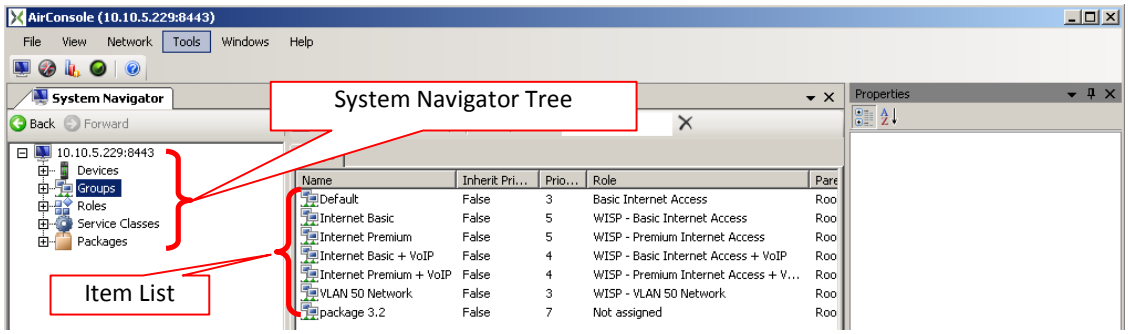
As you can see, there are quite a few items to manipulate and because several items can be manipulated at the same time, each in its own window, the screen can fill up quickly. The next few sections discuss how to manipulate the on-screen items.

Menu Items

All of the items from the menu opens a window. Each window is dedicated to some different action (e.g. System Navigator window is dedicated to manage all items in AirSync, Statistics window is dedicated to chart statistics for selected connections) but they are connected to each other and works as a entirety.

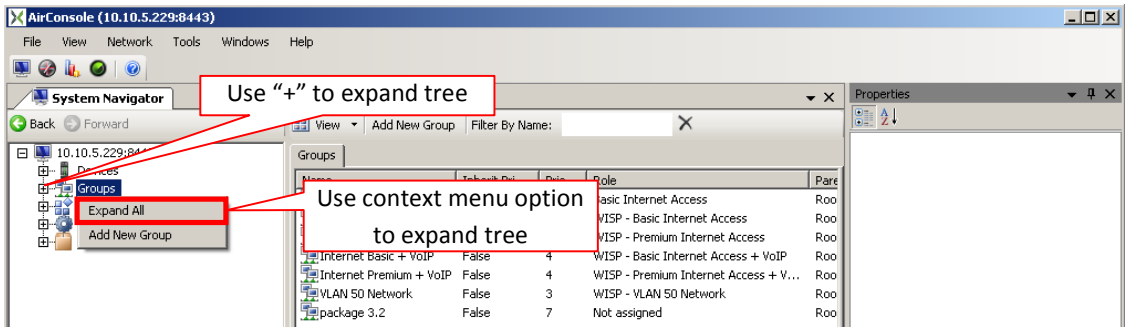
Tree, Item List, Item Details Metaphor

System Navigator window presents a tree containing all items when initially opened. Screen Capture 7 shows tree with selected **Groups** item.



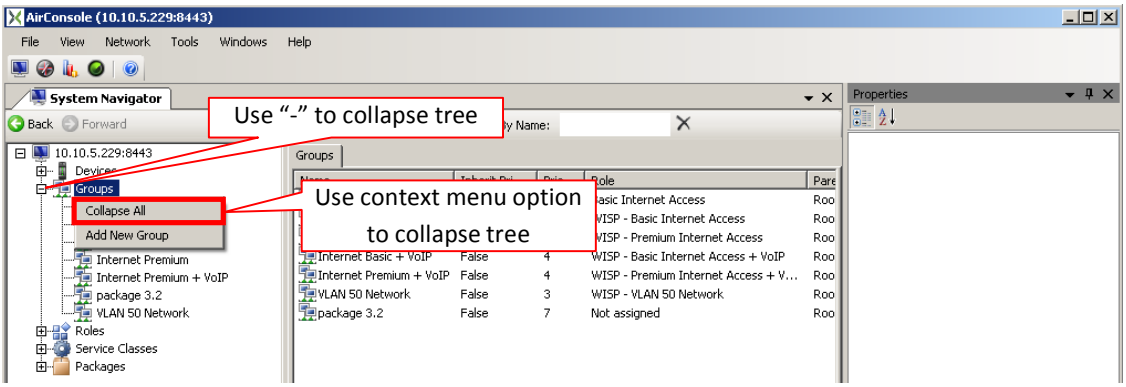
Screen Capture 4. System Navigator tree

To expand any item on the tree use context menu option or "**+**" item as shown in Screen Capture 5.



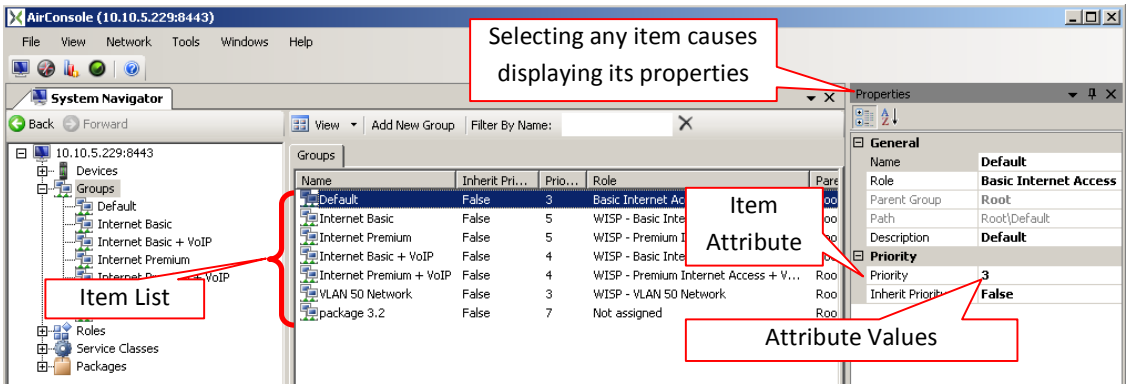
Screen Capture 5. Expanding tree

To collapse tree use context menu option or "-" item as shown in Screen Capture 6.



Screen Capture 6. Collapsing tree

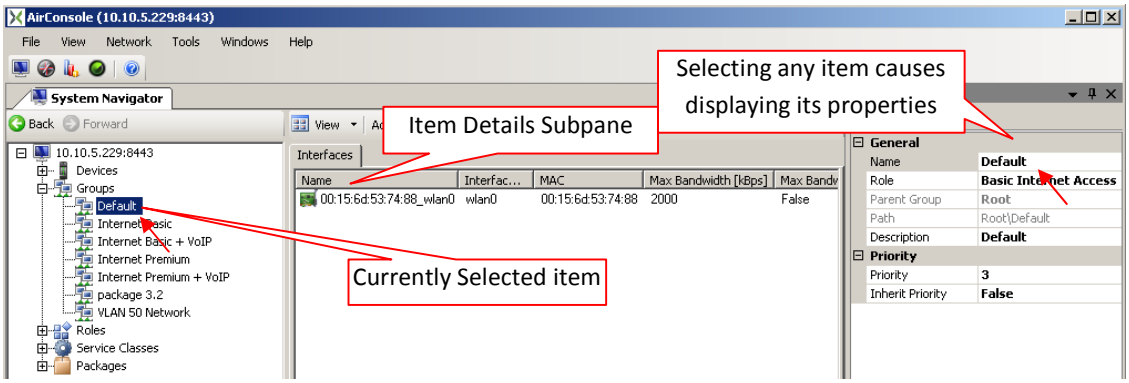
All of the items from System Navigator tree present a simple list of items as shown for **Groups** in Screen Capture 7. The item list begins with a row of column headings that label which attribute values will be displayed for each item in the list. The list displays a row for each item containing a record of the items' attribute values.



Screen Capture 7. Item List for Groups

Selecting any item e.g. "Default" group causes displaying properties of this item in **Properties** window.

Double-clicking on a specific item in the list, in this example the group named "Default" toggles the display of a detailed information sub pane (in the middle) and displays properties for the selected item as shown in Screen Capture 8.

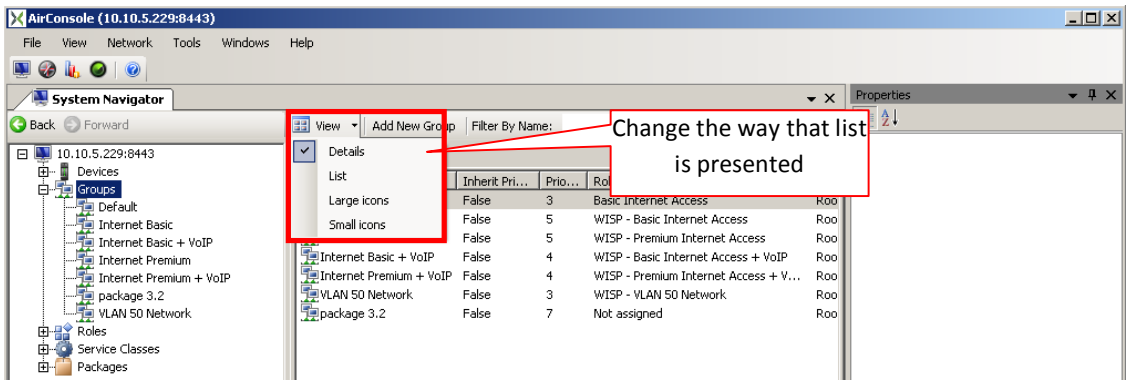


Screen Capture 8. Item details for selected item in "Groups" Item

Notice as you select different items in the tree or item list pane, the information displayed in the **Properties** window is updated to accurately reflect the detailed information for the item selected in the tree or list pane.

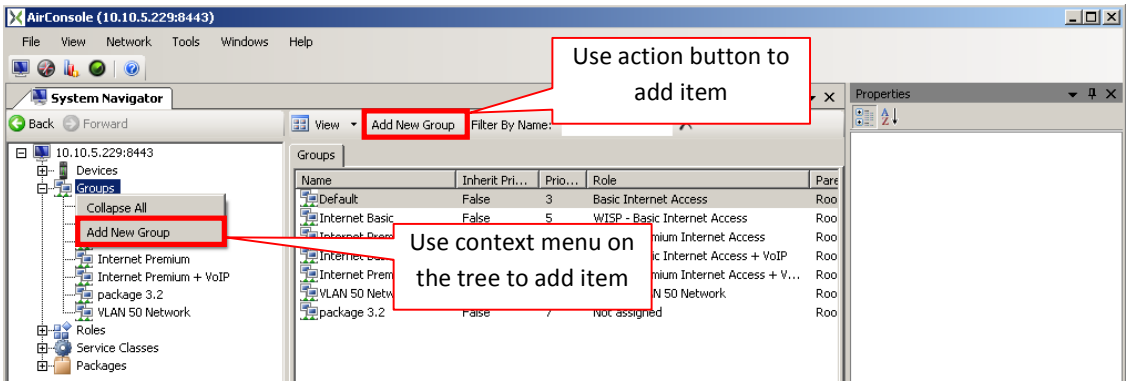
Context menu option/Action button

Use action button/context menu options to perform operations on the tree or item list. Some of actions cause only changing view or expanding/collapsing tree as shown in Screen Capture 5, Screen Capture 6 or Screen Capture 9.



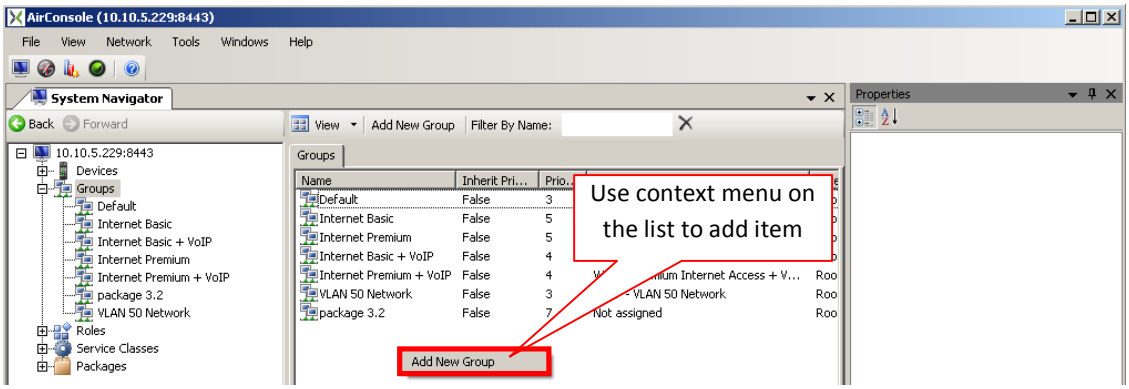
Screen Capture 9. Changing view

Another group of action such as adding, assigning, removing or deleting items causes directly changes in managed items for example adding new item, deleting some item or removing association between items. Screen Capture 10 shows example of context menu on the tree which allows adding new group.



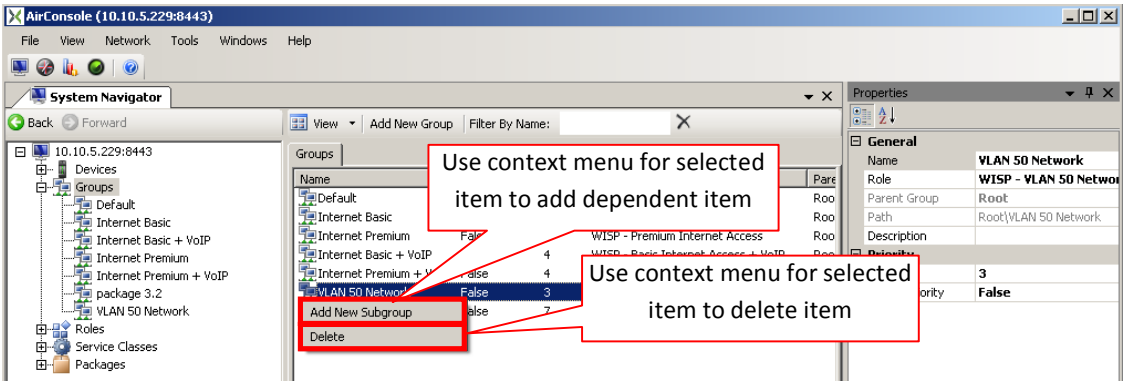
Screen Capture 10. Context menu on the tree

The same action can be taken using action button or as shown in Screen Capture 11 context menu on the list when no item is selected.

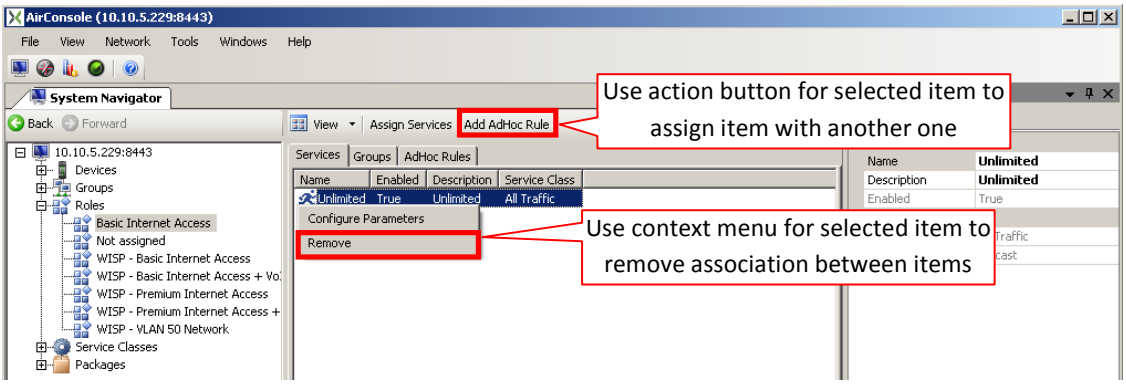


Screen Capture 11. Context menu on the list

In case that any item is selected as shown in Screen Capture 12 you may for example add dependent item, delete item or remove dependency as shown in Screen Capture 13.



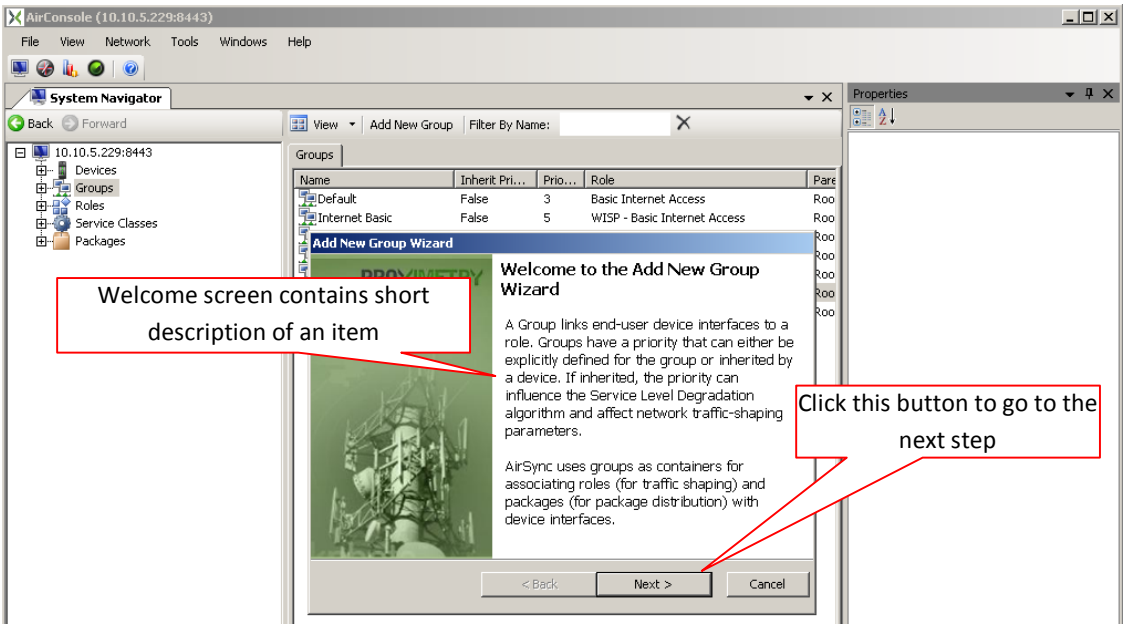
Screen Capture 12. Context menu for selected item



Screen Capture 13. Different context menu for selected item

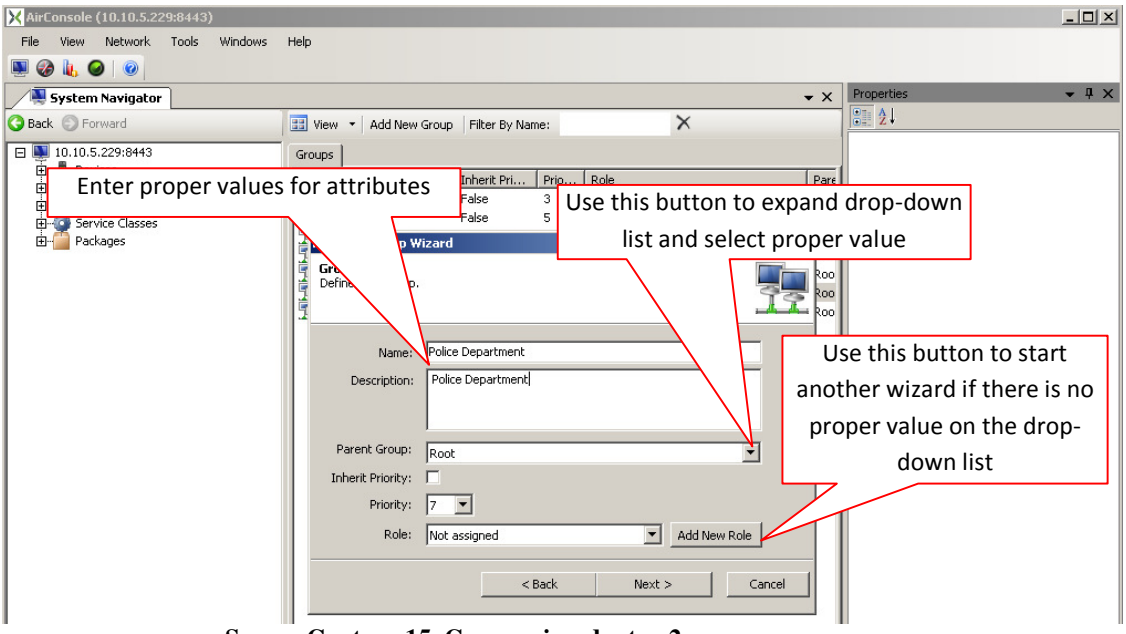
Wizards

Using "**Add…**" action buttons/context menu options causes starting wizards which allow adding particular items. For example using **Add New Group** action button/context menu option will start **Add New Group Wizard** which will guide you through the process of creating a new group as shown in Screen Capture 14. Wizard's welcome screen contains short description of an item which is being added.



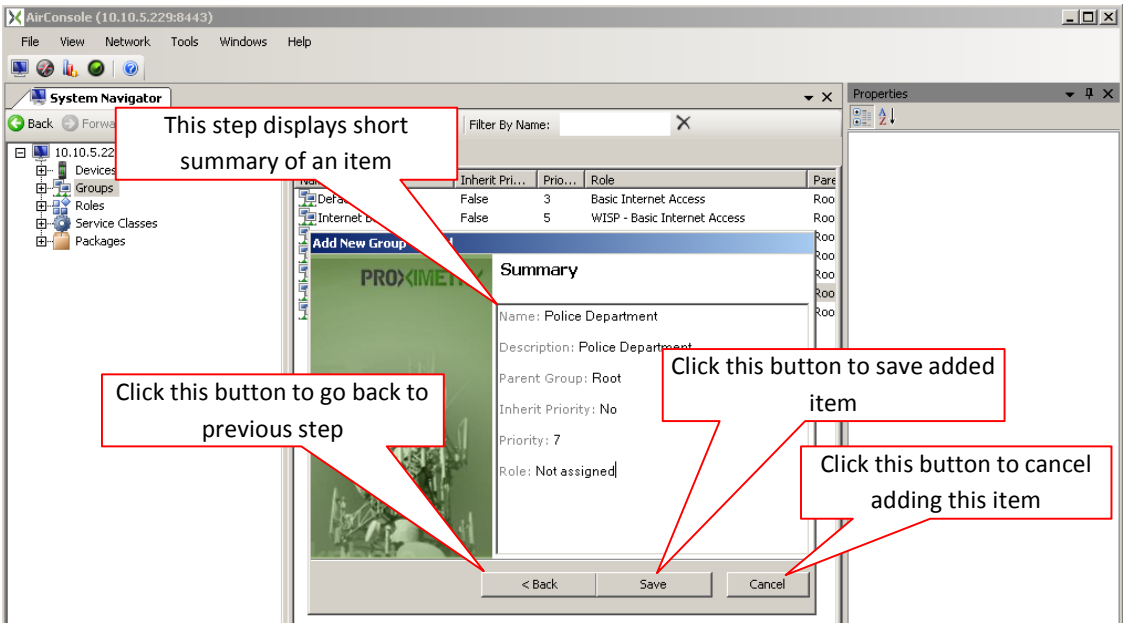
Screen Capture 14. Starting Group wizard

Clicking **Next** button opens successive step of the wizard and allows entering proper values for attributes as shown in Screen Capture 15.



Screen Capture 15. Group wizards step 2

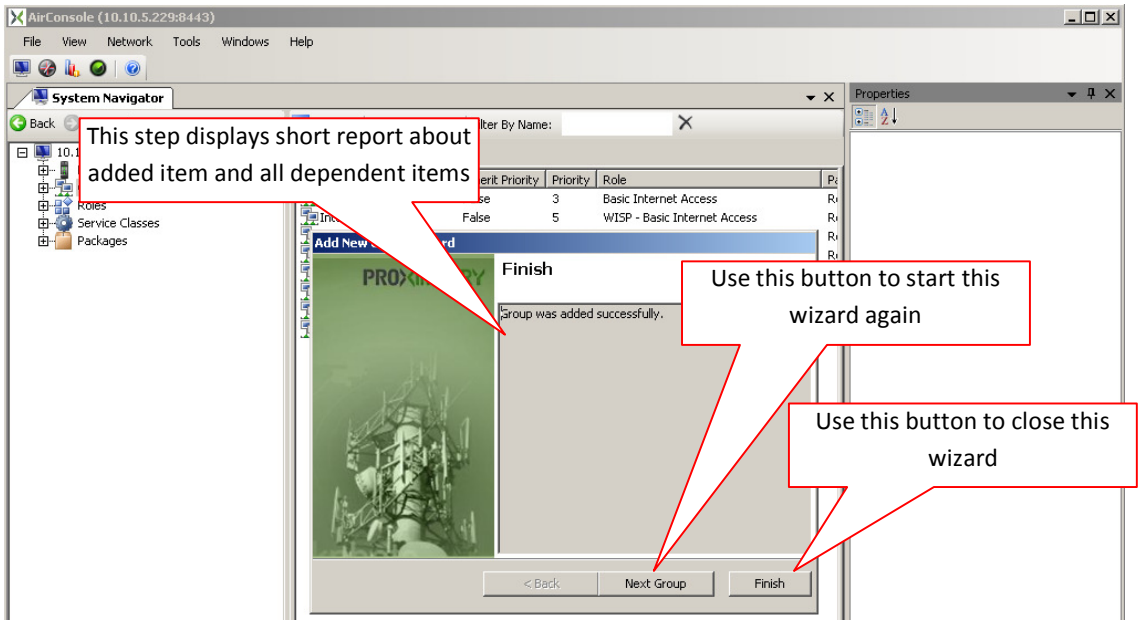
In case everything was set properly after clicking **Next** button you will see Summary step as shown in Screen Capture 16.



Screen Capture 16. Group wizard summary step

Clicking **Save** button causes saving item to database and displays Finish step as shown in Screen Capture 17. Using **Back** button let you go back to previous step. **Cancel** button closes wizard without saving item to database.

There is a possibility to run wizard again and add another item (in this example Group) or simply close this wizard.



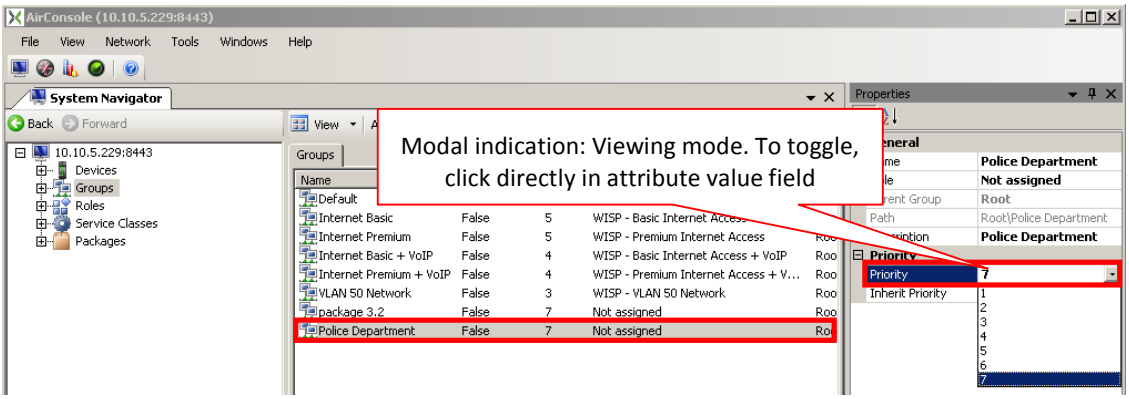
Screen Capture 17. Group wizard finish step

Wizards may differ depending from items in amount of steps or design of particular steps.

Editing Item Attributes

Editing item attributes is a modal operation, in part because editing mode implies a SQL "update" query transaction on the underlying database, which has a different structure than a SQL "insert," "delete," or "select" query. Therefore, before you can edit item attribute, you must leave viewing mode and enter editing mode. To enter editing mode, go to the item **Properties** window and click directly to the attribute value field as shown in Screen Capture 18.

Toggling between Edit and View Modes



Screen Capture 18. Click directly into attribute value field to enter edit mode

Once you enter editing mode, the attribute field is highlighted on blue as shown in Screen Capture 18. Click the **TAB** key on keyboard or Left Mouse button outside this field to return to viewing mode without making any changes. In case some modification was done moving focus somewhere else will run validation and if modification was made properly changes will be saved before returning back to viewing mode.

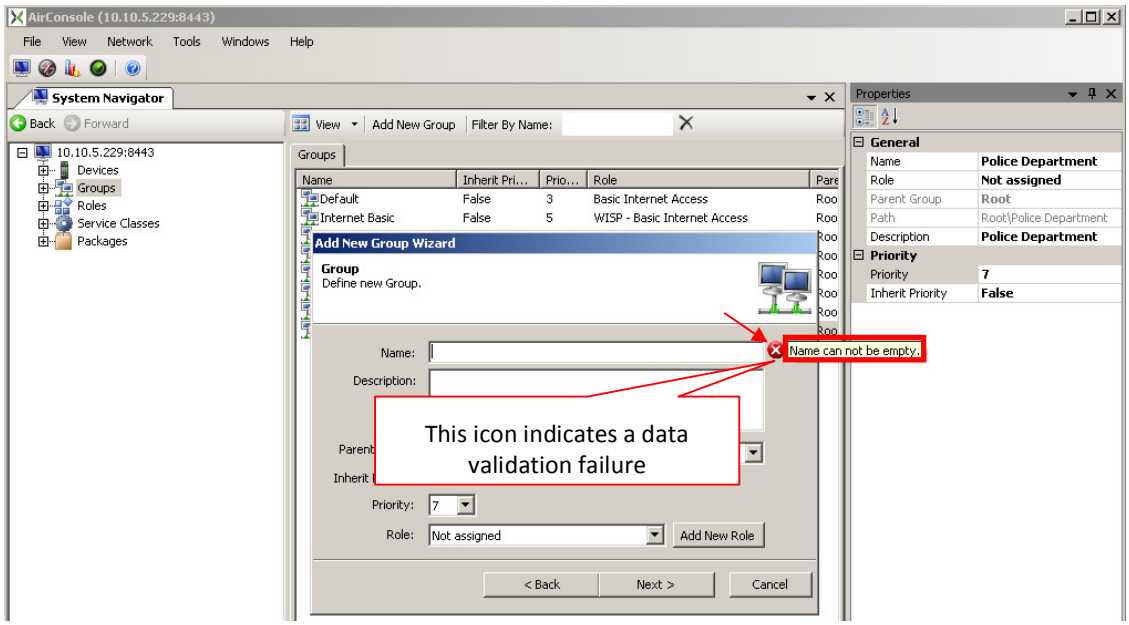
Certain Attributes May Still be Read-Only Even in Edit Mode

Even in editing mode, some attributes may not be editable. Item attributes that are editable appear with a black color. Attributes that appear with a gray color are not editable, often because these attributes serve as primary keys into internal database tables, and editing them could lead to database consistency issues.

In some cases, it may be possible to edit these items from another GUI object. In other cases, the best way to change an item's attribute value(s) may be to delete the entire item and then add it again with the correct attribute value(s). Examples of this include trying to change the MAC address attribute value on a device interface or the values for attributes such as **Image Build ID**, **Serial Number**, or **UUID** on devices. The meaning of these concepts will be explained in greater detail later.

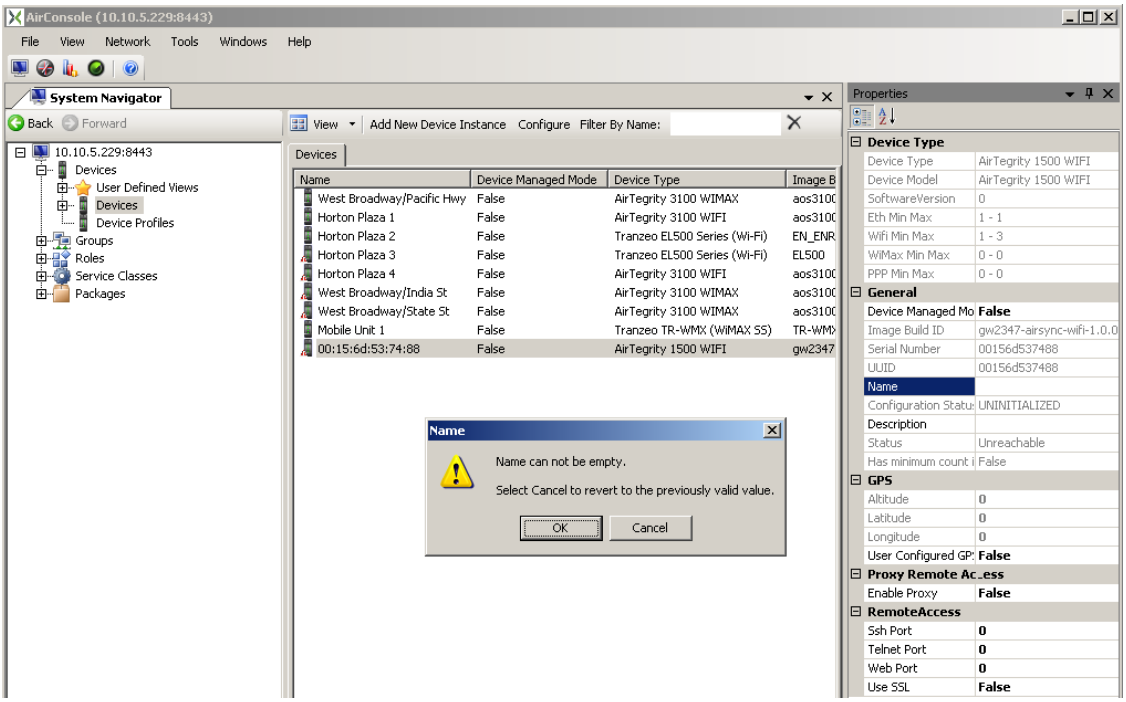
AirSync Data Validation

AirSync validates attribute values as they are added using wizards or edited in properties window. While adding items the system will display a red circle with white cross icon indicating a data validation failure as shown in Screen Capture 19. You will get a hint about why the validation failed. The system will force you to adjust the value before you can go to next step or save it successfully.



Screen Capture 19. Graphical indication of data validation failure during adding item

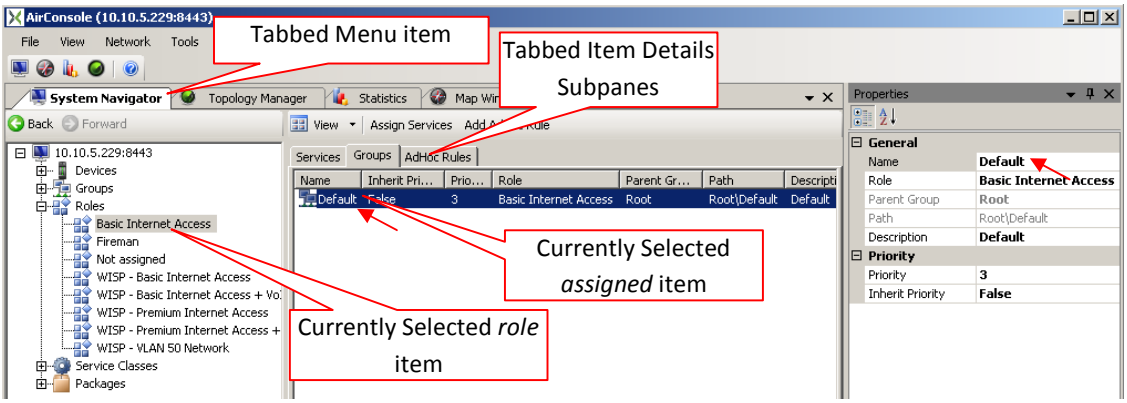
In case editing attributes the system will display a message indicating a data validation failure as shown in Screen Capture 20. When clicking **Cancel** button changes will be rolled-back. Hitting **OK** button leaves changes in focused field without saving them to database so you may re-use them to make proper change.



Screen Capture 20. Graphical indication of data validation failure during editing item

Tabbed Window Metaphor

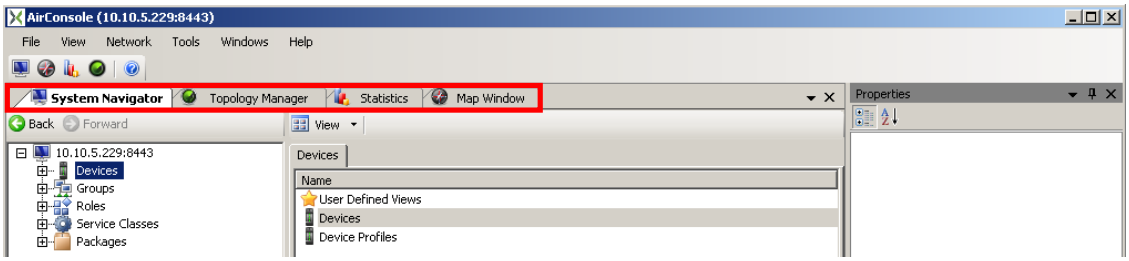
Notice in Screen Capture 21 the use of tabs to save screen real estate but allow users to see that there are more menu items open or more information sub panes available.



Screen Capture 21. Item details for selected item in "Roles" item

Tabs also allow users to switch rapidly between different items when multiple windows are open, and between detail sub panes for items that have distinct groups of related details. In the case of tabbed sub panes such as **Services**, **Groups** and **AdHoc Rules** above, each tab will show detailed information related to the item currently selected in the tree on the left, in this example, the role named "Basic Internet Access."

Managing Multiple Window Regions



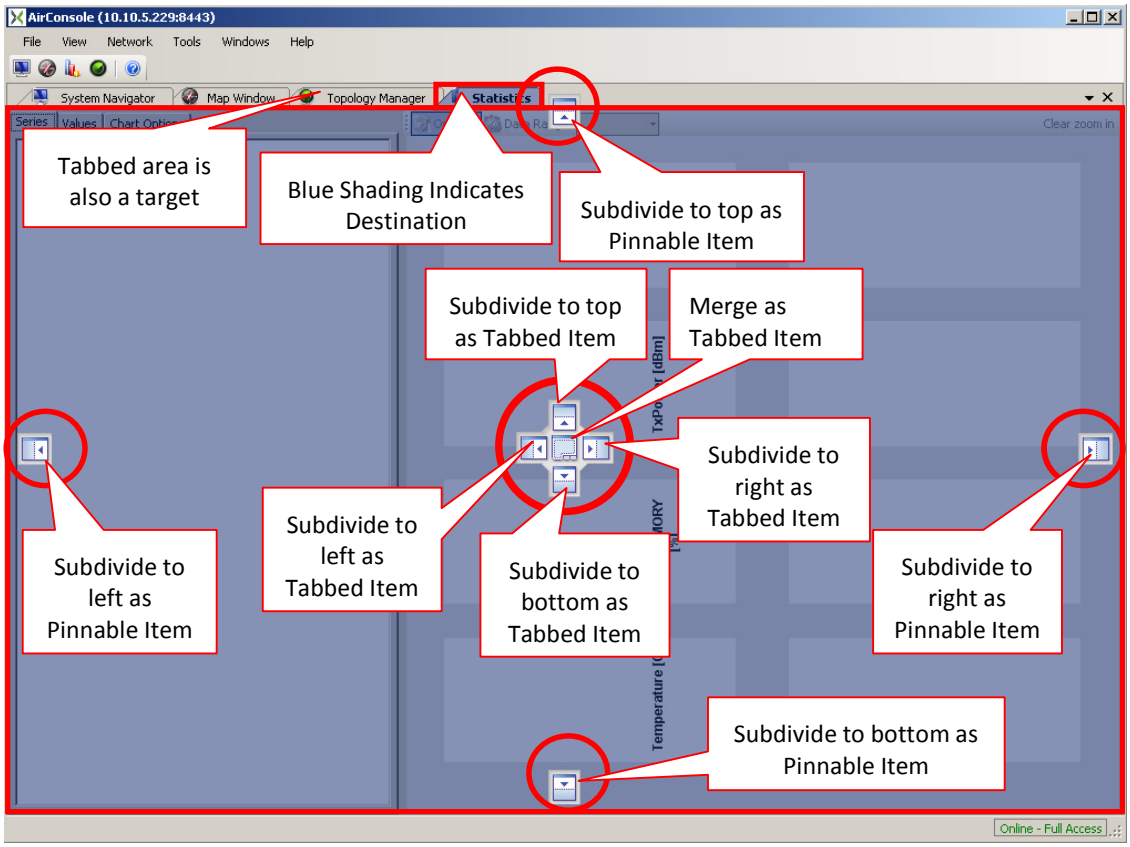
Screen Capture 22. Multiple Tabbed Items are open

As previously mentioned, and shown in Screen Capture 22, users can open multiple items and switch between them by selecting the tab corresponding to the desired item. It is also possible to subdivide the window into multiple regions (each of which can have multiple tabs), reorder the tabs, undock the tabbed items into floating windows, and re-dock GUI items on the top, right, left, or bottom portion of the window region. The following sections cover these operations.

Moving GUI Objects by Dragging and Observing Visual Cues

GUI objects can be moved around by direct "click and drag" or "drag 'n' drop" manipulation. There are a variety of different behaviors that will be explained below, but the key concept is to manipulate the intended object by dragging it, and observing the visual feedback the GUI provides indicating the state of the operation in progress.

Screen Capture 23 shows the visual feedback cues that occur as a user clicks (and holds) on a tabbed item, before beginning a drag operation. The important cues in the screen capture have been annotated. Learning to recognize and react to the visual feedback is the key to manipulating GUI screen objects effectively.



Screen Capture 23. Visual feedback cues when selecting a Tabbed Item

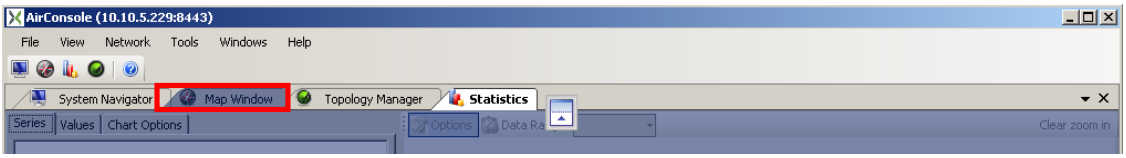
Properties window is opened as pinnable item subdivided to a right by default so you will not see a possibility to subdivide windows in this area.

As an item is selected, look for a blue shaded region (annotated above with red rectangle). This indicates the current destination of the operation. In the example above, the shaded region indicates that the tabbed "Statistics" item is docked together with all the other tabbed items.

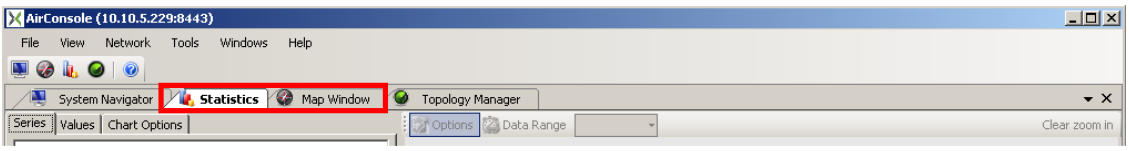
The on-screen controls annotated with red circles represent special targets where the item could be dragged to create a different user interface experience. All of the targets are available for all items.

Reordering Tabbed Items

Users can reorder the sequence of tabbed items by dragging them. The sequence of Screen Capture 23, Screen Capture 24 and Screen Capture 25 shows the **Statistics** item being moved to the left of the **Map Window** item. Partial images of the final two screen captures have been used to minimize space, emphasize the visual cues (the blue shading moves from the tabbed item **Statistics** in Screen Capture 23 to the tabbed item **Map Window** in Screen Capture 24 indicating the ending destination), and to emphasize the final result (tabbed item **Statistics** is now to the left of tabbed item **Map Window** in Screen Capture 25.



Screen Capture 24. Drag selected item to the left, highlighted tab changes to indicate new position

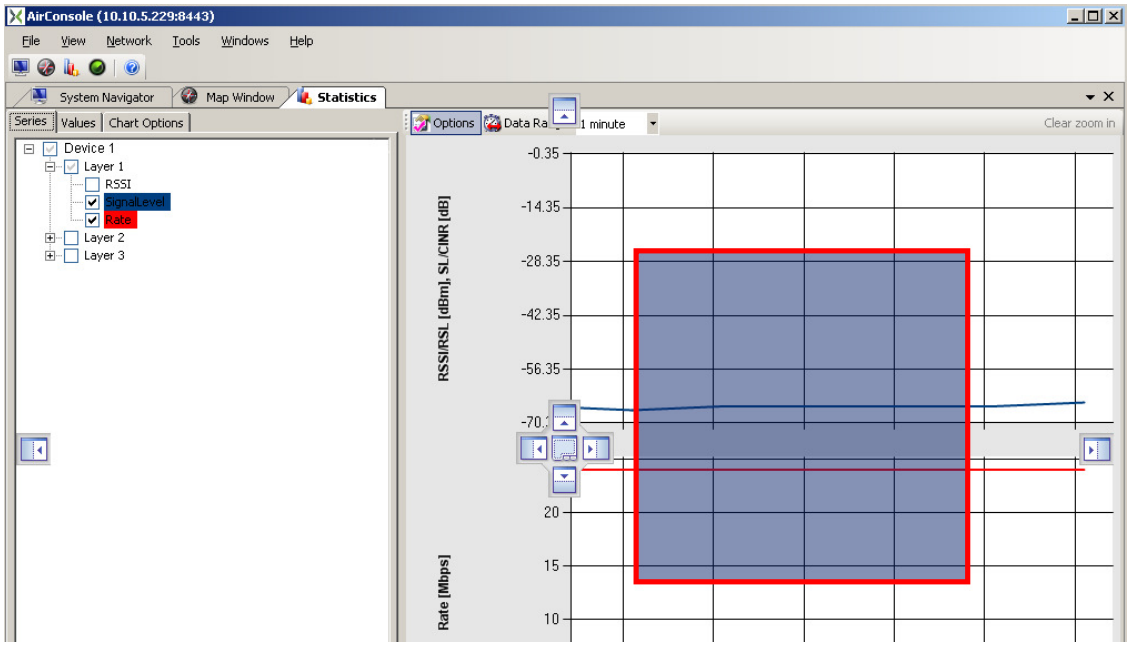


Screen Capture 25. After release, "Map Window" item has been moved to the right of "Statistics" item

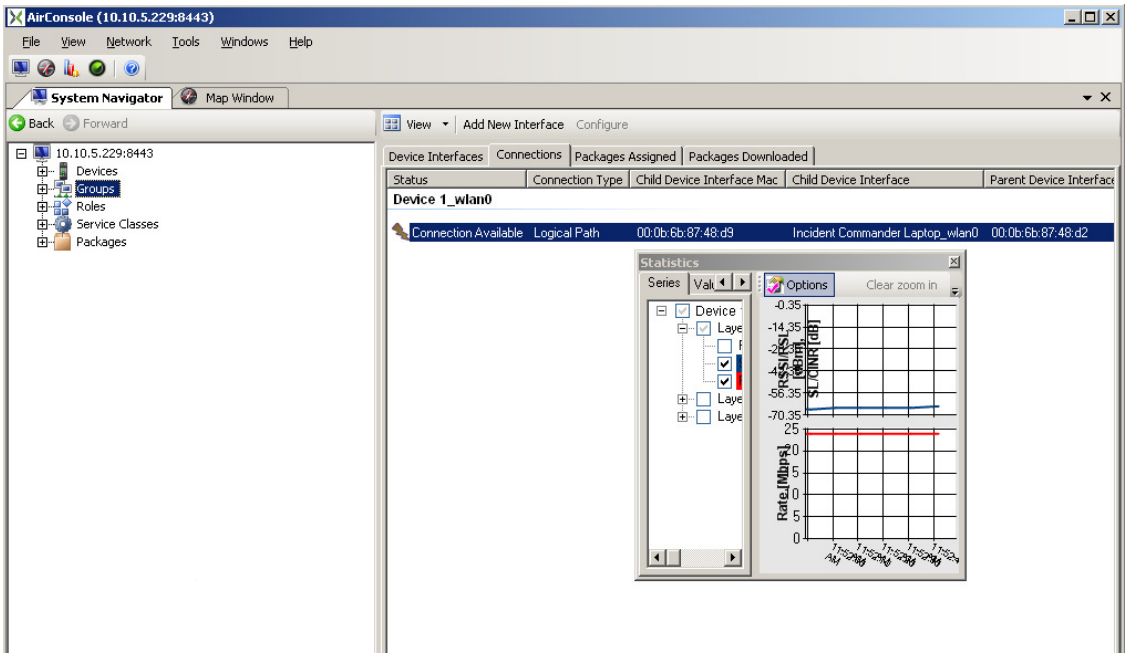
Moving Tabbed Items to Floating Windows

Users can move items to floating windows in a similar fashion. The key is to look for the visual cue indicating a floating window destination. Unlike the visual cues shown in Screen Capture 23 that appear upon clicking and holding the item to be moved, this cue won't appear until after starting the drag operation (moving the mouse) as shown in Screen Capture 26. Screen Capture 27 shows the final result after releasing the drag operation. The floating window can be resized to suit the user's preferences.

Moving an item to a floating window can be useful, for instance on workstations that have multiple monitors available, enabling the user to selectively split AirSync display items between the available monitors. In a network operations center (NOC) setting, the **Map Window**, **Statistics** and **Network Diagram** items are especially well suited for display on separate large screen monitors typically found in NOC environments.



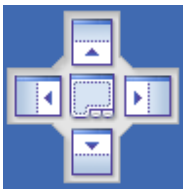
Screen Capture 26. Dragging Statistics item to produce a floating window cue



Screen Capture 27. Statistics item in floating window upon release

Moving Items to Different Window Regions

Users can move items to different window regions and subdivide windows by using the primary AirSync GUI item placement control, shown in Screen Capture 28, as a target for drag 'n' drop operations.



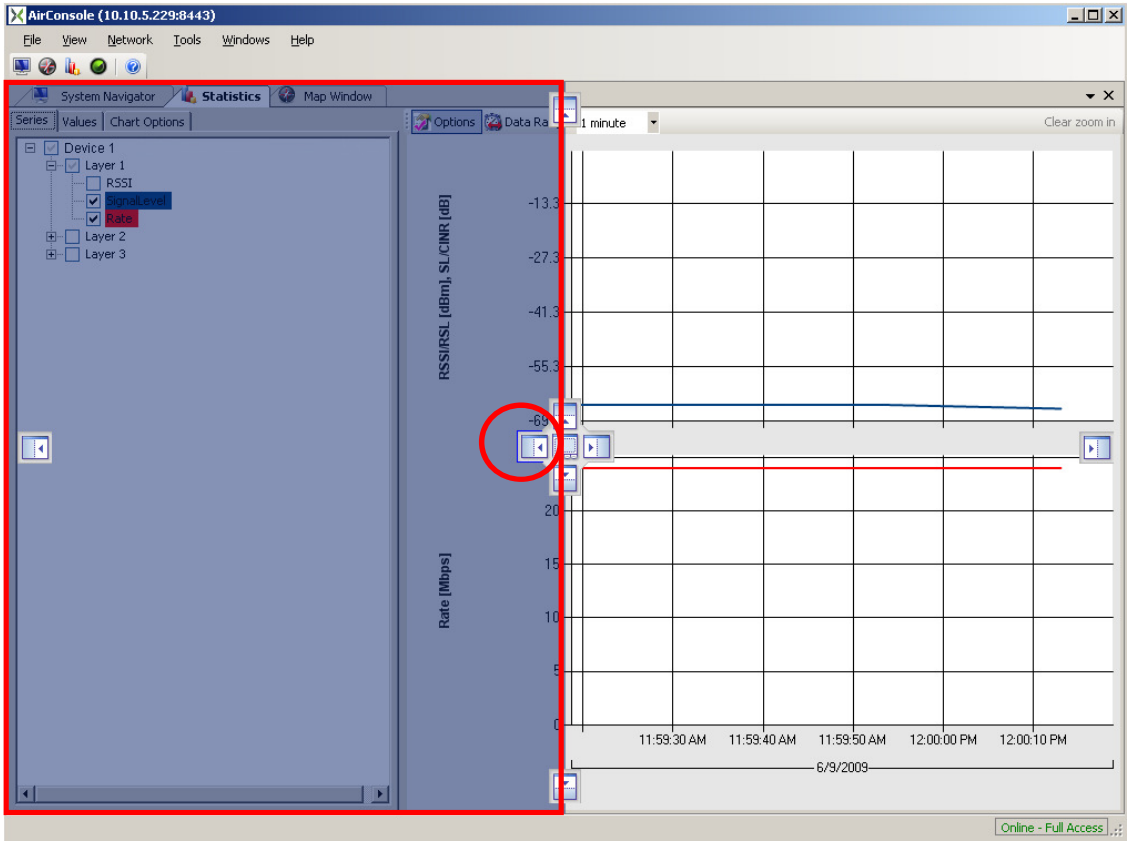
Screen Capture 28. The primary AirSync GUI item placement controls

Items can be moved into a new subdivided window region to the left, right, top or bottom of the original window region by using the left, right, top, or bottom portion of the control as a target.

Items can be merged back to the main tabbed area of another window region by using the central portion of the control as a target.

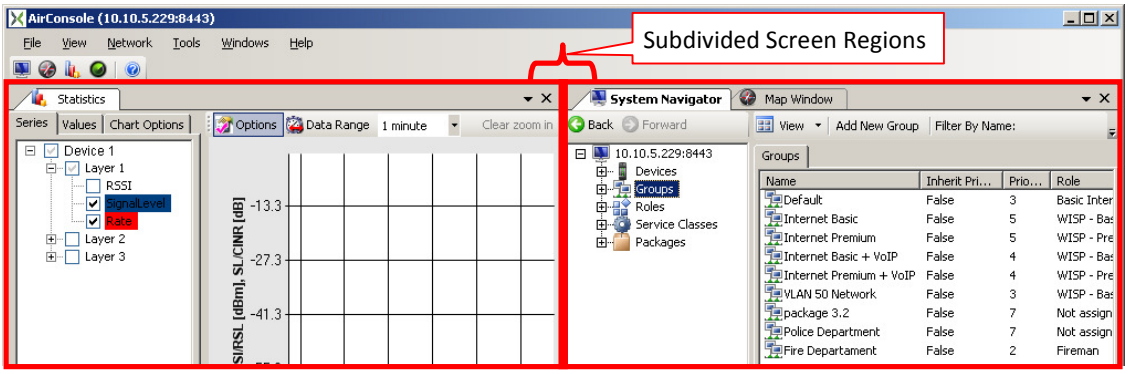
Screen Capture 29. AirSync GUI item placement targets

While dragging the item over the target, look for the appearance of a blue shaded region to indicate the destination screen location for the item. The annotation in Screen Capture 30 indicates a "Subdivide to Left as Tabbed Item" operation.



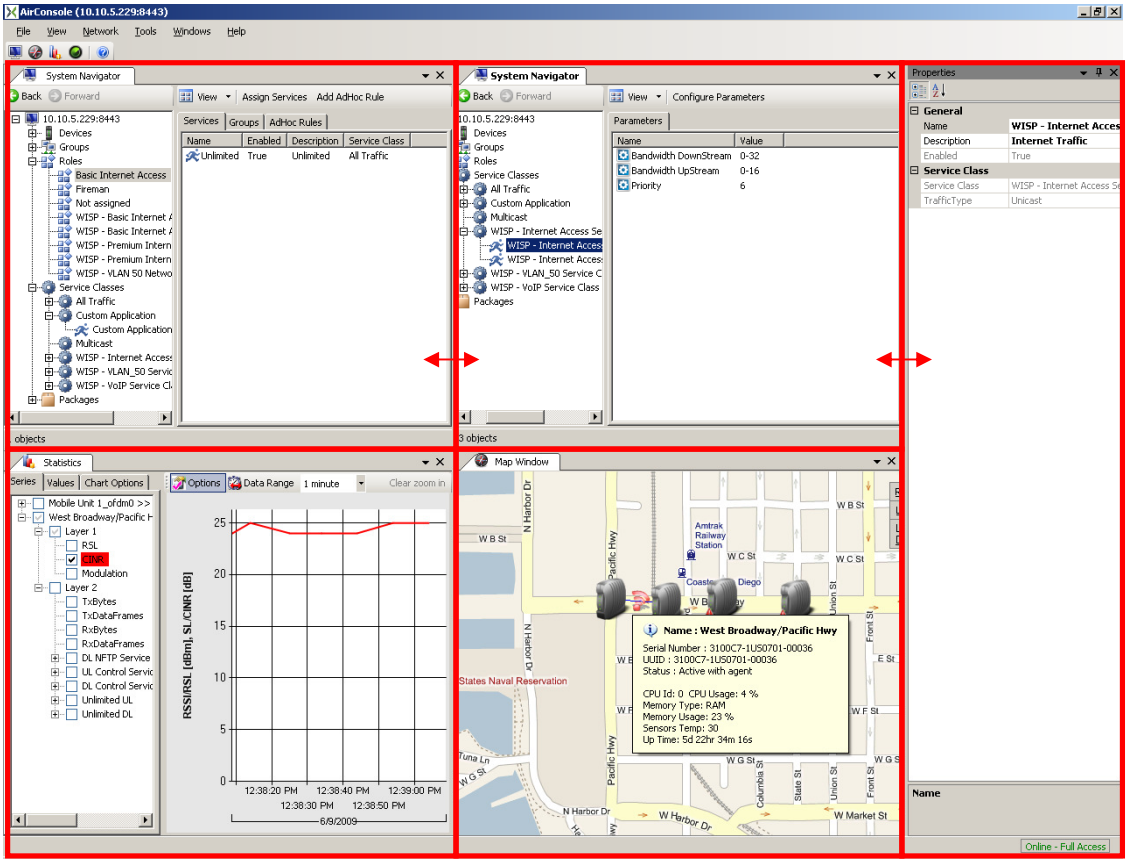
Screen Capture 30. Dragging the Statistics tab over the left portion produces a visual cue

It may seem awkward the first couple of times, but after a few tries it is easy to get the hang of the operation. Screen Capture 31 shows the "Statistics" item in a subdivided screen region to the left of the original after completing the previous drag operation.



Screen Capture 31. The Statistics item in a subdivided screen region to the left of the original

Screen Capture 32 shows a complex window that has been subdivided many times. The individual regions can be resized by dragging on the borders between the regions.



Screen Capture 32. Resizing regions in a complex, subdivided window

Hints for Manipulating GUI Objects

Here are a few hints to note when manipulating GUI objects:

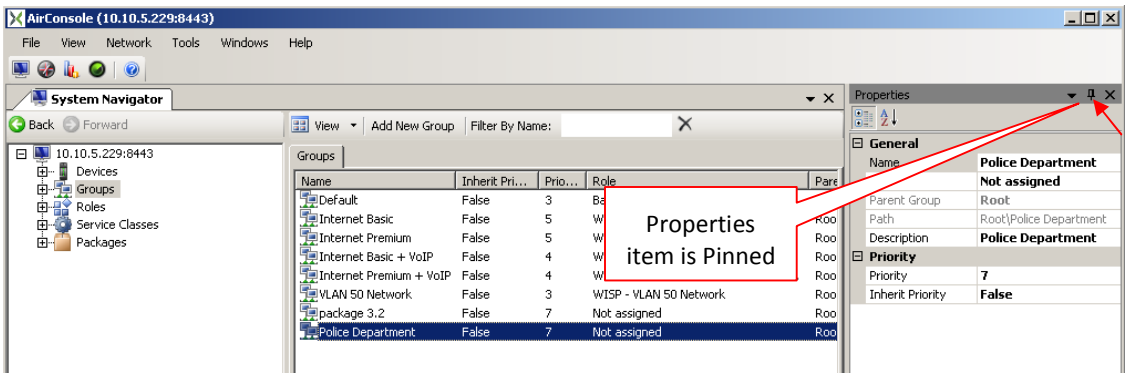
- To drag an item: select it by clicking on its tab or by its title bar if it is a floating window. Otherwise, the item might not appear to be drag-able.
- If you have difficulty getting the target control(s) to appear, try selecting the title bar or tab from a slightly different location.
- To move an item back to the tabbed area, use the icon with tabs or just drag the item to a tabbed area. If you drag the item to a tabbed area, you will see a visual indication of the tab position corresponding to destination location.

- You can drag a floating window onto another floating window. If you do so, you may appear to "lose" one of the windows. To find the "lost" item, look for tabs appearing at the bottom of the window.
- If it gets confusing, try closing and reopening some items.
- To move an item that has been unpinned, you must first pin it again.

Pinning and Unpinning Items to Toggle the Auto-hide Feature

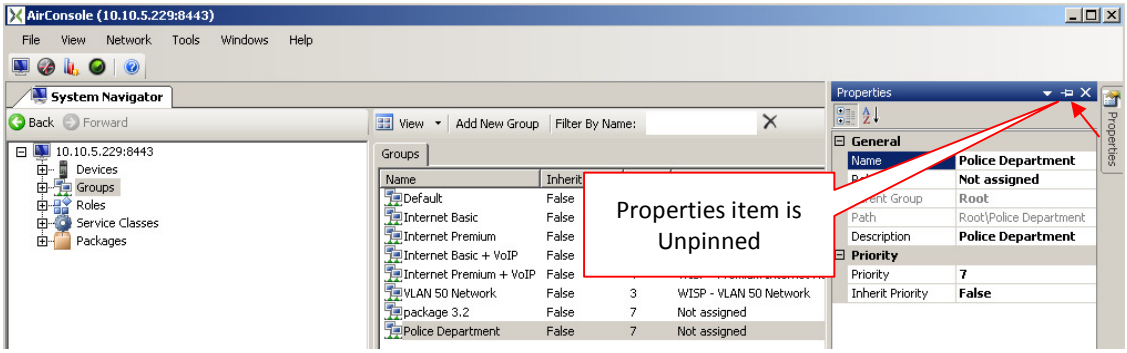
The GUI objects (especially **Properties** window) can be pinned and unpinned. When unpinned, the window for the item will automatically hide near the left, right, top, or bottom edge of a screen region to conserve screen real estate. The corresponding edge will display a visual cue indicating that the hidden window will automatically display by hovering the mouse over or clicking on the cue.

Screen Capture 33 shows the **Properties** item subdivided as a pinned window to the right. Notice the pin detail in the left screen region. To toggle the pinned status, click the pin icon.



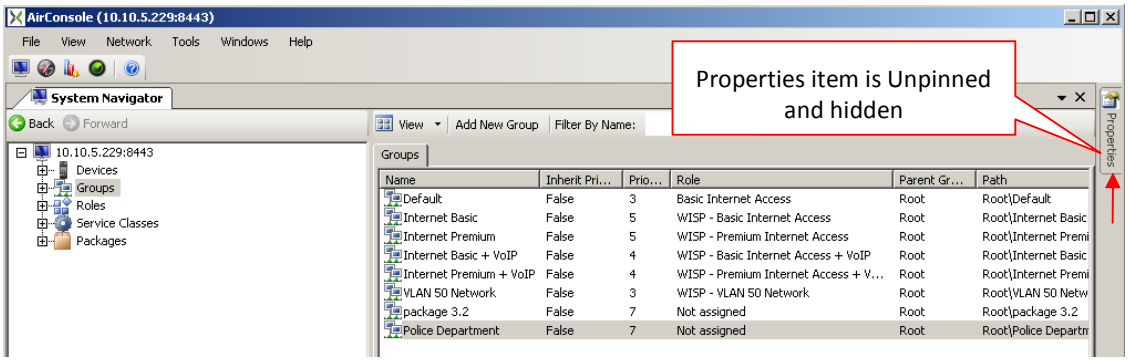
Screen Capture 33. Properties item pinned on the right

Screen Capture 34 shows the **Properties** item unpinned but still displayed to the right. Notice the pin detail in the left screen region.



Screen Capture 34. Properties item unpinned, but displayed on the right

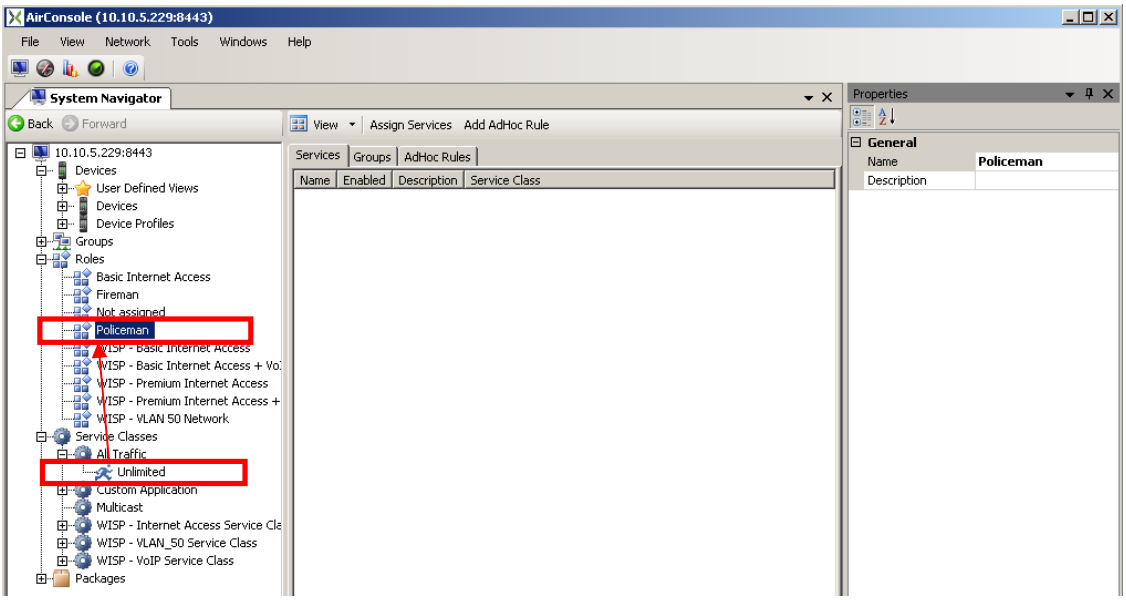
Upon clicking in a different window region, the unpinned **Properties** item will automatically hide itself as shown in Screen Capture 35. To redisplay the hidden item, hoover the mouse over and/or click on the visual cue on the left edge indicating the item is unpinned.



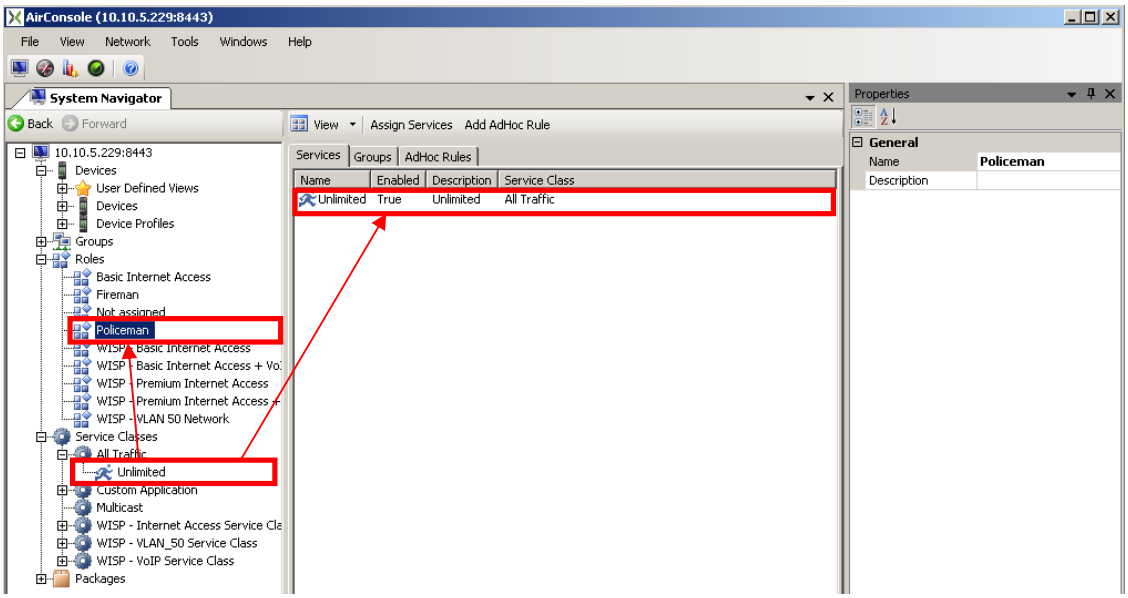
Screen Capture 35. Properties item unpinned and hidden on the right

"Drag 'n' Drop" Operations with the System Navigator Window

To facilitate assignment actions, AirSync GUI supports drag 'n' drop mouse operations. The System Navigator supports "drag 'n' drop" operations for appropriate items selected from GUI objects (**tree** or **list)**. For example, to quickly assign a service to a role, using the direct, graphical drag 'n' drop object manipulation paradigm, drag a service item from the **Services tree** or **Services list** GUI object and drop it on the appropriate role in the **Roles tree** or **Roles list** GUI object. Screen Capture 36 and Screen Capture 37 shows all System Navigator tree as well as the in-progress result of dragging the **Unlimited** service item from the **Service Classes tree** GUI object to the "Policeman" role item in the **Roles tree** GUI object. Upon release, the service will be assigned to the role.



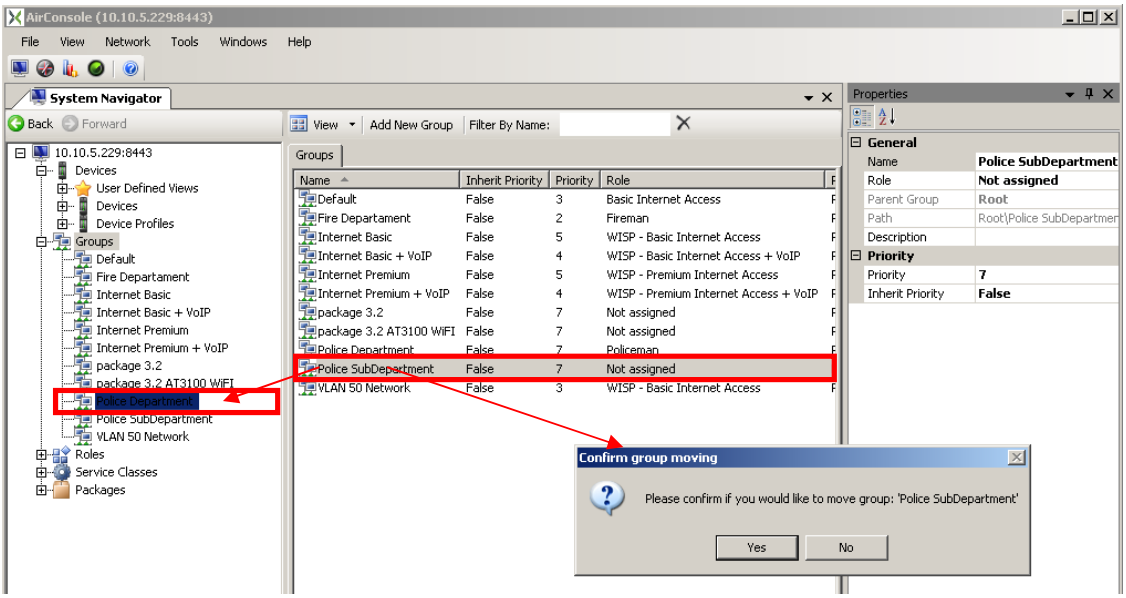
Screen Capture 36. Dragging and Dropping a Service from Service Classes tree to Roles tree –step 1



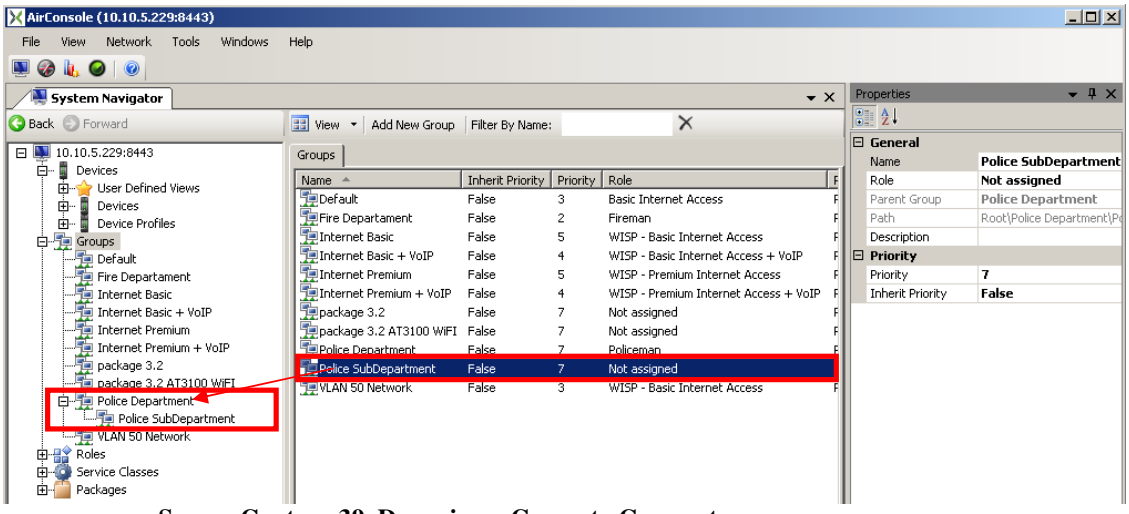
Screen Capture 37. Dragging and Dropping a Service from Service Classes tree to Roles tree –step 2

Screen Capture 38 and Screen Capture 39 shows a similar in-progress result of dragging the "Police SubDepartment" group item from the **Groups list** GUI object to the "Police Department" group item in the **Group tree** GUI object. Upon release, there will be confirmation message displayed. After clicking **Yes** the group will be assigned as a "child" to the "parent" group.

Only in case moving group to groups tree such a confirmation message may be displayed if proper parameter is set in Options.



Screen Capture 38. Dragging a Group from Groups list



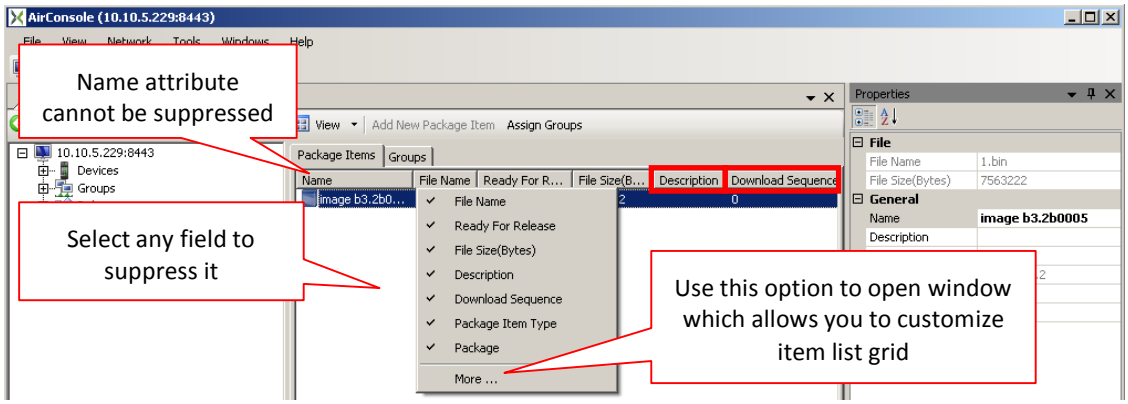
Screen Capture 39. Dropping a Group to Groups tree

In general, the System Navigator tree and item lists acts as source and destination targets for the drop operation, for example you may drag group directly from the **Groups** tree/list area, and drop it to **Groups** tree/list area if desired.

Customizing Item List Grids

For objects that display as item lists, it is possible to customize which item attributes are displayed, what order they are displayed in and how the list will be sorted. Screen Capture 40 shows how to invoke the **Grids Customization** item and the original **Package Items** list before customizing the display grid. Notice the sequence of column headings for the **Package Items** list: **Name**, **File Name**, **Ready For Release**, **File Size**, **Description**, **Download Sequence**.

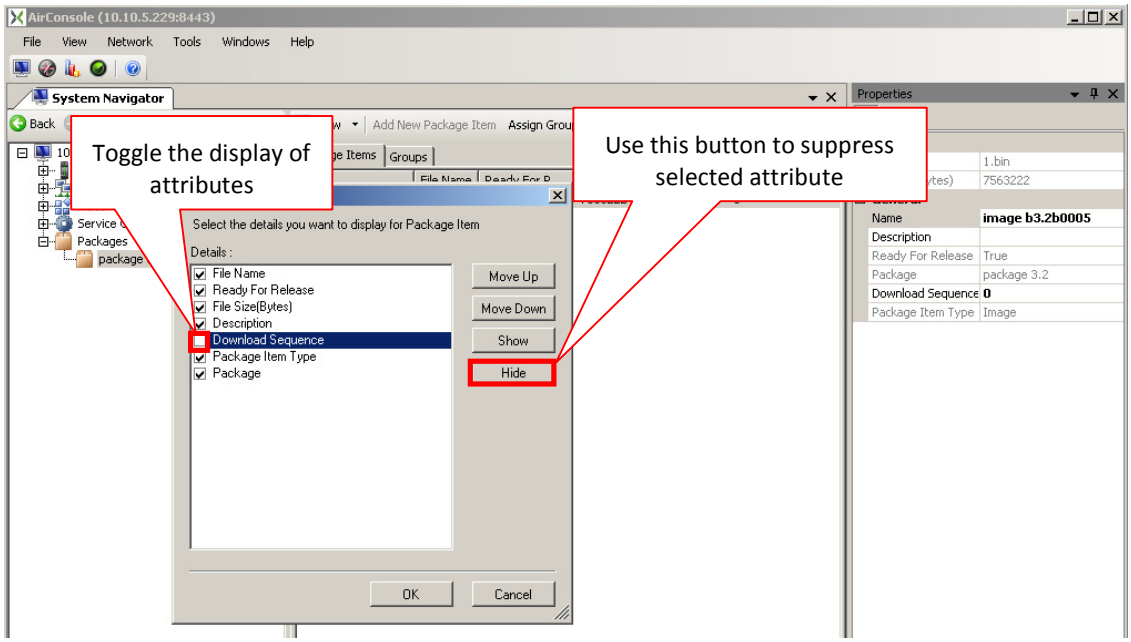
On all lists first attribute is **Name** and it cannot be suppressed or moved in another place.



Screen Capture 40. Original "Package Items" List Grid Layout

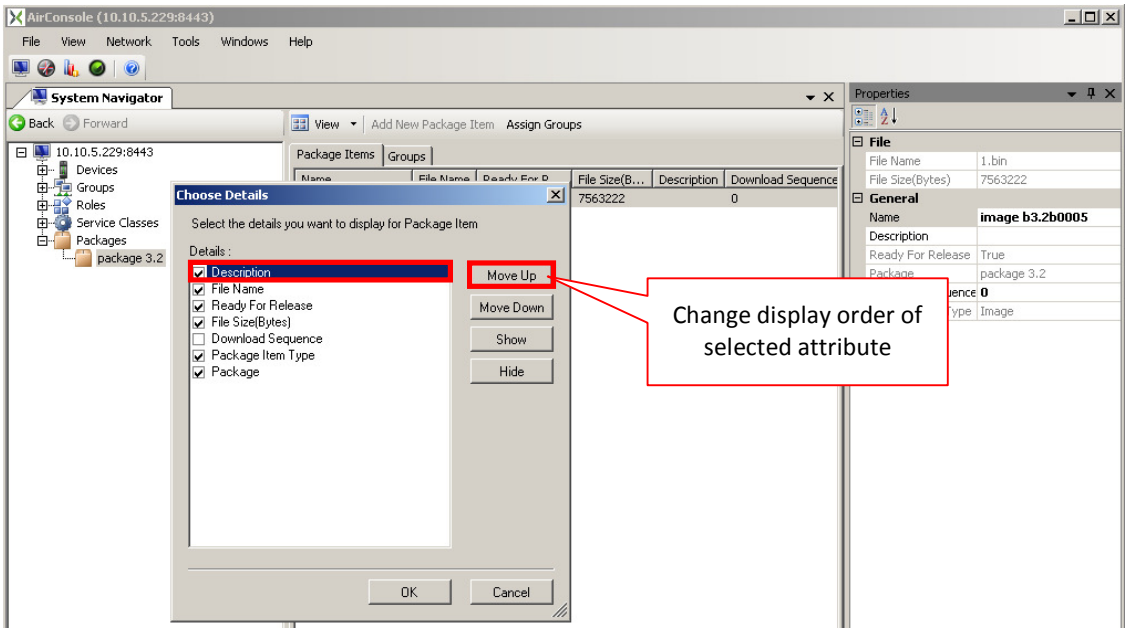
The following example shows how to suppress the display of the **Download Sequence** attribute and reorder the **Description** attribute to display as the first (leftmost) item. Screen Capture 41 shows the dialog box used to suppress the display of the **Download Sequence** attribute for the **Package Items** list.

The same effect you may obtain simply clicking on attribute directly on context menu as shown above.



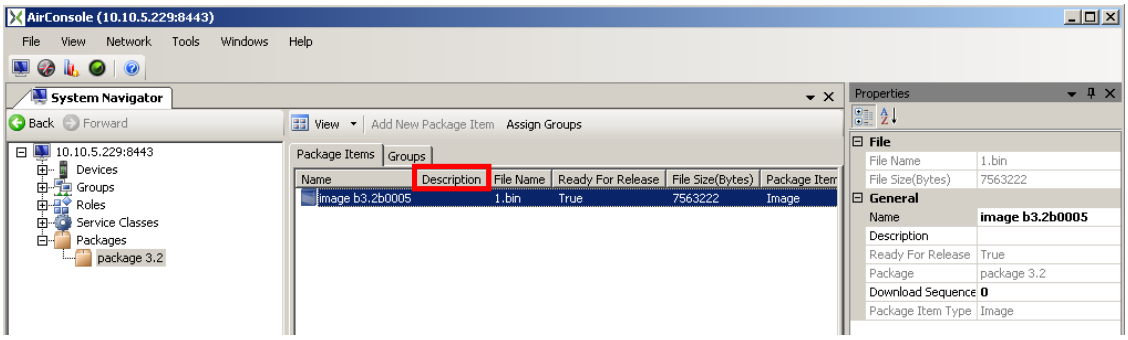
Screen Capture 41. Toggling off display of the "Download Sequence" attribute for "Package Items"

Screen Capture 42 shows how to reorder the attribute display columns in the list. In this example the **Description** attribute has been moved from the fifth display column to the second by selecting the item and clicking the **Move Up** button.



Screen Capture 42. Moving "Description" item to the left on "Package Items" Display

Screen Capture 43 shows the final result. The **Download Sequence** attribute is no longer displayed and **Description** is the second left column in the **Package Items** list display.



Screen Capture 43. Final result, "Description" displayed second, "Download Sequence" suppressed

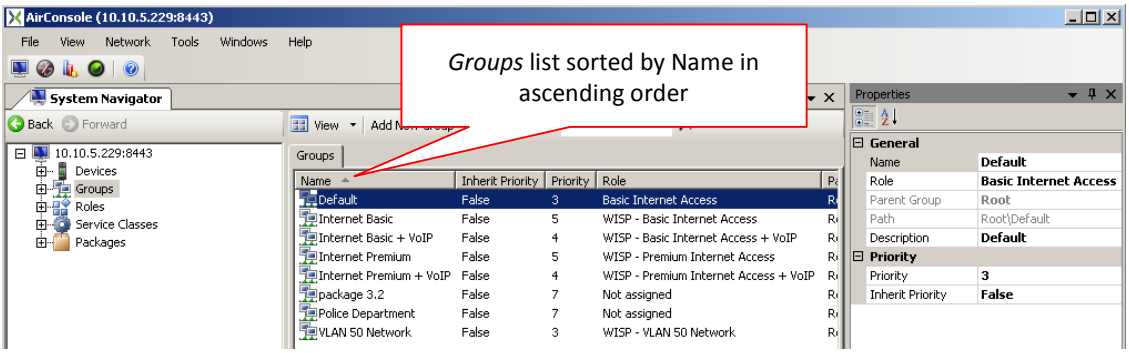
The same effect you may obtain simply dragging proper column and dropping it in new place.

The display width of each column can be directly manipulated by dragging the divider between any two-column headings.

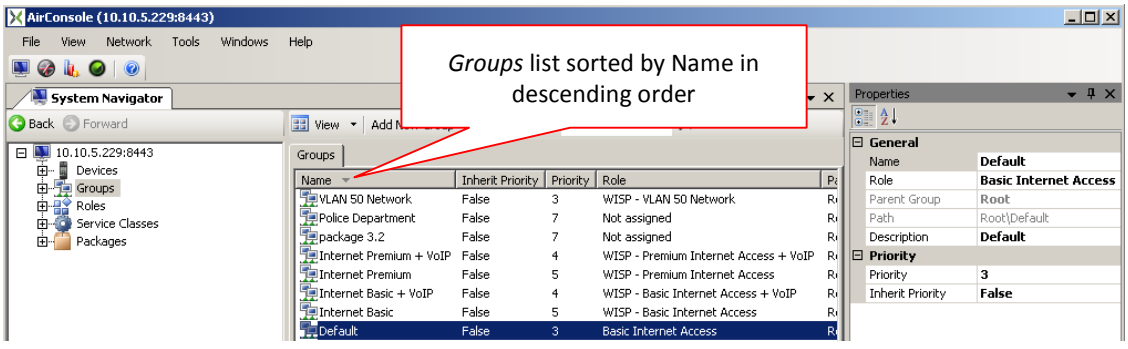
Sorting Item Lists

On an ad-hoc or temporary basis, you can change the sort order of any item list by clicking on any column heading. As shown in Screen Capture 44, the system will display an up arrow or a down arrow next to one column heading indicating the list is currently sorted by that column in ascending or descending order, respectively.

To sort the list by a different attribute, click on the column header for the desired attribute by which to sort the list. Click on the same column header again to toggle between ascending and descending sort order. Screen Capture 45 shows the same **Groups** list, now sorted in descending order by the **Name** attribute. This simple technique makes it much easier to find specific items in long item lists.



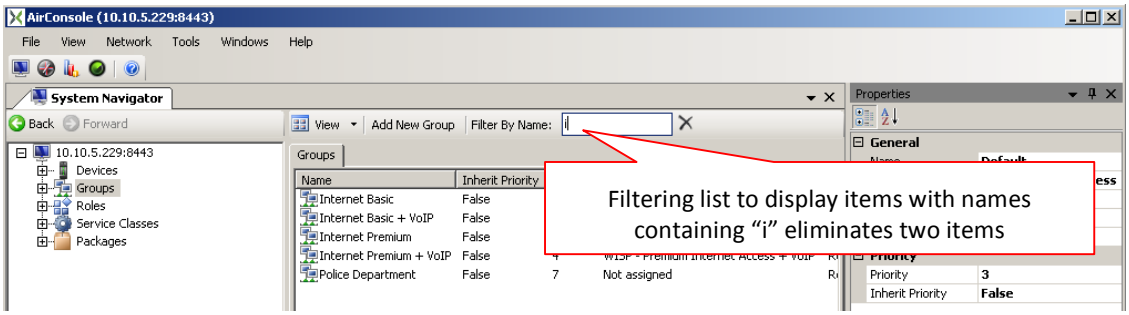
Screen Capture 44. Groups list sorted by Name in ascending order



Screen Capture 45. Groups list sorted by Name in descending order

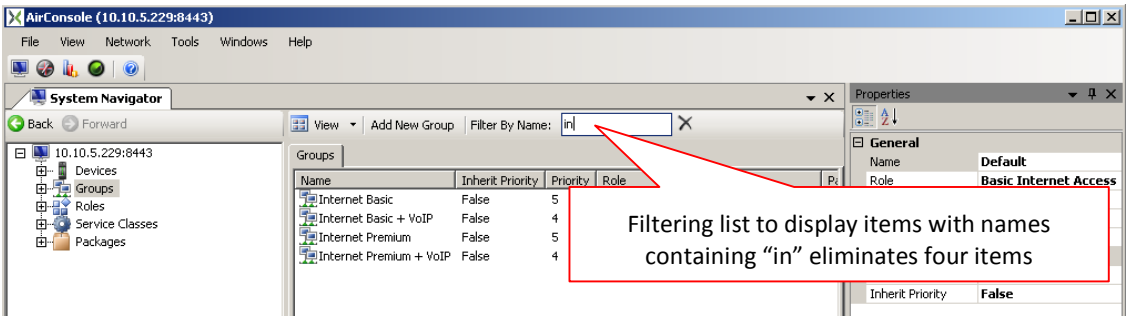
Filtering Item Lists

Filters can be applied to item lists to narrow the list of items displayed. Filters can be used to quickly search for a set of one or more items from a large list or set of items. Screen Capture 45 shows a small, unfiltered **Groups** list containing eight distinct items. Screen Capture 46 shows the list filtered to display only items with names containing "i". This filter eliminates three items from the displayed list of items. Filters provide a handy search mechanism, especially when used in conjunction with a well-designed item naming convention.



Screen Capture 46. Filtering Groups list to display only items with names containing "i"

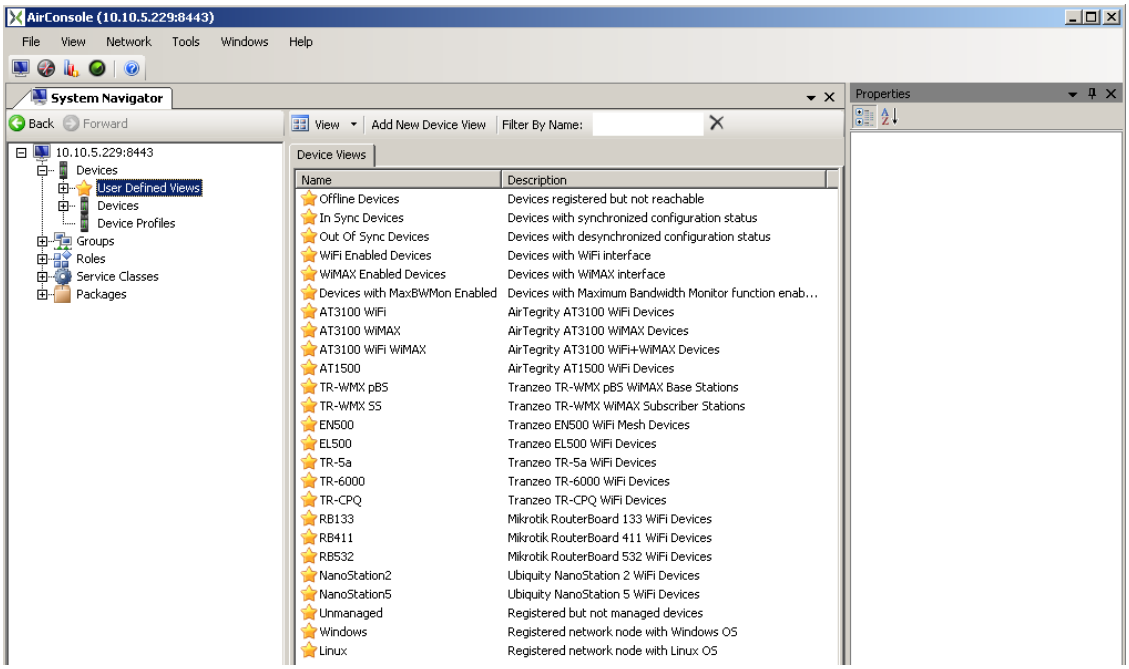
Screen Capture 47 shows the list filtered to display only items with names containing "in". This filter eliminates another one item from the displayed list of items.



Screen Capture 47. Filtering Groups list to display only items with names containing "in"

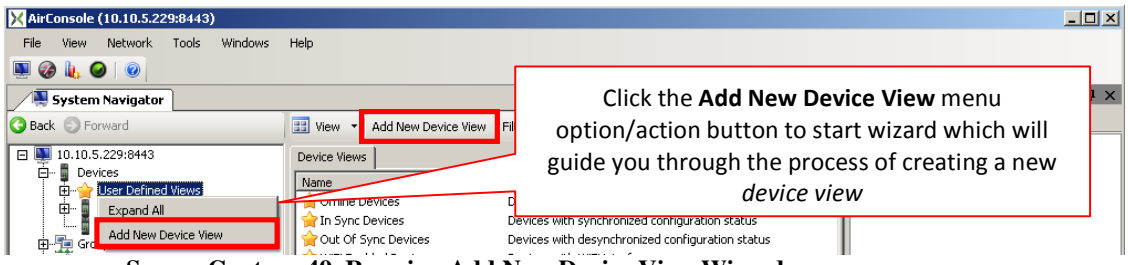
User Defined Views

As shown in Screen Capture 48 AirSync initially has a lot of defined User's views depending on i.e. Device Types, device's Statuses or type of interfaces. There is a possibility to display all devices double-clicking on **All Devices** item or define some customized views.



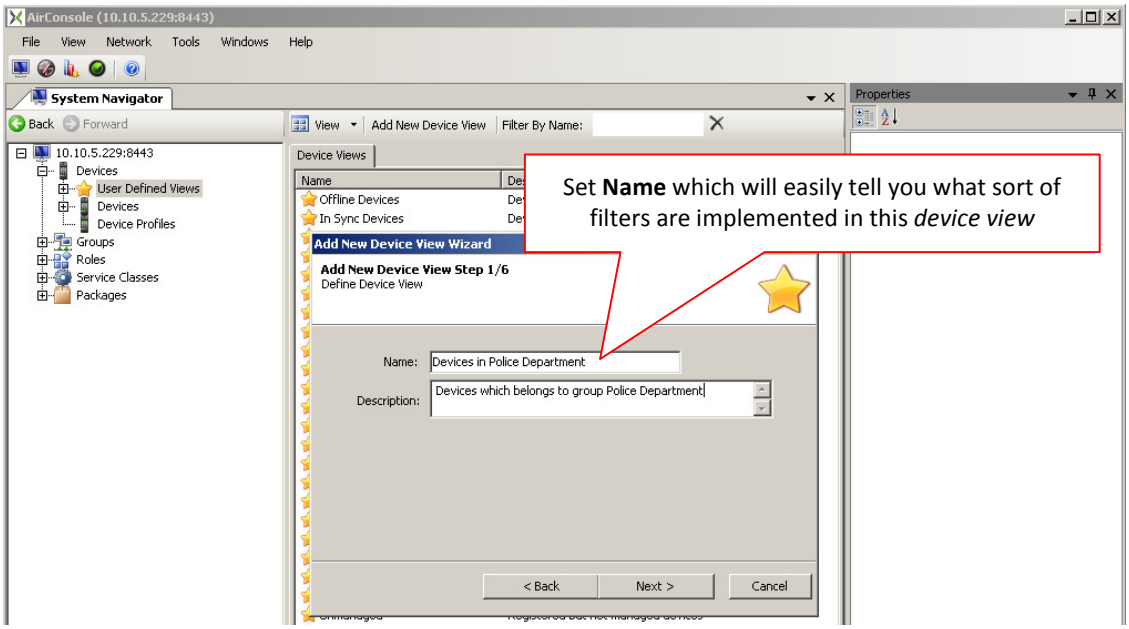
Screen Capture 48. Initial devices views list

To add own view start **Add New Device View Wizard** as shown in Screen Capture 49. An example of adding a user defined view follows.



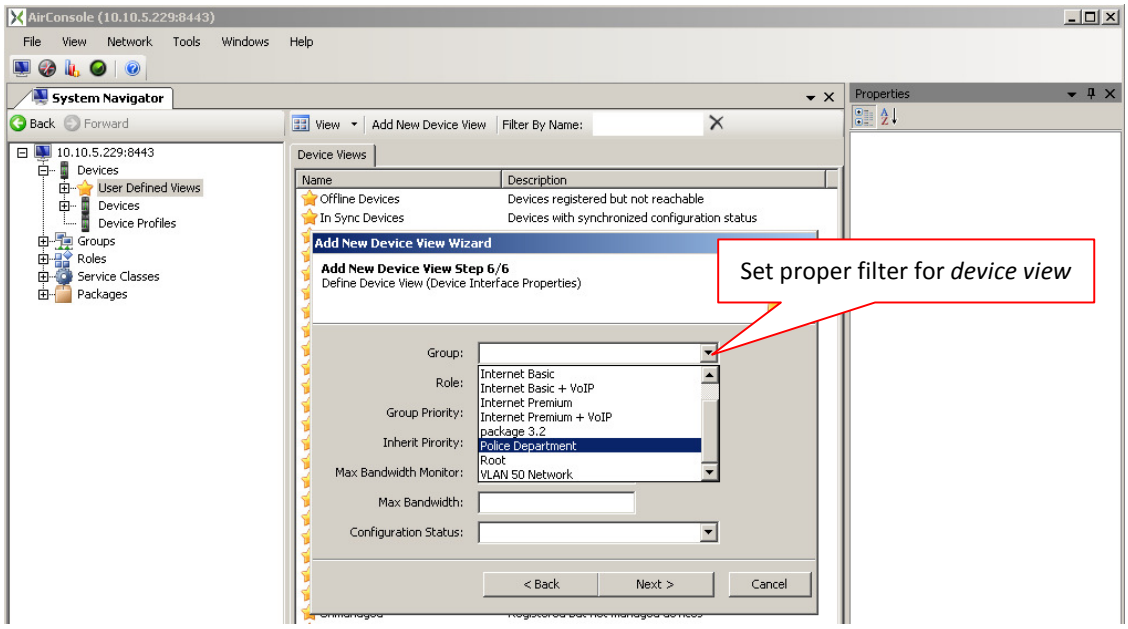
Screen Capture 49. Running Add New Device View Wizard

Set **Name** and **Description** for added device view as shown in Screen Capture 50.



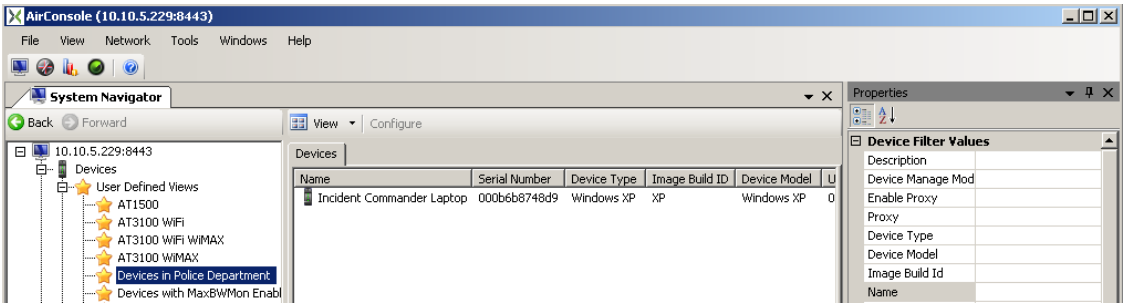
Screen Capture 50. Adding Users Device View

Set proper filters for Devices or Device Interfaces fields on next steps. Screen Capture 51 shows setting filter on Group field.



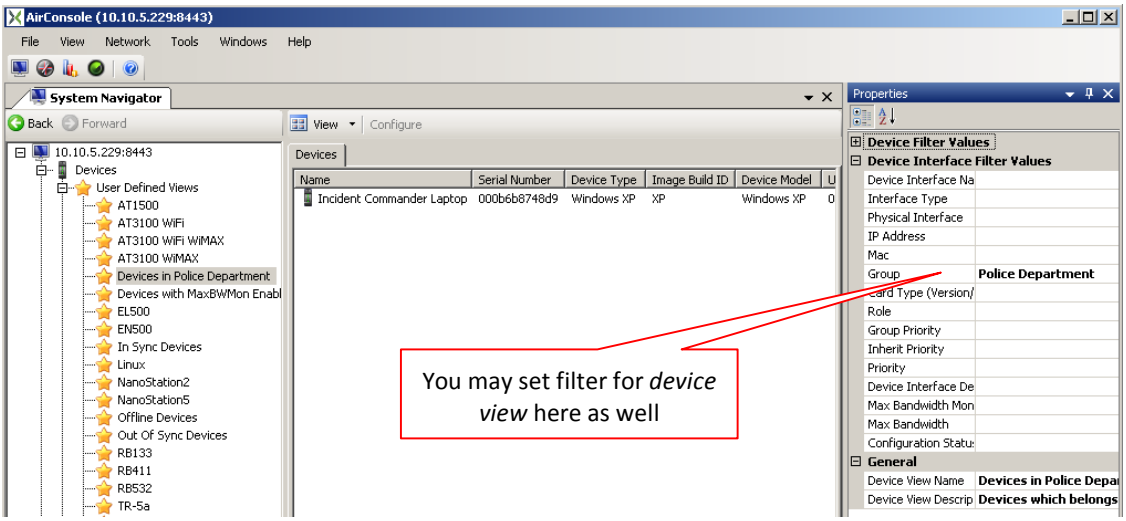
Screen Capture 51. Entering group filter on wizard's step 6

Finally when double-clicking on saved users defined view you will see list of filtered devices as shown in Screen Capture 52.



Screen Capture 52. List of filtered devices

The same effect you may obtain setting/manipulating filters directly on Properties window.



Screen Capture 53. Setting filters for device view on Properties window

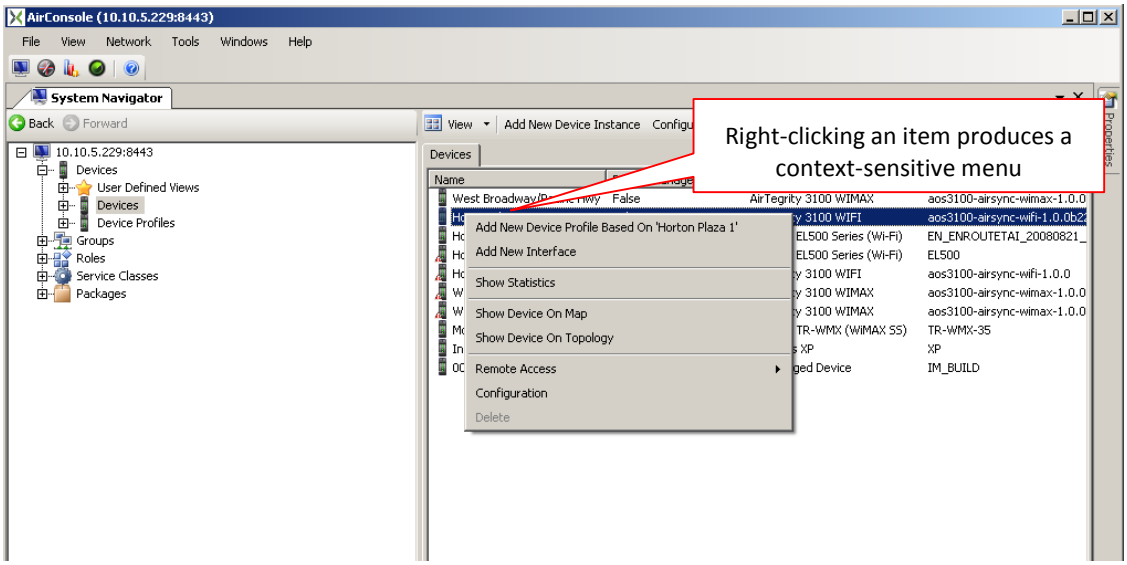
Context-sensitive Menus

Right-clicking objects in many of the GUI screens will bring up context-sensitive menus whose contents vary depending on the item selected and/or the GUI object or location from which the item was selected. Screen Capture 54 shows a context-sensitive menu that appears when right-clicking on an item in the **Devices** item list.

Context-appropriate actions for a selected device include:

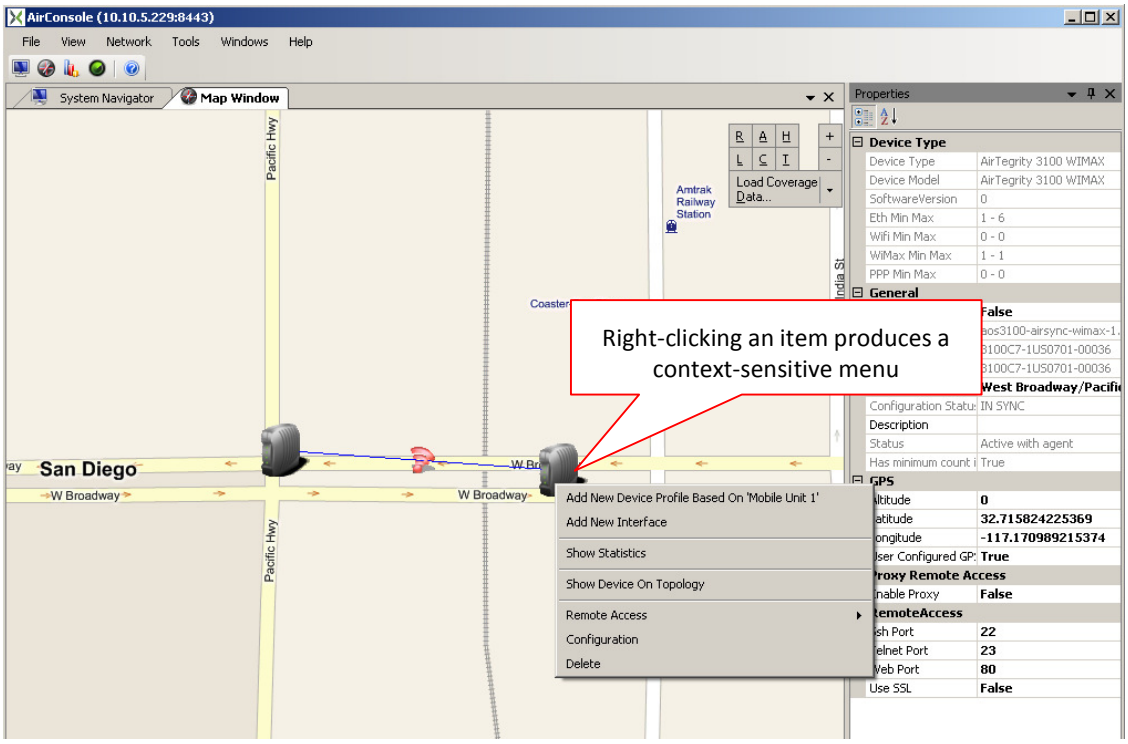
- Adding new interface
- Showing statistical information for the selected device

- Displaying the device on a map
- Showing selected device on Network Navigator
- Showing selected Device on Network Diagram
- Launching a remote access connection to manage the device
- Deleting device



Screen Capture 54. Right clicking on selected item brings up context-sensitive menu

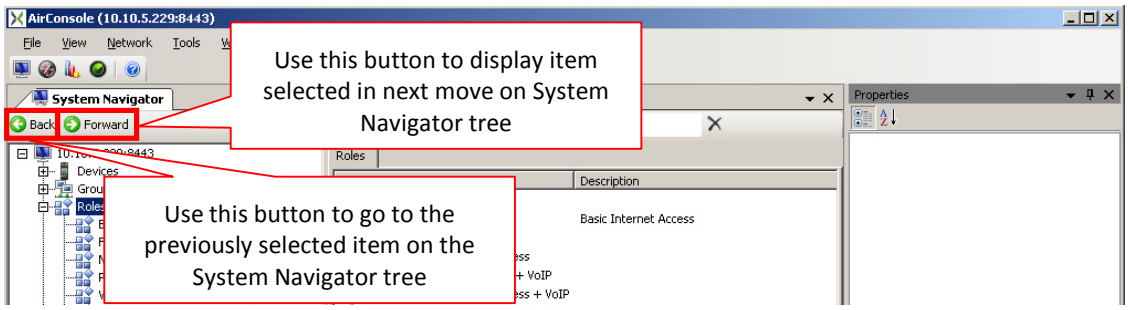
Screen Capture 55 shows a slightly different context-sensitive menu that appears when right clicking a device from the **Map Window** item.



Screen Capture 55. Different Context-sensitive menu when selecting device from "Map Window"

Back/Forward buttons

Back/Forward buttons placed on **System Navigator** tab allows you to go back or in some cases to go forward on the tree. This means that you may display previously selected item on the tree by hitting **Back** button or (in case you have went back a few steps) you may display item chosen after currently selected by hitting **Forward** button.



Screen Capture 56. Back/Forward buttons

GUI decorators

Decorators described in Table 1 are used by AirConsole to emphasize device's status or show in what role device is working. Last two are used to illustrate what kind of connection exists between devices.

Decorator	Description
	Device unreachable
	Device active but agent does not respond
	Device active but authorization failed (wrong username or password)
	Device active and authorization succeeded
	Device works as a mesh repeater
	Device works as a mesh gateway
	WiFi connection
	WiMAX connection

Table 1. Decorators used in AirConsole

GUI tips and tricks

Here are a couple of additional tips and tricks:

- If you don't see an item you expect to see in a particular item list, try checking for filters and disabling them if found.
- The best way to locate an item quickly on the map is to open the **Devices** item list (instead of opening the **Map Window** item) and right click on the desired item. From the context-sensitive menu, select **Show on Map** and the **Map Window** item will open with the selected item centered in the map.
- The best way to set GPS position for a device in case device does not send it is to use probing tool for Longitude and Latitude on map.
- The context-sensitive menu available by right clicking on a device is a handy way to initiate telnet, SSH or HTTP management connections to a device.

Initial AirSync System Setup

Before using AirSync to manage a wireless network, a few items must be tailored to appropriate site-specific values. This is largely a matter of making sure AirSync knows the correct location for its various distributed software components. Initial system setup also involves setting a few user preferences, such as governing the degree to which the system will present confirmation messages, as well as setting up some of AirSync's context-sensitive menu items to work with third-party software tools. The final steps involve registering devices in the system.

The following bullets summarize the initial setup steps, each of which is discussed in greater detail below:

- Assure the system requirements specified by AirSync (in "readme.txt" and in "Proximetry_AirSync_Quick_Install_Guide") are met as well as preinstallation requirements described in Appendix C
- Set System Configuration parameters
- Set Options for
    - System confirmation messages,
    - The use of third-party tools such as terminal emulators for establishing remote access sessions with managed devices,
    - Internal timers,
    - Charting options
- Register Devices

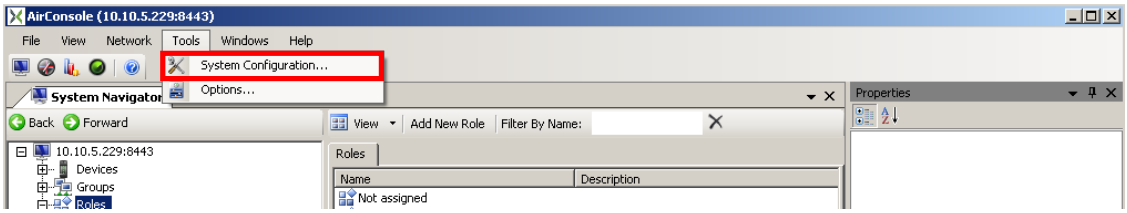
Setting System Configuration Parameters

AirSync exposes several parameters in the user interface with which an administrator can tailor an AirSync installation. Generally speaking, most of the parameters will be set appropriately during system installation, but it may be necessary to adjust a few of the values, especially if IP addresses get manipulated after the installation.

During the initial system setup, only a few of the parameters will require verification and/or adjustment:

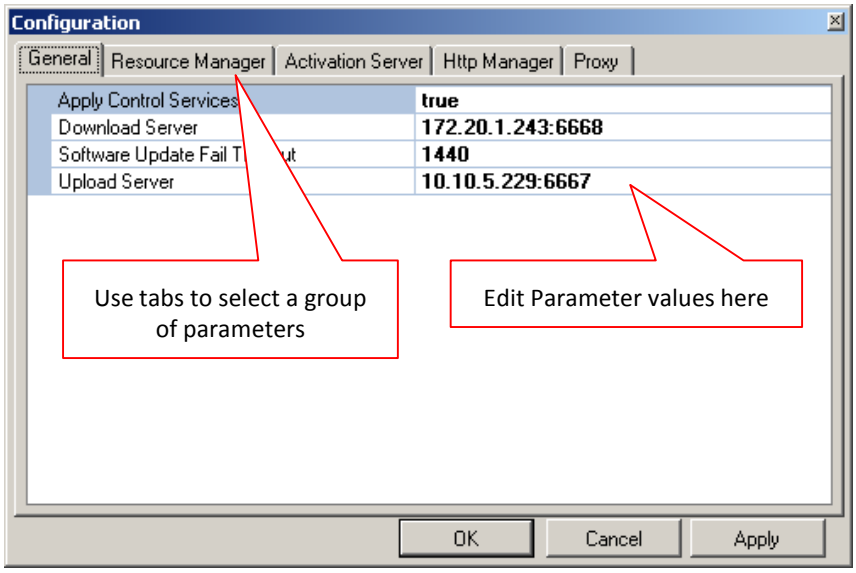
- Under the **General** tab
  - Verify/Adjust the **Download Server** parameter value. It should contain the IP Address of the AirSync Server followed by a colon ":" followed by the port corresponding to the NFTP download server which is generally port 6668.
  - Verify/Adjust the **Software Update Fail Timeout** parameter value. It should contain time (in seconds) that is designated as the maximum allowed time span for a requested software update to complete.
  - Verify/Adjust the **Upload Server** parameter value. It should contain the IP Address of the AirSync Server followed by a colon ":" followed by the port corresponding to the NFTP upload server which is generally port 6667.
- Under the **Activation Server** tab
  - Verify/Adjust the **RM Server** parameter value. It should contain the IP Address of the AirSync RM Server.
  - Verify/Adjust the **RM Server Port** parameter value. It should contain the TCP port of the AirSync RM Server, which is usually port 5000. This value will be transmitted to clients by the Activation Server.

The system configuration items can be accessed by clicking the Tools menu item as shown in Screen Capture 57.



Screen Capture 57. Accessing System Configuration items from the "Tools" menu

Screen Capture 58 shows the **General** tab of the resulting system configuration dialog box. Use the tabs to switch between groups of related parameters. The middle part of the dialog box will display the parameter names and their values. Use the set of controls located immediately below the tabs to select a specific parameter for modification in the area at the bottom of the dialog box. The **Configuration** dialog box is modal. Users can't navigate to any other AirSync GUI object before closing it.

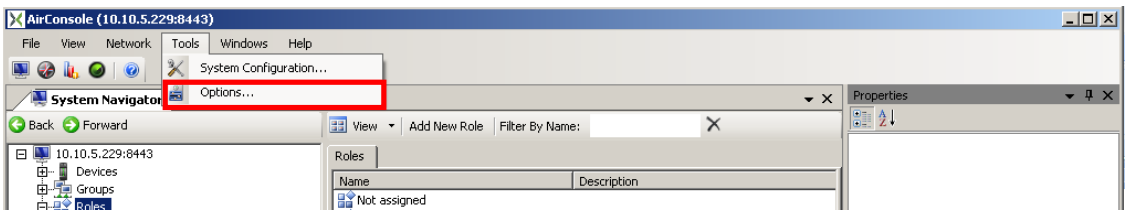


Screen Capture 58. The system configuration dialog box

Setting Options

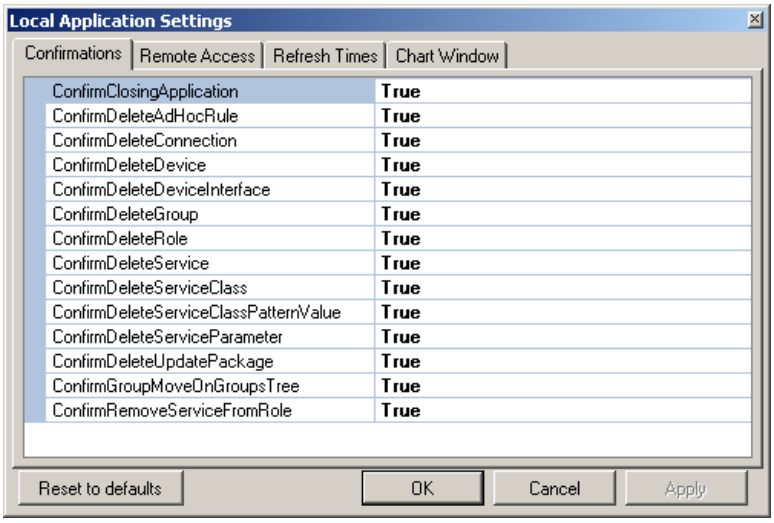
AirSync allows administrators to set a wide variety of options to tailor the product to a user's preferences. In general, AirSync should work fine without setting these options, but setting them can improve the user experience. For example, users can adjust these options to control the way rolling averages are computed for the **Statistics** item, or control which user actions will generate confirmation messages.

The user settable options can be accessed by clicking the Tools menu item as shown in Screen Capture 59.



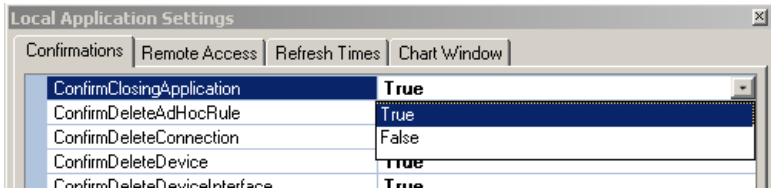
Screen Capture 59. Accessing the Options item from the Tools menu

Screen Capture 60 shows the resulting Options dialog box, opened to the **Confirmations** tab. The **Options** dialog box is modal. Users can't navigate to any other AirSync GUI object before closing it.



Screen Capture 60. Confirmations tab of Options dialog box

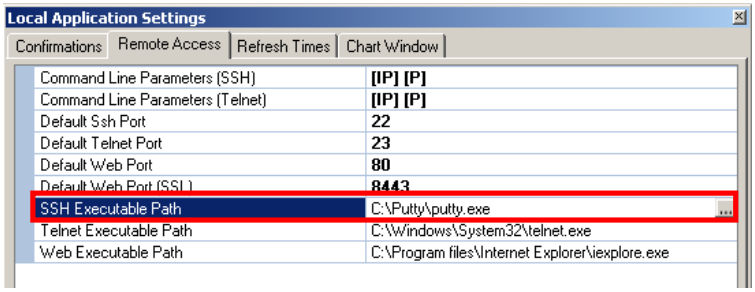
Screen Capture 61 shows the use of a drop down control to toggle a confirmation preference.



Screen Capture 61. Toggle confirmation option preferences as desired

Setting up Third-party Remote Access Tools

During initial setup, users can configure AirSync to use specific third-party software products for remote access operations. For example, to configure AirSync to use a third-party program named PuTTY for SSH access to managed devices, furnish the correct path to the executable for the **SSH Executable Path** item as shown in Screen Capture 62. Adjust any other path items or port items appropriately.



Screen Capture 62. Configuring AirSync to use a third-party remote access tool

You may use Command Line Parameters to set some special configuration for some remote access tools. For example to use third-party program named SecureCRT set **\[IP]** parameter in **Command Line Parameters (SSH**) field.

Device Profiles and Device Instances

Starting from AirSync 3.1 Devices are split into two groups – instances (devices in your network) and profiles (devices which are examples of use). It was introduced because new functionality was added in this version. New functionality allows users to define device profiles which let you to pre-provision devices with configuration and QoS before they are even plugged in. In this situation devices have to be split into separate groups to visualize users that they have some device instances registered and some profiles defined as well. For more information please see section Defining Device Profiles in the AirSync System starting below and section Registering Devices in the AirSync System starting on page 64 and section Device Pre-provisioning starting on page 83.

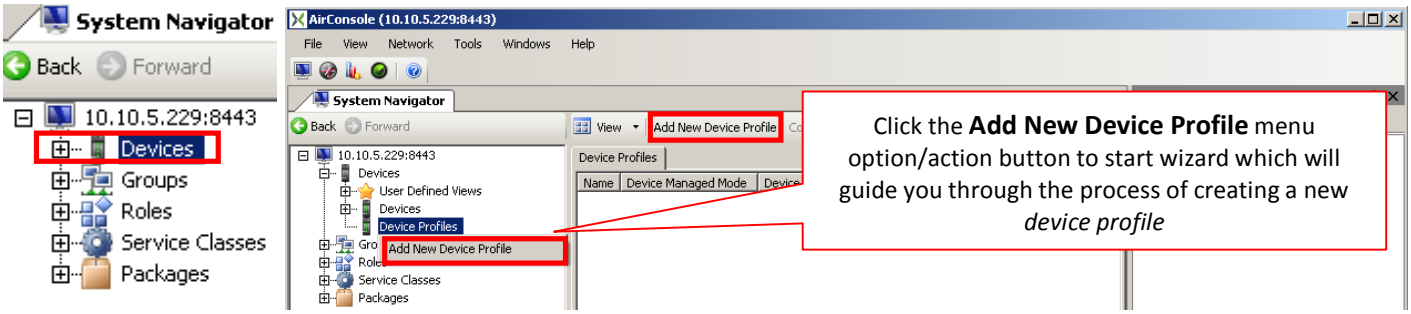
Whenever in this document “device” is mentioned it means that we are talking about “device instance”.

Defining Device Profiles in the AirSync System

As it was previously mentioned, defining profiles is new functionality introduced in AirSync 3.1. This feature allows users to add profiles which can be configured. By “configured” you may understand configuration of parameters for devices and interfaces and QoS policy adjusted. For more information how to use profiles see section Device Pre-provisioning on page 83.

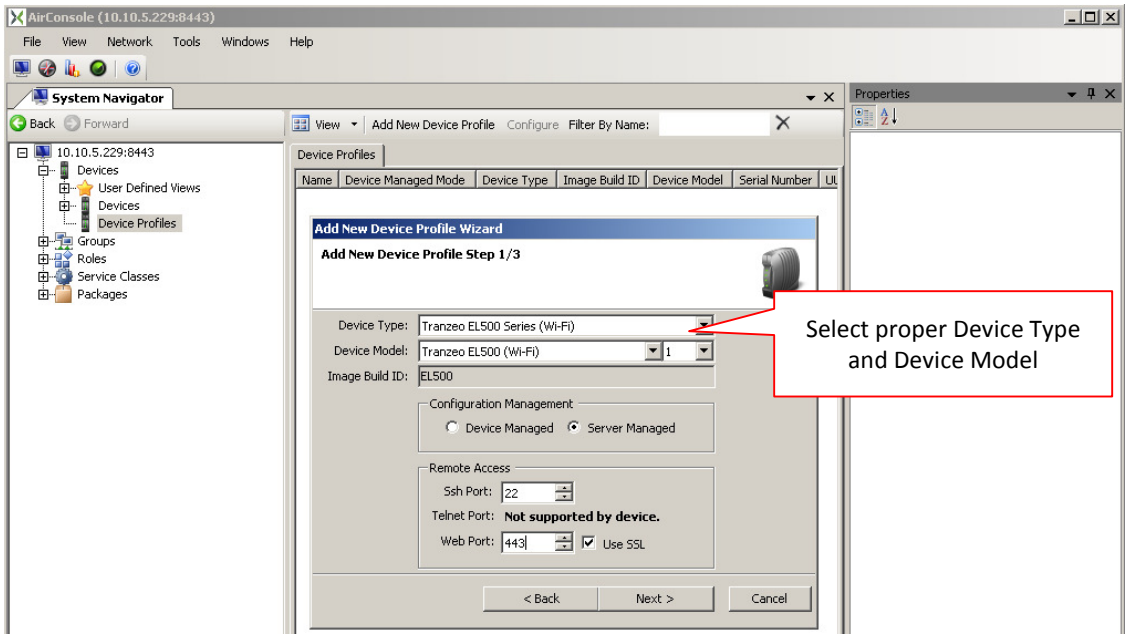
Adding Device Profile

To add new device profile select **Device Profiles** item in **System Navigator** tree as shown in Screen Capture 63.



Screen Capture 63. Starting Add New Device Profile Wizard

Clicking the **Add New Device Profile** context menu option/action button runs the **Add New Device Profile Wizard** as shown in Screen Capture 64.



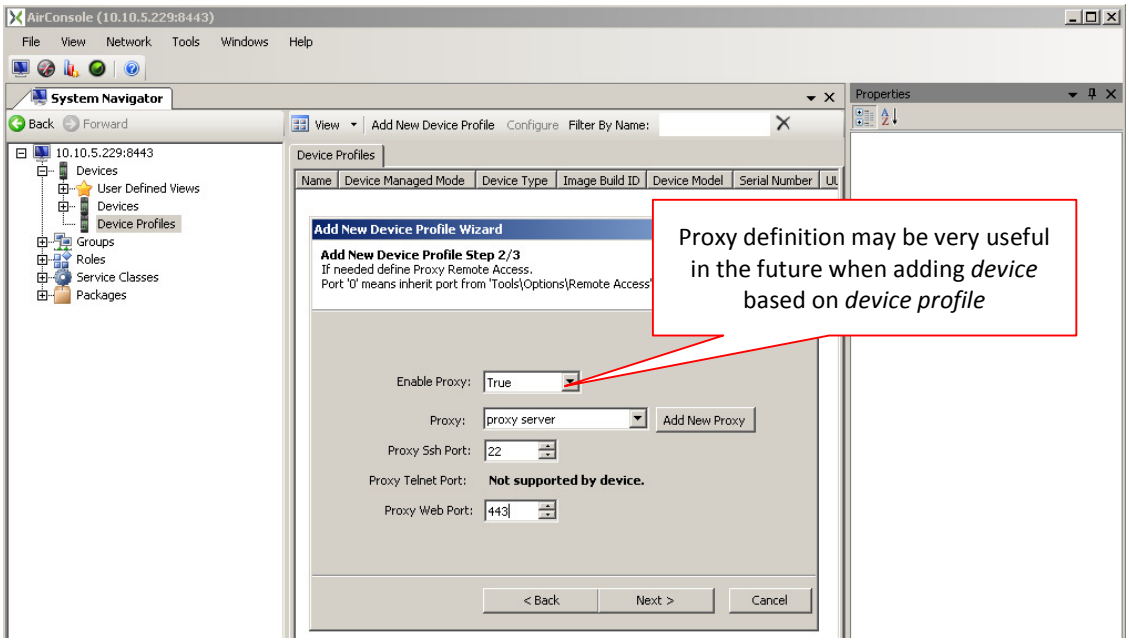
Screen Capture 64. Adding a new device profile

Device Type and Device Model

Some of device types may have different models (for example Tranzeo Pico BaseStation has three models). To enable selecting models for a device type there is a list of **Device Models** which contain only available models for selected **Device Type**. You should select here proper device type for profile equal to device type of devices which will be added in the future based on this profile.

Remote Access

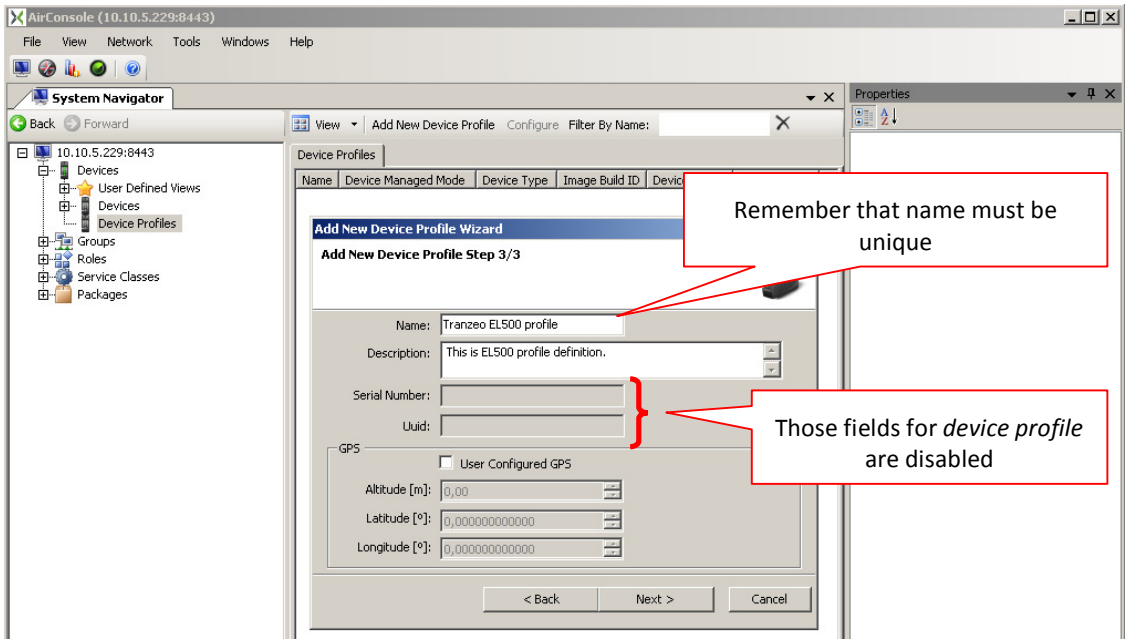
In case defining profile you must decide whether this set of attributes is needed for profile or if it will be useful for further device adding.



Screen Capture 65. Setting proxy for profile

Proxy Remote Access

As it is shown in Screen Capture 65 while defining device profile user may set proper proxy settings. Those settings may be used in the future when another device will be added using this profile definition.



Screen Capture 66. Other attributes for profile

Device profile name is validated as unique against all devices (it means instances and profiles).

"Disabled" Attributes

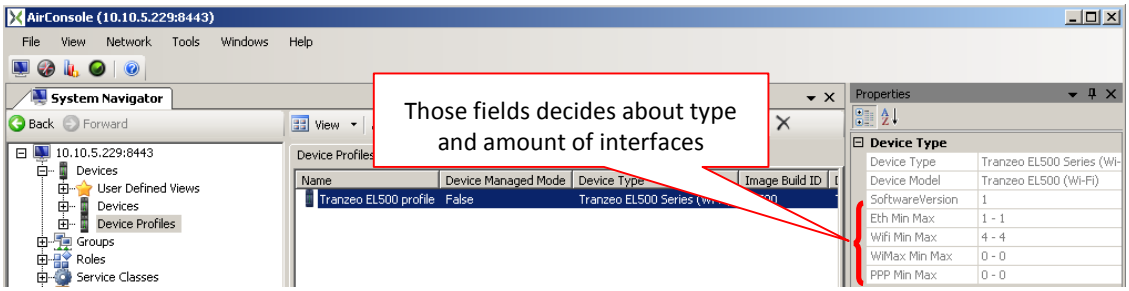
As you can see in Screen Capture 66 some attributes are disabled. It is on purpose because there is no sense to set **Serial Number** or **UUID** for device profile. Those attributes are useful in case registration of device.

GPS settings

By default GPS settings are in "**Device Configured GPS**" state like shown in Screen Capture 66. It means that "**User Configured GPS**" is not selected therefore **Altitude**, **Latitude** and **Longitude** are disabled and set to 0. Device profile cannot send GPS position therefore those values are 0. For further device adding based on device profile you may set some GPS position which will be copied to destination device.

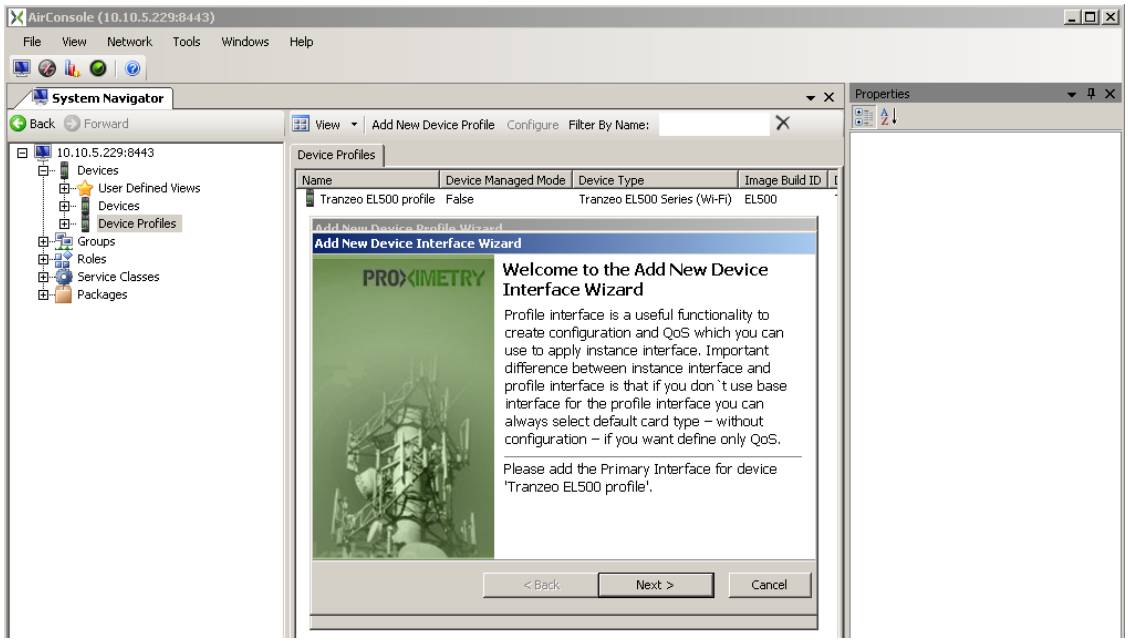
Adding Device Interface for added Device Profile

When device profile was successfully saved you may add interface or a few for this device profile. Amount of interfaces and their types depends on Min – Max attributes for selected device type as shown in Screen Capture 67.



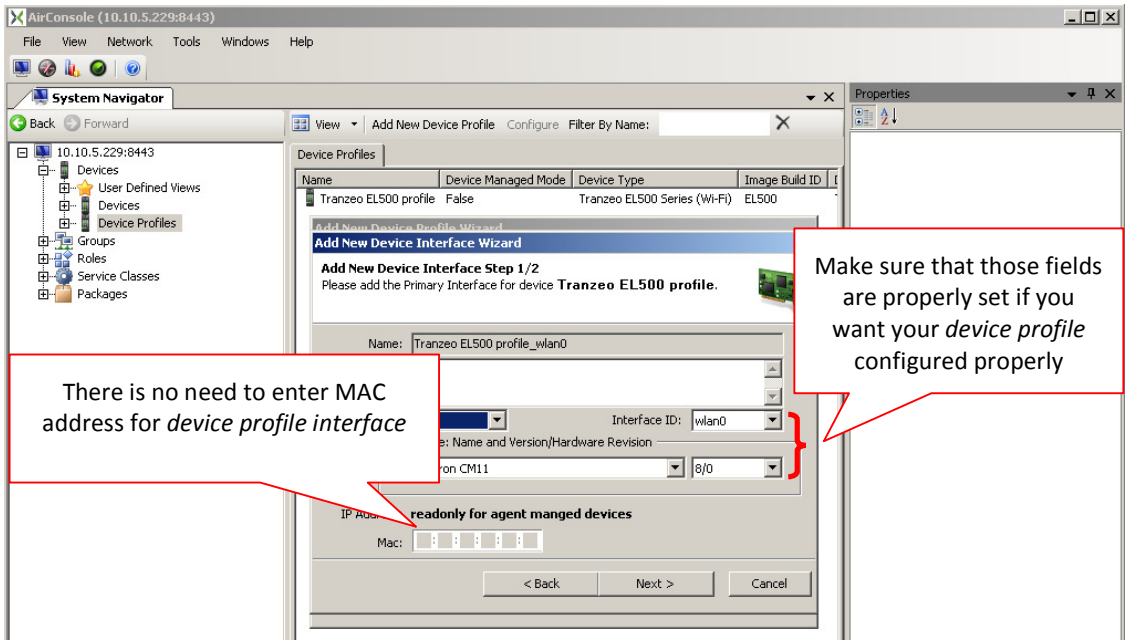
Screen Capture 67. Amount of interfaces depends on min - max value

Just after saving device profile **Add New Device Profile Interface Wizard** will start as shown in Screen Capture 68.



Screen Capture 68. Add New Interface Wizard will start just after saving device profile

You may cancel this operation but remember that till device profile does not contain any interface it is incomplete and you cannot use all possibilities which are delivered by device profile feature.



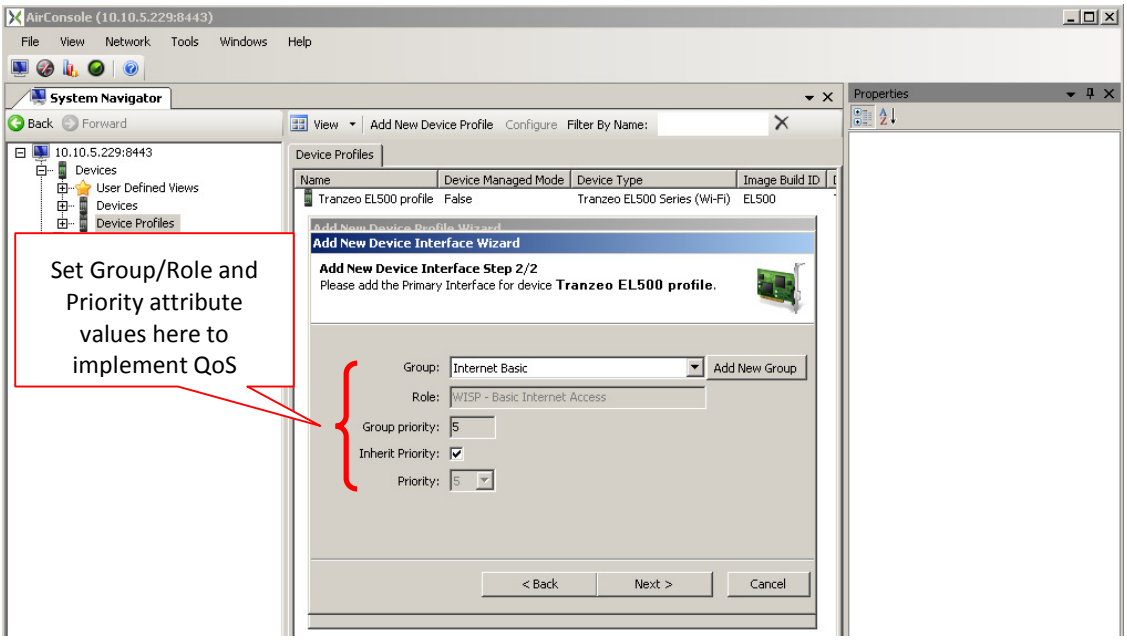
Screen Capture 69. Attributes for device profile interface

While defining interface for device profile you do not have to add all possible interfaces for this device type. You should decide which interfaces are necessary to configure parameters and QoS. Select **Interface Type** and then proper **Card Type** as shown in Screen Capture 69. Those two attributes decides about configuration parameters for this interface. There is no need to enter IP Address but you may do it for further device adding.

MAC is disabled because there is no need to enter this value for device profile interface.

QoS policy for device profile interface

In case you want to set proper QoS policy for device profile interface which will be further used for pre-provisioning or adding new devices select proper Group as shown in Screen Capture 70.

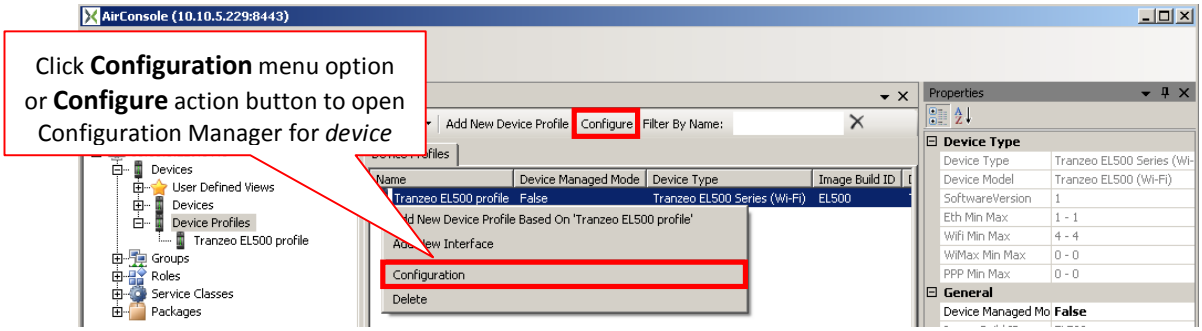


Screen Capture 70. Assigning QoS policy

After saving you may already use this profile for further purposes but remember that there is default configuration for interfaces. To have complete defined device profile please see Configuring Device Profile Interface which starts below.

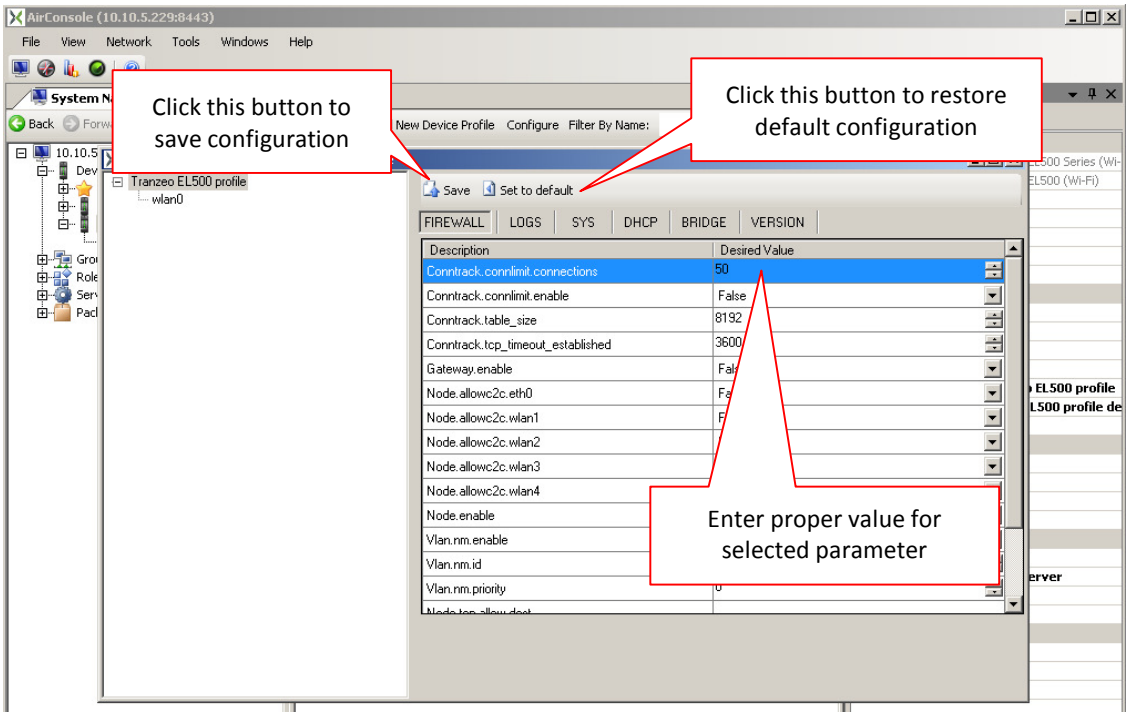
Configuring Device Profile

After saving your device profile you should select it on Device Profiles list as it is shown on Screen Capture 71 and start Configuration Manager to configure its parameters.



Screen Capture 71. Starting Configuration Manager for Device Profile

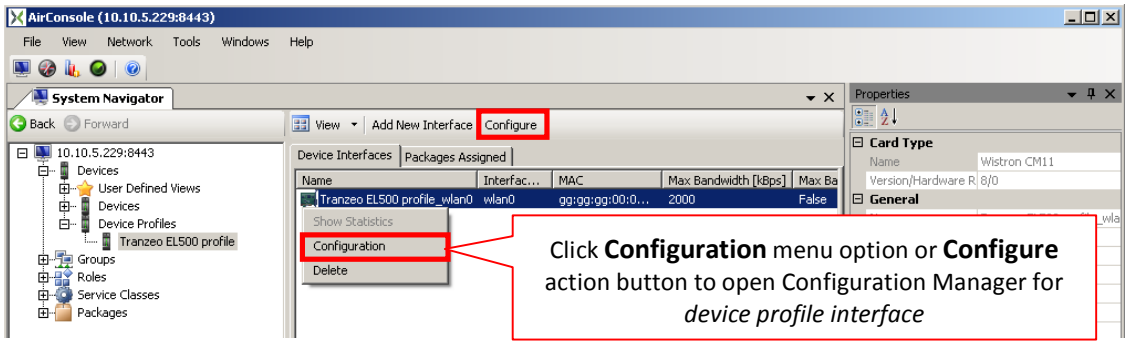
In opened window you should adjust device profile parameters by setting proper value in **Desired Value** column as shown in Screen Capture 72. In case you want to roll-back default configuration just press **Set to default** button. All changes will be cancelled.



Screen Capture 72. Customizing device profile

Configuring Device Profile Interface

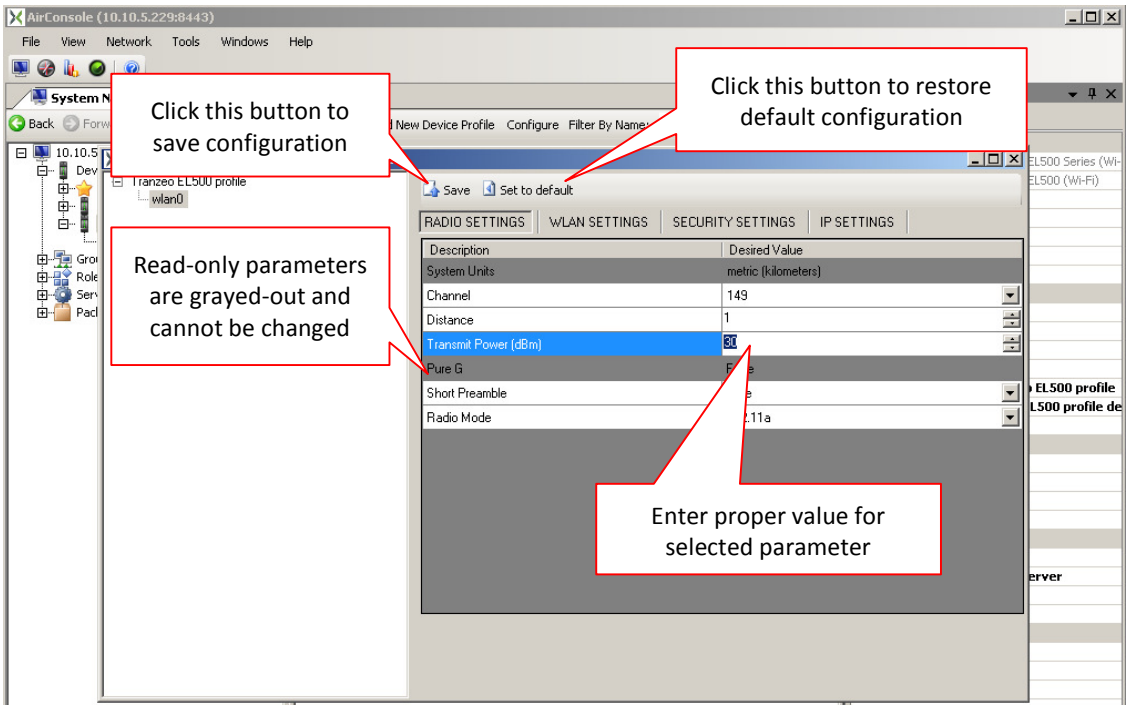
After saving your device profile you should select its interface and start Configuration Manager as shown in Screen Capture 73.



Screen Capture 73. Configuration Manager for device profile interface

The same effect you may obtain double-clicking on selected interface or selecting interface in Configuration Manager opened for device profile or other interface.

In opened window you should adjust profile interface parameters by setting proper value in **Desired Value** column as shown in Screen Capture 74. In case you want to roll-back default configuration just press **Set to default** button. All changes will be cancelled.



Screen Capture 74. Customizing device profile interface

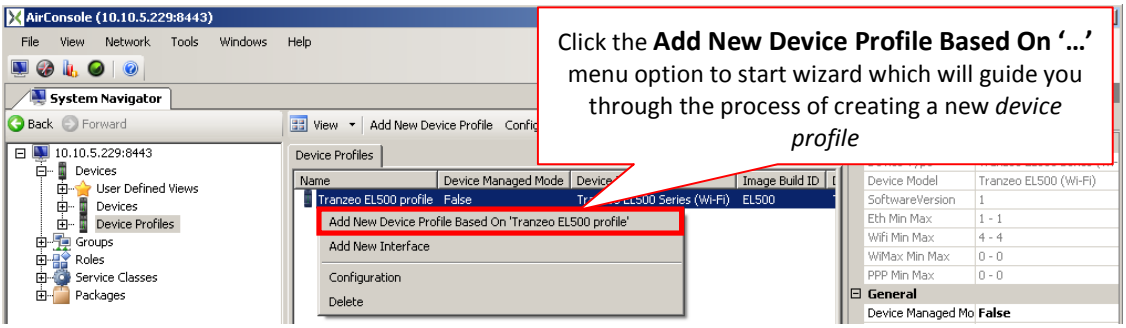
After setting all needed parameters just press **Send** button. Configuration will be saved.

Now you may use this profile for adding new device profiles or device instances or to pre-provision devices which are already registered or even not installed in your network.

Adding Device Profile based on other Device Profile

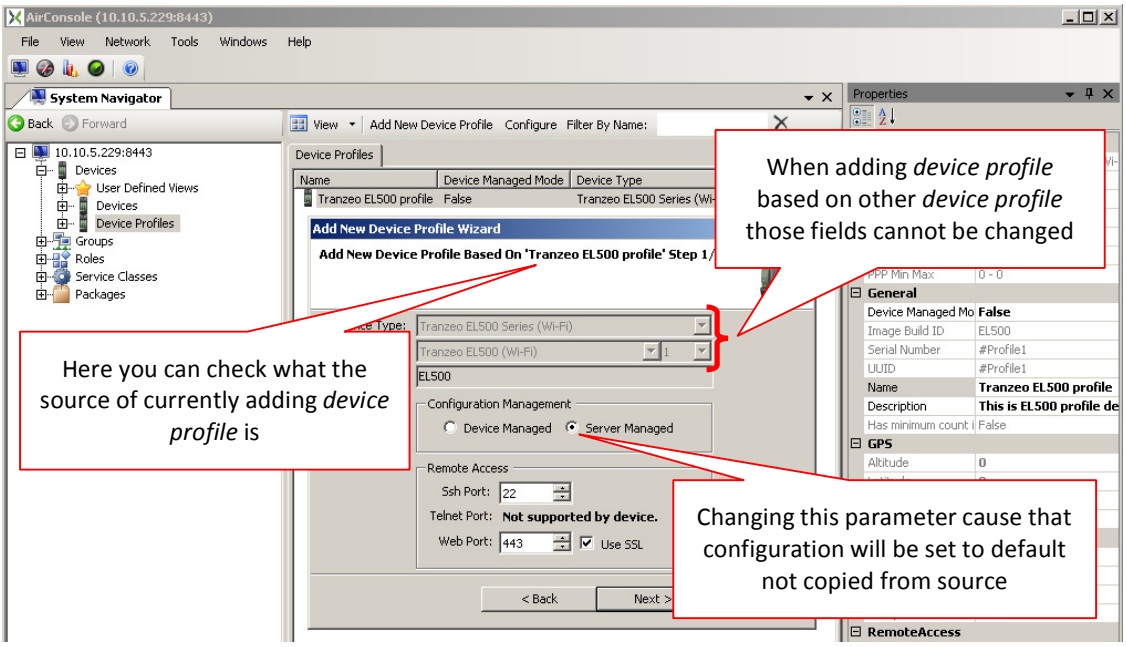
Once you added device profile you may use it as a source to add another device profile. To start the **Add New Device Profile Wizard** select device profile and click **Add New Device Profile Based On '…'** as shown in Screen Capture 75. Generally

speaking whole process is the same like described already in Defining Device Profiles in the AirSync System on page 51, but in details there are some differences.



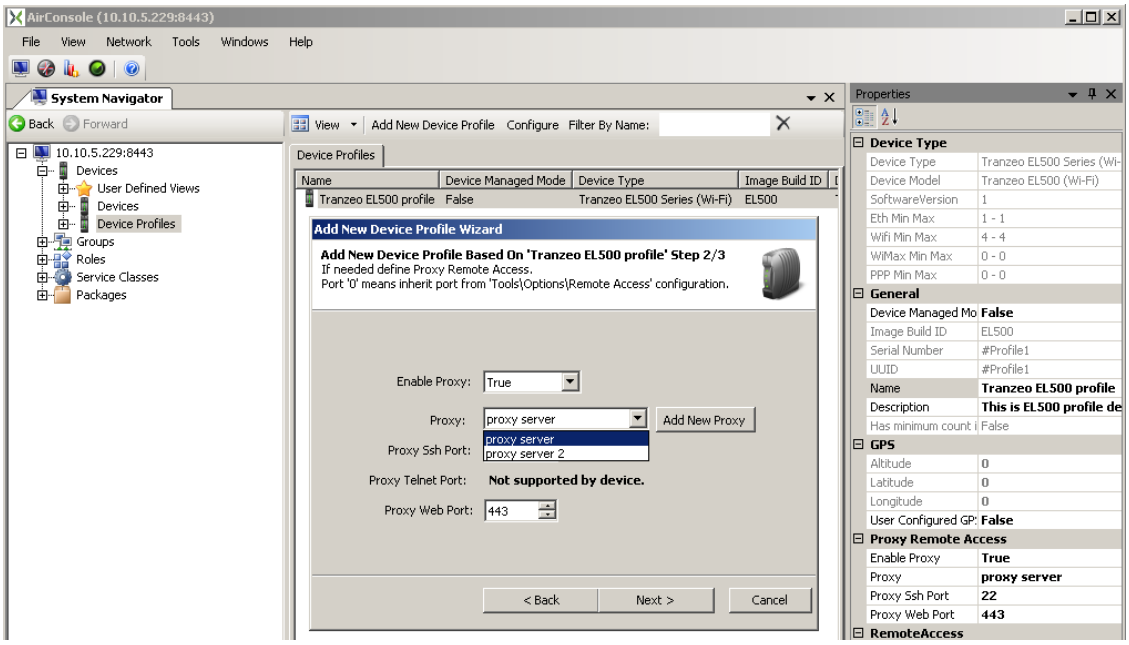
Screen Capture 75. Starting the Add New Device Profile

As you can see on Screen Capture 76 user has no ability to change device type and device model. Those fields are disabled in case adding device profile based on other profile. However user may change other attributes i.e. **Configuration Management** mode or **Remote Access**.

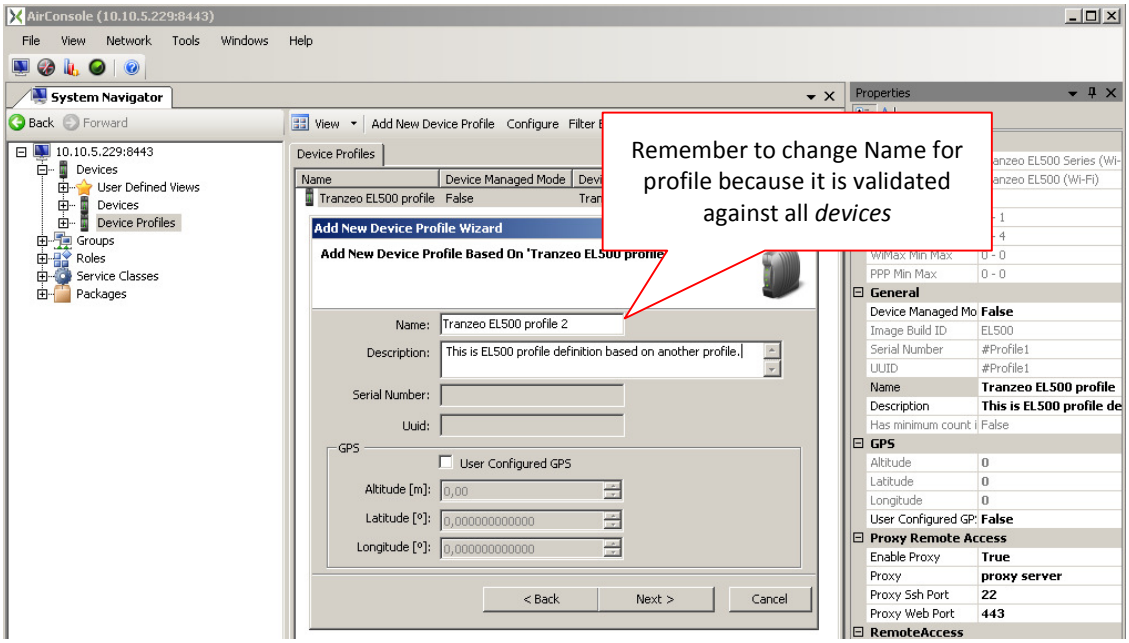


Screen Capture 76. Defining device profile based on other profile - step 1

As you can see on Screen Capture 77 there is a possibility to change values of proxy settings which are copied from source profile.



Screen Capture 77. Defining device profile based on other profile - step 2

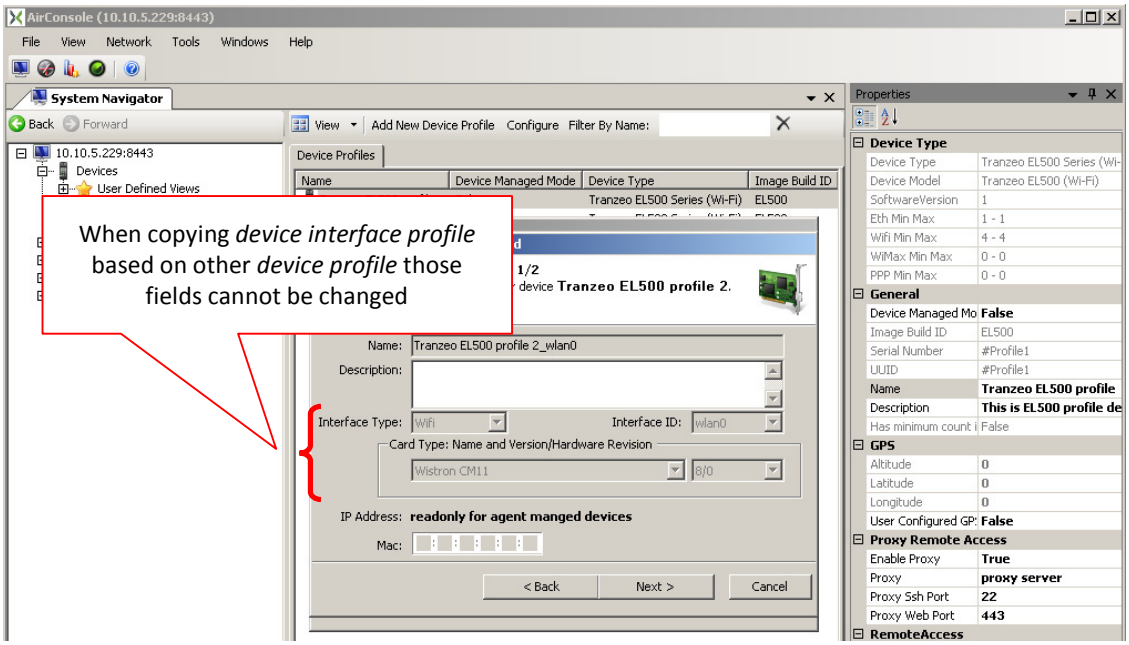


Screen Capture 78. Defining device profile based on other profile - step 3

While adding device profile based on another profile its name is copied as well therefore you must change it because it is validated against all device profiles and instances.

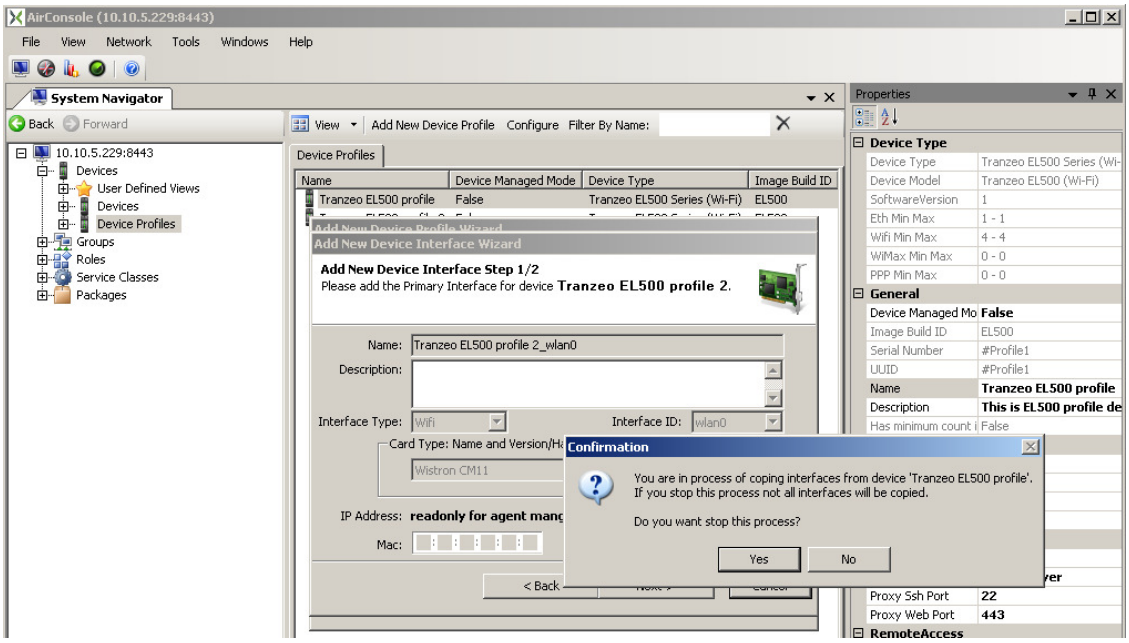
Adding interfaces (based on other profile interfaces)

After saving device profile the **Add New Device Interface** wizard will start, same like in case adding new device profile. This wizard will allow you to copy interfaces from source device profile to destination device profile. As it is shown on Screen Capture 79 it will fulfill some attributes with value from source and disable them therefore user cannot change them.



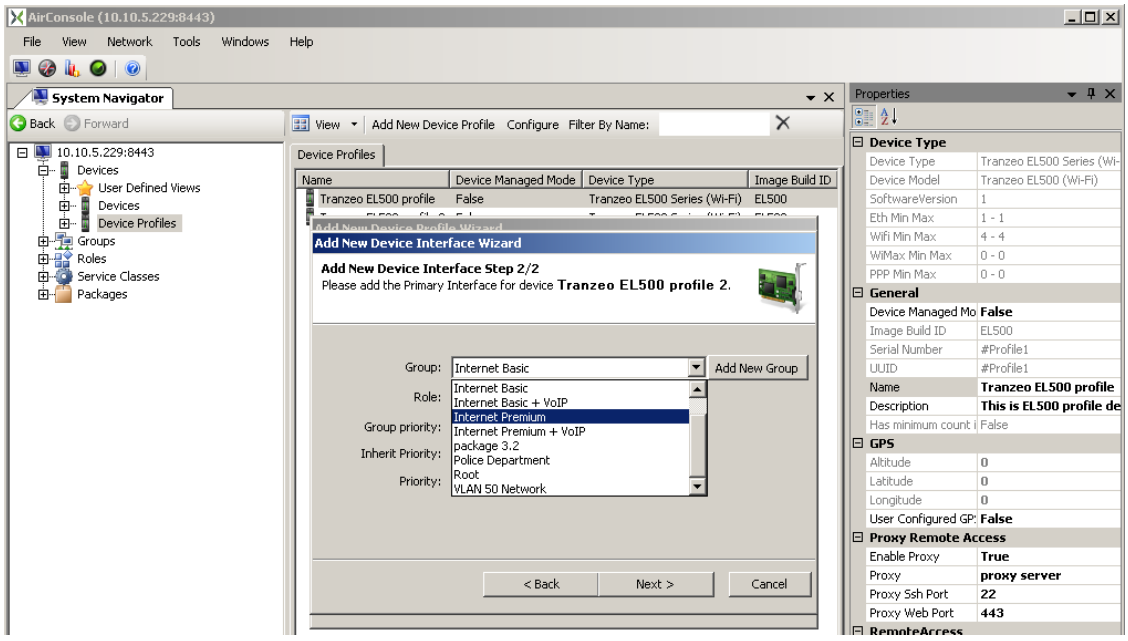
Screen Capture 79. Defining interface for profile based on another profile – step 1

Wizard works in a loop as long as there is any interface in source device profile to copy. In case you do not want to copy all interfaces press **Cancel** button. You will see a message like on Screen Capture 80.



Screen Capture 80. Cancelling defining interface for profile based on another profile

As it is shown on Screen Capture 81 you may change Group attribute. It means that you are setting different QoS policy for this profile.



Screen Capture 81. Defining interface for profile based on another profile – step 2

Pressing **Save** button on next step causes saving interface to database and what is more copying all parameters from source interface to destination interface.

If there is more interfaces in source device profile to copy, after pressing **Next Interface** button wizard will run step 1 again if not there are two possibilities:

1. It will display a message that cannot add more interfaces for this device
2. It will start step 1 again and let you add more interfaces to fulfill device and make it compliant with its definition.

In both cases it depends on Min – Max attribute as it was mentioned above on page 54.

If you are trying to add profile based on another profile where Device Managed Mode is set to True configuration will not be copied from source profile but set to default values.

Registering Devices in the AirSync System

Devices must be registered in AirSync, i.e., populated in the **Devices** list in order to benefit from AirSync's management capabilities. Devices can be registered in AirSync in an automated fashion or in an entirely manual fashion.

Automatic Device registration

To use the automatic registration facility, start the AirSync **Activation Server** and ensure the device has network connectivity. The automatic device discovery/registration process depends on the following factors:

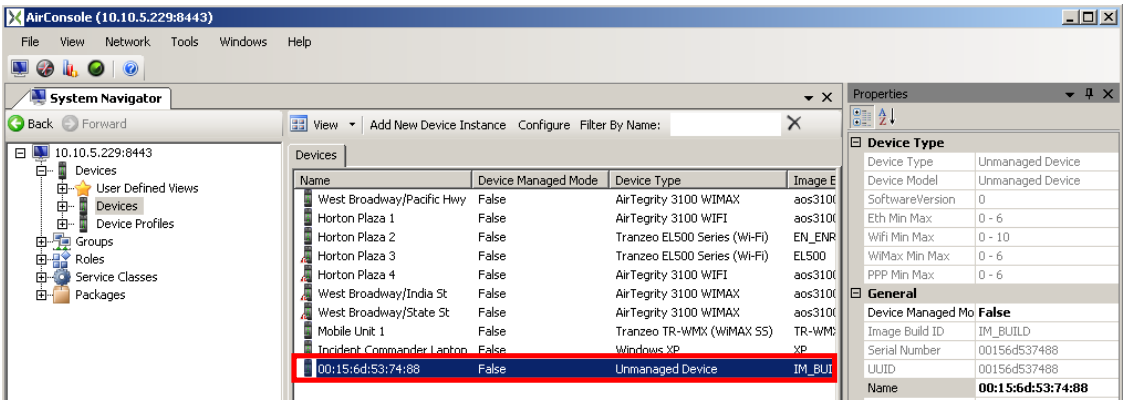
- The device must be powered on and have network access.
- The IP addressing scheme must be appropriate. This involves some platform-specific device configuration, for example, the IP addressing details and some details about the AirSync server must be configured.
- The system configuration parameters on the **Activation Server** tab must contain appropriate values.
- The **Activation Server** process must be running.
- The **Device Types** list and **Device Model** list must contain an appropriate entry.

Automatically Registered Devices Appear with Special Names

After a brief moment, the newly discovered/registered device(s) should appear in the **Devices** list. Newly discovered devices will be apparent in the list by observing the value of the **Name** attribute in the **Devices** list. The **Name** attribute for newly discovered devices depends on device type and may contain a MAC address value of an interface on the device as shown in Screen Capture 82.

Verify/Adjust Attribute Values for Automatically Registered Devices

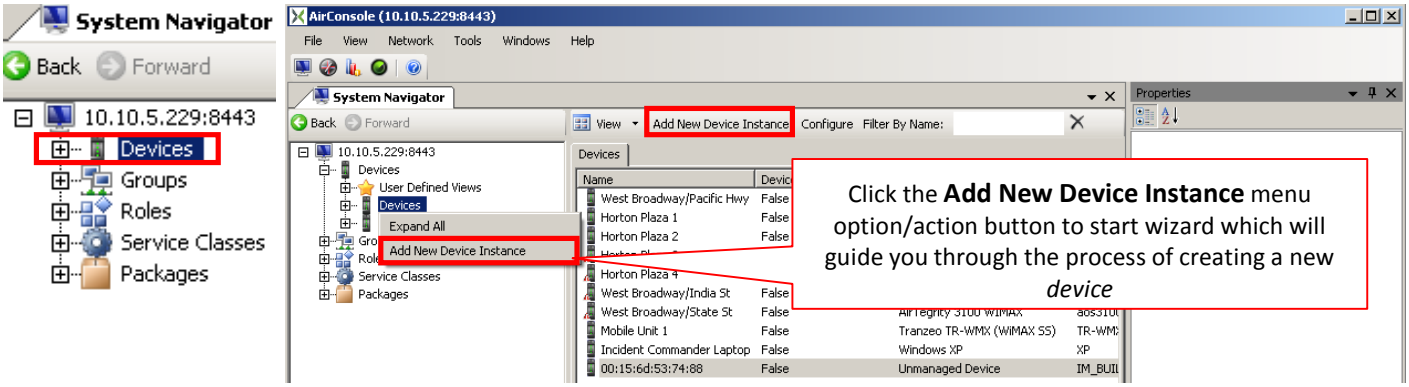
You should edit the name to a value consistent with the organizational naming convention as discussed on page 9. You should also verify/adjust/add interface details for all relevant device interfaces.



Screen Capture 82. The value of Name attribute may contain MAC address of new device

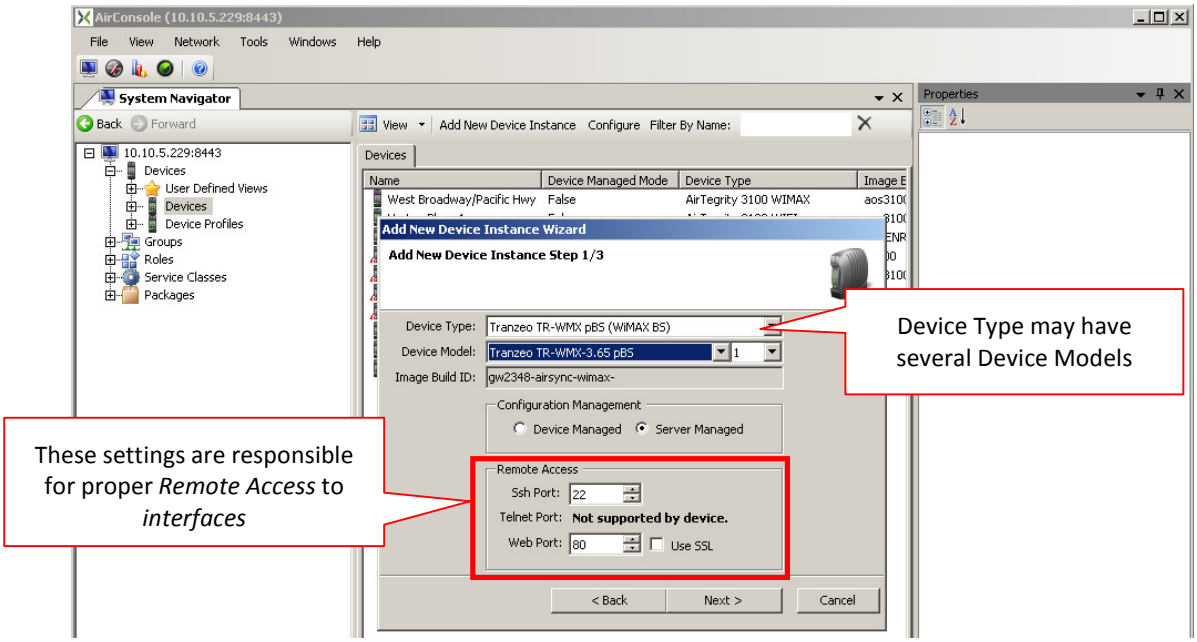
Manual Device Registration

To manually register a new device select **Devices** item from **System Navigator** tree as shown in Screen Capture 83.



Screen Capture 83. Starting Add New Device Wizard

Clicking the **Add New Device** context menu option/action button runs the **Add New Device Instance Wizard** as shown in Screen Capture 84.



Screen Capture 84. Manually adding/registering a new device

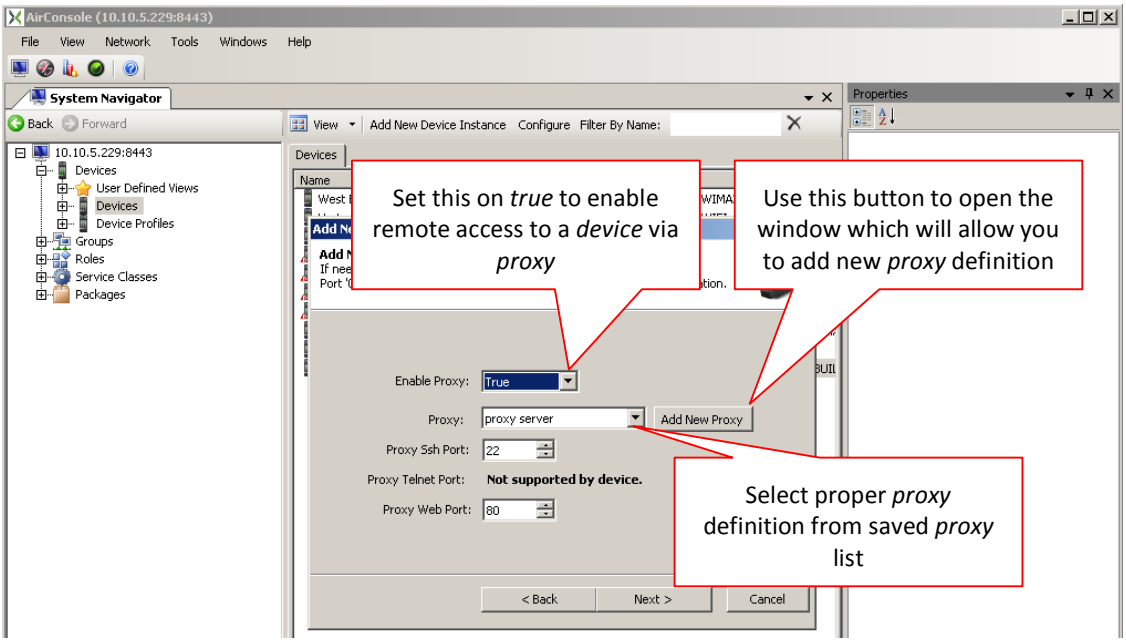
Device Type and Device Model

As you already know device type and device model are connected together. What is more choosing device type and model you choose availability of other attributes which depends on type and model i.e. remote access or decide about value range of some attributes i.e. card type for interface.

Remote Access and Proxy Settings

Device Type determinates possibilities of using **Remote Access** for device interfaces as shown in Screen Capture 84. If selected **Device Type** does not support some way to gain remote access appropriate port number field cannot be set.

If necessary there is a possibility to set **Proxy** settings as shown in Screen Capture 85.

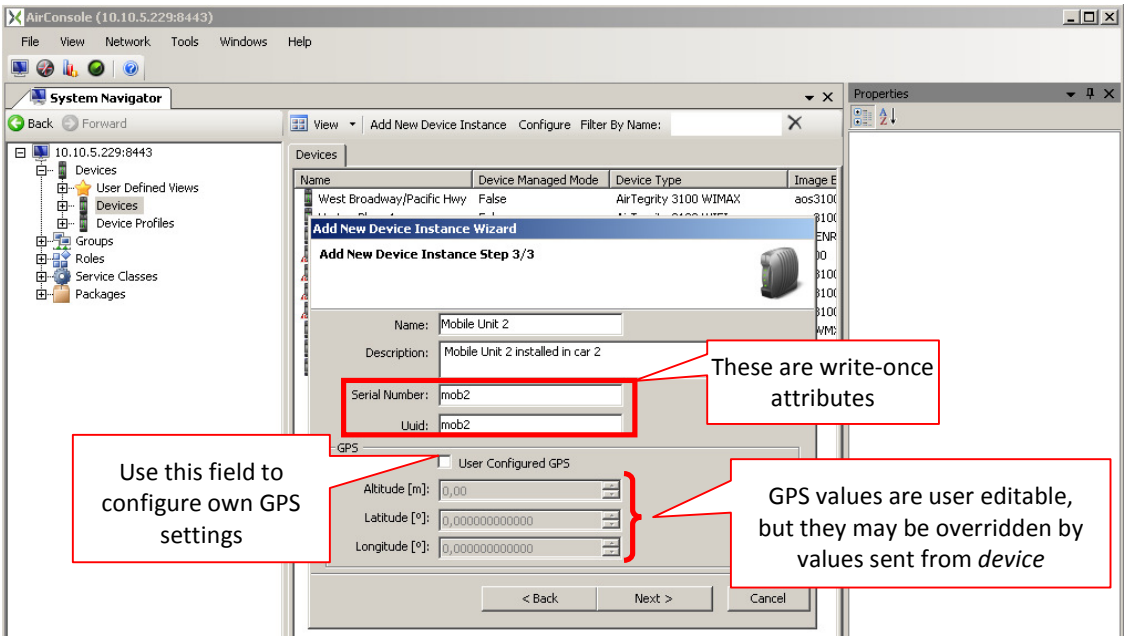


Screen Capture 85. Enabling Proxy settings

"Write-Once" Attributes

When adding a device or a device interface, many attributes cannot be modified after the device or device interface is initially saved. **Serial Number** and **UUID** are examples of such write-once attributes as shown in Screen Capture 86.

If you make a mistake entering the values for any of these attributes, correct the mistake by deleting the entire item and re-adding it with the correct attribute values



Screen Capture 86. Setting attributes for a Device

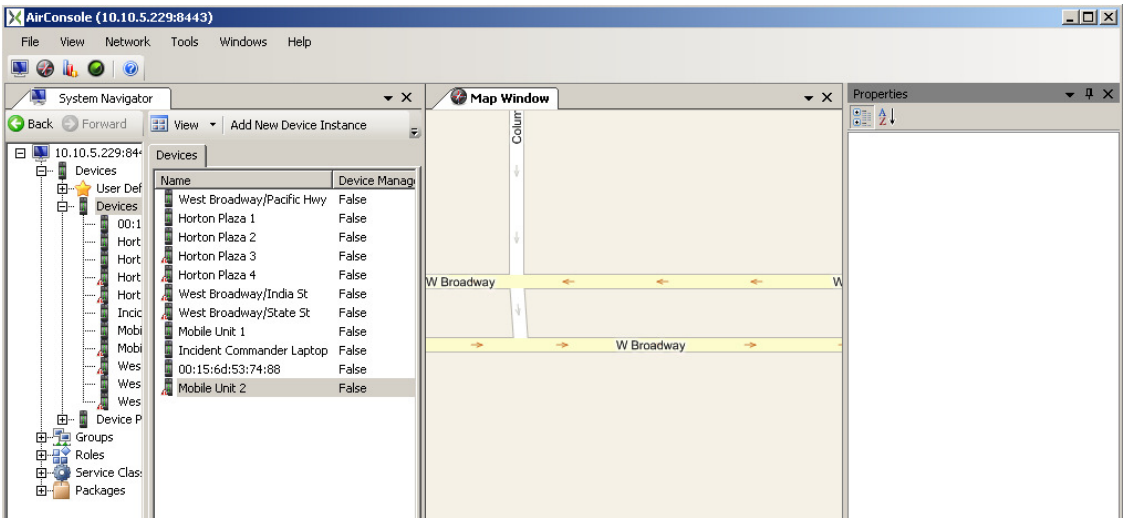
Device name is validated as unique against all devices (it means instances and profiles).

GPS Values Set on Device May Override those Set on Server

It is possible to enter values for the **Altitude**, **Latitude,** and **Longitude** GPS-related attributes found on the **Add New Device Wizard** step 3 of the AirSync server as shown in Screen Capture 86. However, depending upon the vendor platform, some managed devices in AirSync have client agents that automatically send updated GPS information on a periodic interval. This allows AirSync to track the device location and update its display on the **Map Window** for example, in response to the movement of mobile devices. In case you want to receive GPS attribute values from the device agent check off **User Configured GPS** field.

In case you want to set the exact GPS position for a device you may use special probing tool to do this.

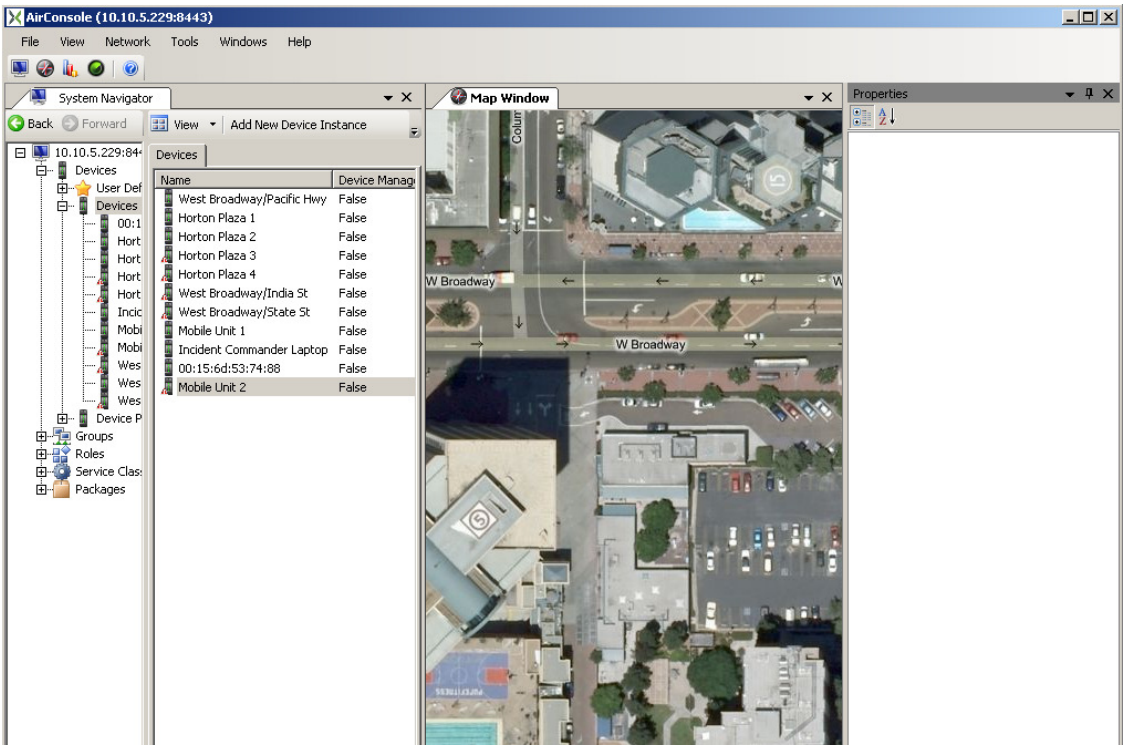
In case setting the very exact GPS position for a device open Map tab together with System Navigator tab as it is shown on Screen Capture 87.



Screen Capture 87. Probing GPS position using special tool - step 1

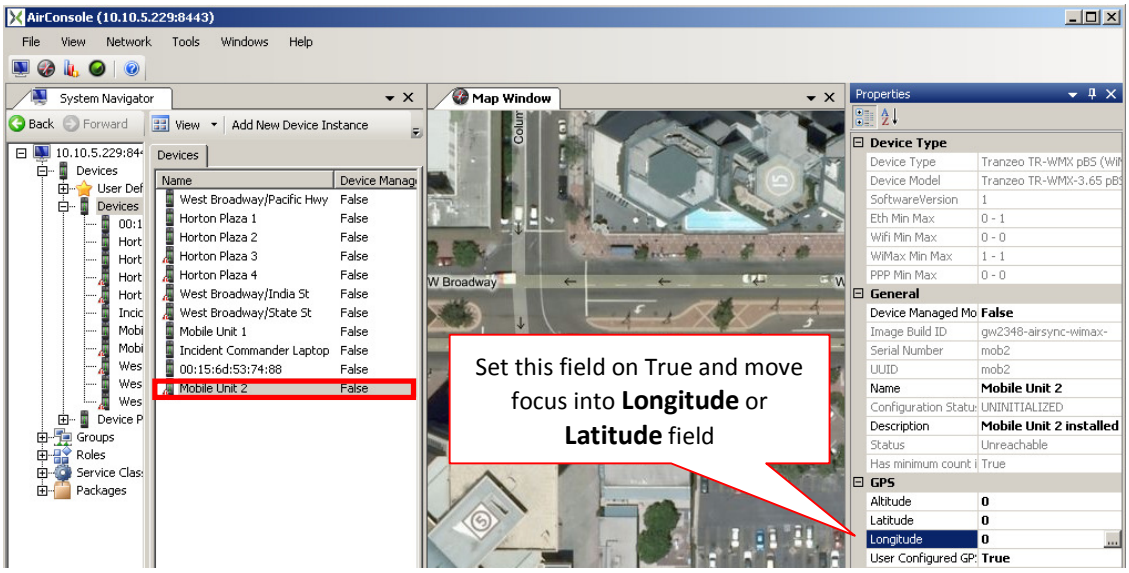
Find a proper place on the map as shown on Screen Capture 88.

Use '**H**'ybrid mode on the map to see aerial view with names on it.

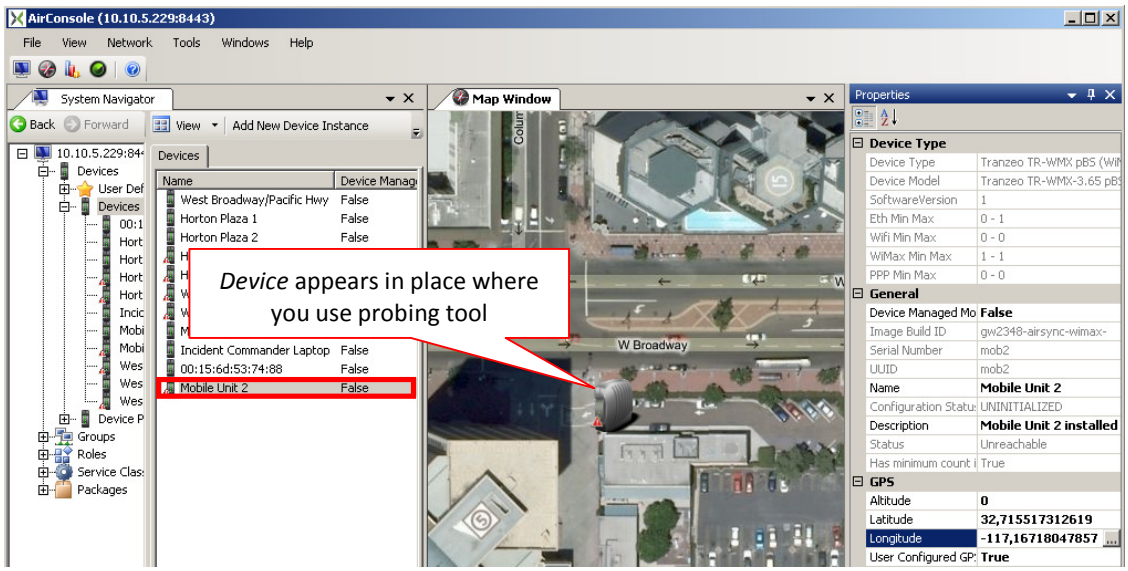


Screen Capture 88. Probing GPS position using special tool - step 2

Select device in question on **Devices** list view. Change **User Configured GPS** field on true and set focus in **Longitude** or **Latitude** field as shown on Screen Capture 89. When you press **…** button and move cursor over the map you will see that cursor has changed into a tool for probing position from the map. Now everything you have to do is to click left mouse button in proper place on the map. It will get GPS position and write it into **Longitude** and **Latitude** fields of your device in question and device will appears on the map as it is show on Screen Capture 90.



Screen Capture 89. Probing GPS position using special tool - step 3

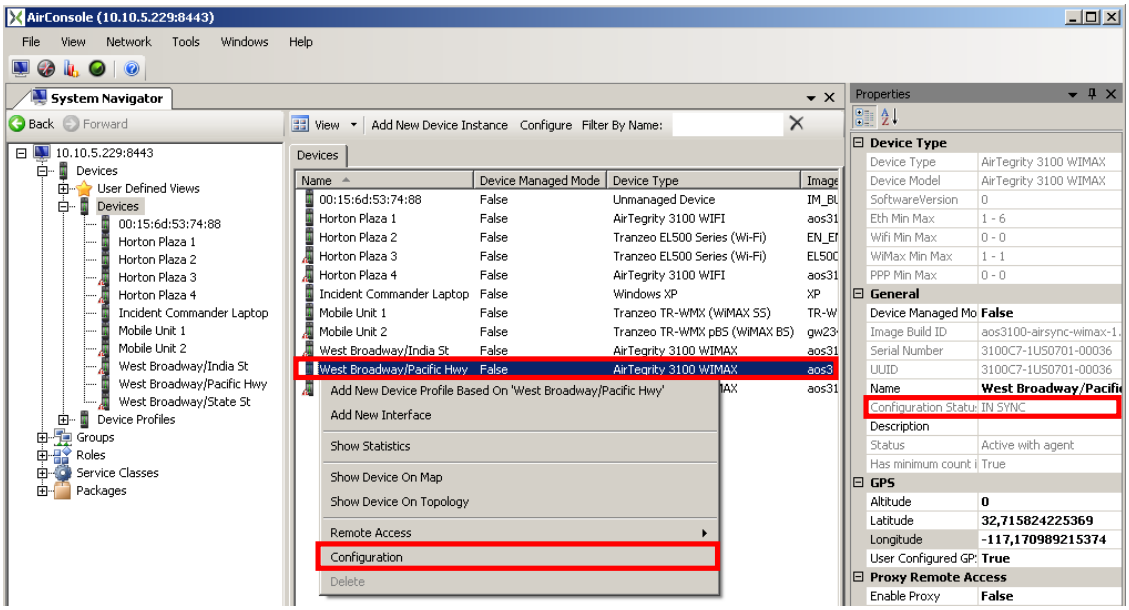


Screen Capture 90. Probing GPS position using special tool - step 4

Configuring Devices

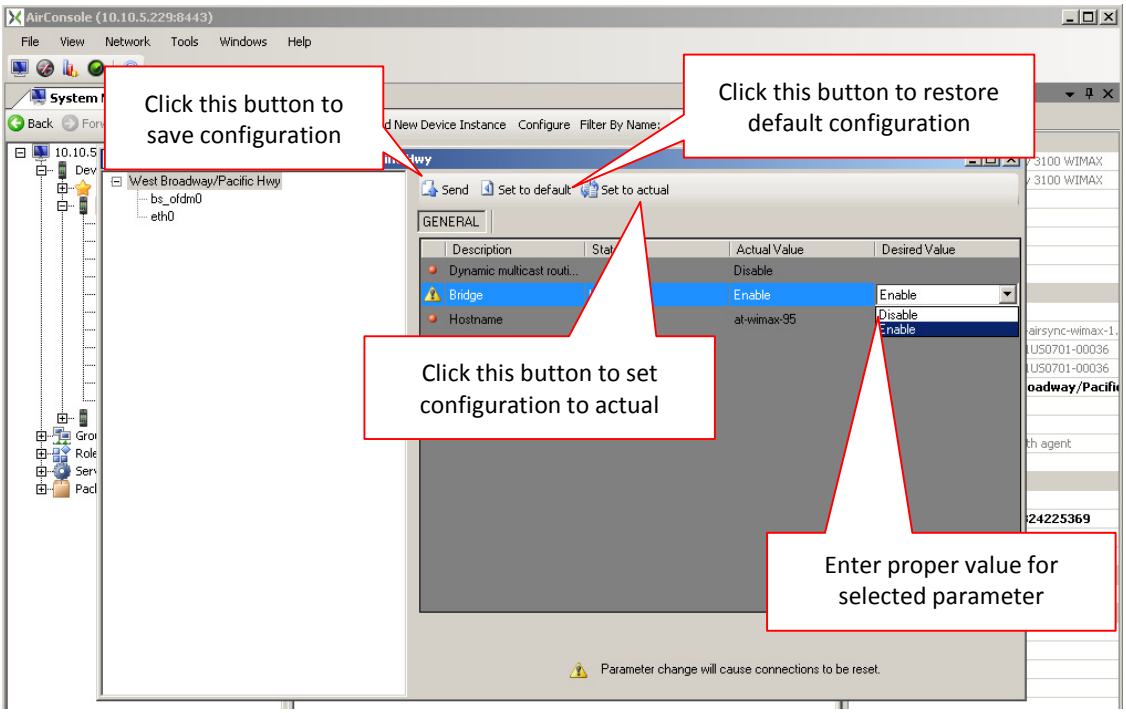
As you already know there is ability to configure device profiles. It was described in section Configuring Device Profile on page 57. In this section you will find how to configure your device instance.

After device registers successfully (its **Configuration Status** is IN SYNC) select device in question on Devices list view and use context menu option Configuration or Configure button to open **Configuration Manager** for it as it is shown on Screen Capture 91.



Screen Capture 91. Starting Configuration Manager for Device Instance

In opened window you may adjust device profile parameters by setting proper value in **Desired Value** column as shown in Screen Capture 92. In case you want to roll-back default configuration just press **Set to default** button. All changes will be cancelled. If you want change Desired Value column to actual values from device press **Set to actual** button.



Screen Capture 92. Configuration Manager for Device Instance

A few words about statuses

As you already may know each device has own configuration status attribute. This field is strongly connected with state described above but filed **State** in **Configuration Manager** affects each parameter of the device and **Configuration Status** affects whole device. Same situation is with interfaces. Interface has own **Configuration Status** which depends on its configuration. Table 3 describes all possible statuses and objects which are affected by them.

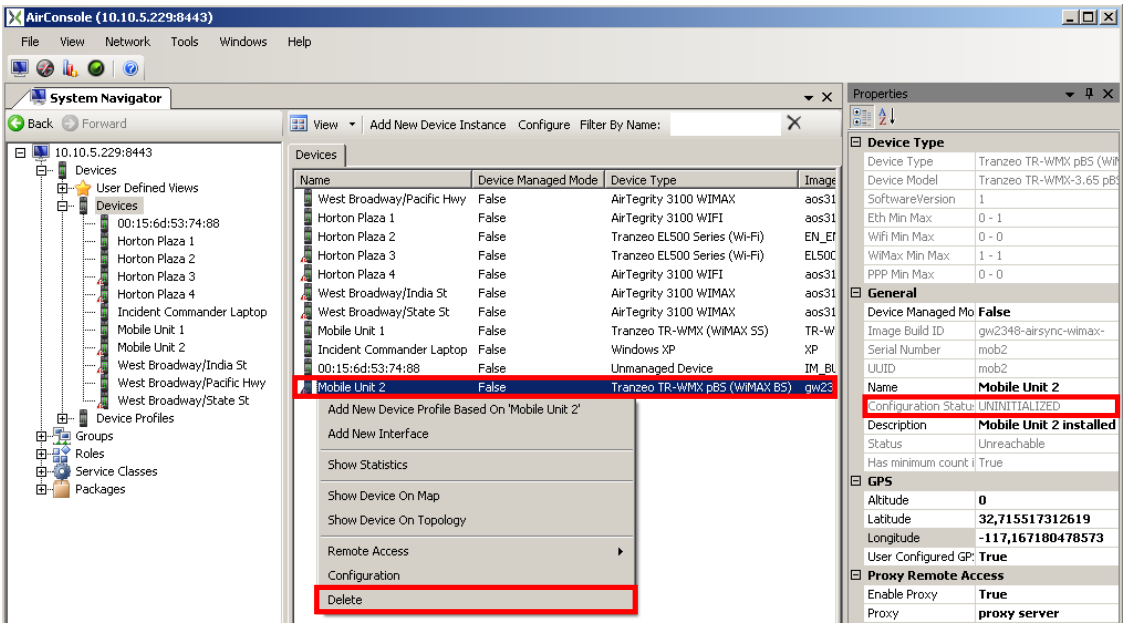
Status	Description	Affects
UNINITIALIZED	Device or interface was not yet registered therefore configuration was not initialized	Device, interface and parameters
IN SYNC	Device or interface is registered and AirSync agent is working and all parameters are synchronized	Device, interface and parameters
REQUESTED	AirConsole requests for changing configuration	Device, interface and parameters
IN PROGRESS	Configuration change is now processed	Device, interface and parameters
TIME OUT	During changing configuration time out	Device, interface

	appeared	and parameters
DEVICE ERROR	Only for WiMAX. An error appeared during changing configuration by agent (agent cannot communicate with device driver).	Parameters
ENFORCED IN SYNC	In case parameter change should cause depending parameter change but it was not sent to agent, agent returns this status	Parameters
OUT OF SYNC	Configuration in server side and sent by agent differs	Device, interface and parameters

Table 2. Possible interface's statuses

Deleting Devices

To delete device you need simply select device in question on **Devices** list view and use context menu option **Delete** as shown on Screen Capture 93. Application will display a question whether you want to delete marked device. After pressing **Yes** device will be deleted.



Screen Capture 93. Deleting device

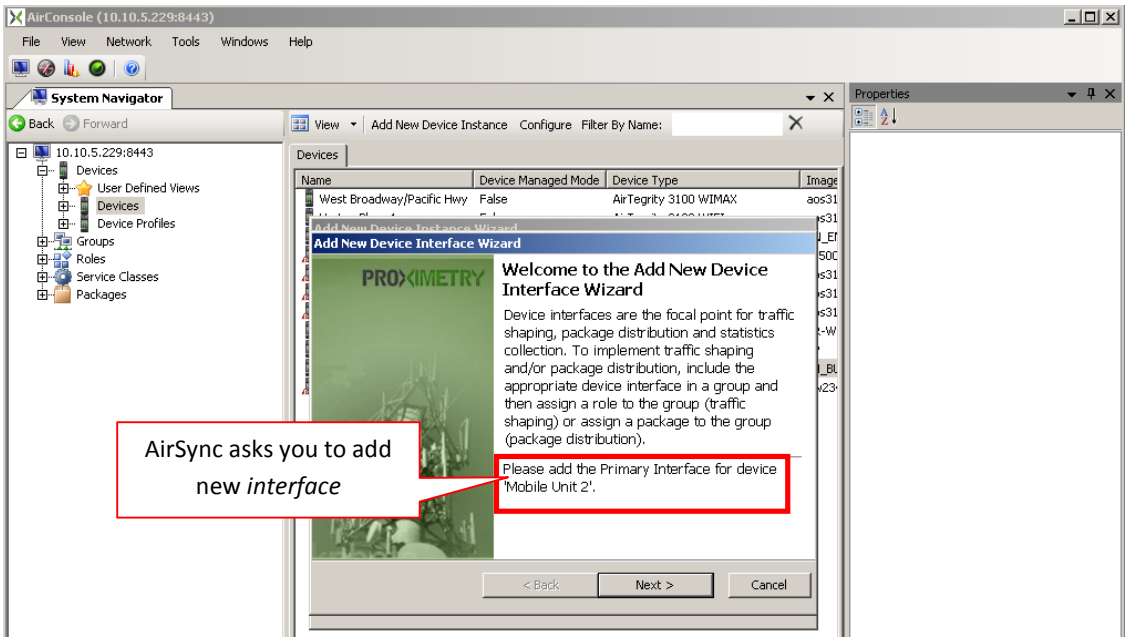
Remember that deleting device causes deleting all interfaces and losing some related information like i.e. packages downloaded.

Conditions of deleting Devices

As it was mentioned before on page 46 there are some decorators which in easy way to show what present status of a device is. The same information is displayed in Properties window for selected device as shown on Screen Capture 93. It is very important information because ability to delete device depends on its state. You may delete device only in case its status is different than '**Active with agent**'.

Adding Device Interface for added Device

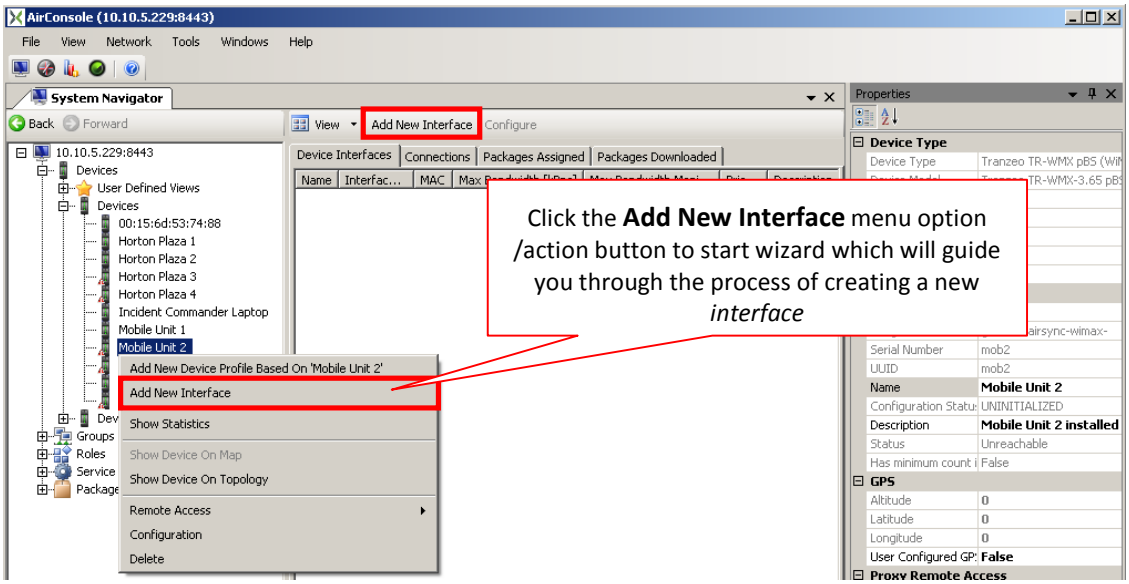
After saving the new manually-added device, the system will start the **Add New Device Interface Wizard** and prompt you to enter the details for the first interface of the new device as shown in Screen Capture 94.



Screen Capture 94. AirSync prompts you to enter device interface details for the newly added device

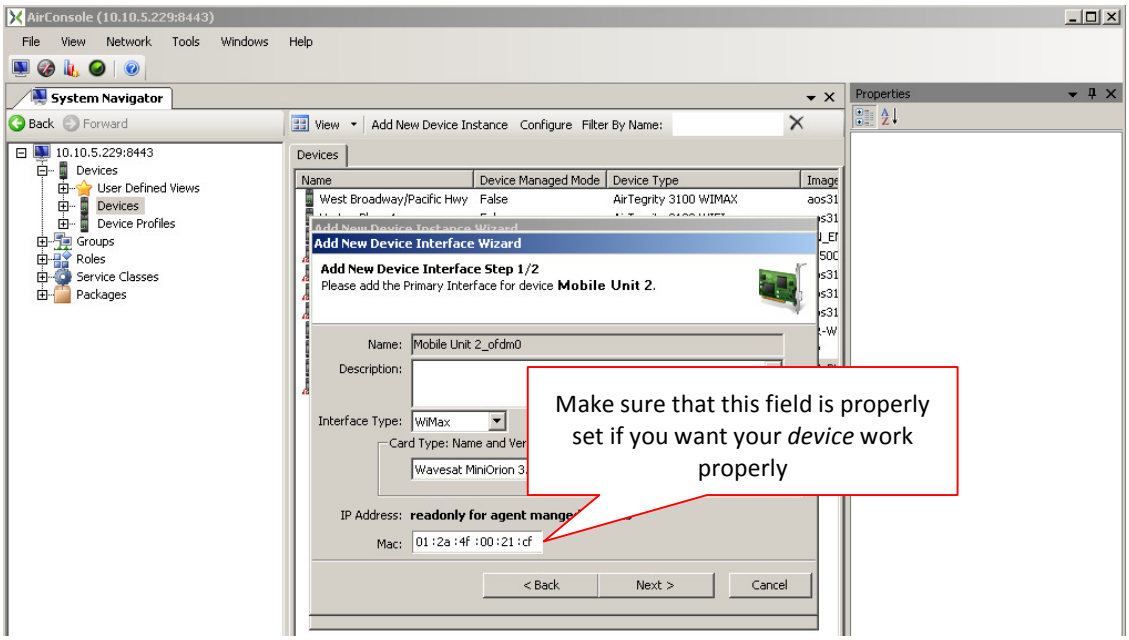
You may cancel this operation but remember that till device does not contain any interface it is incomplete and useless.

To add interface for a device use **Add New Device Interface Wizard** started for an existing device.



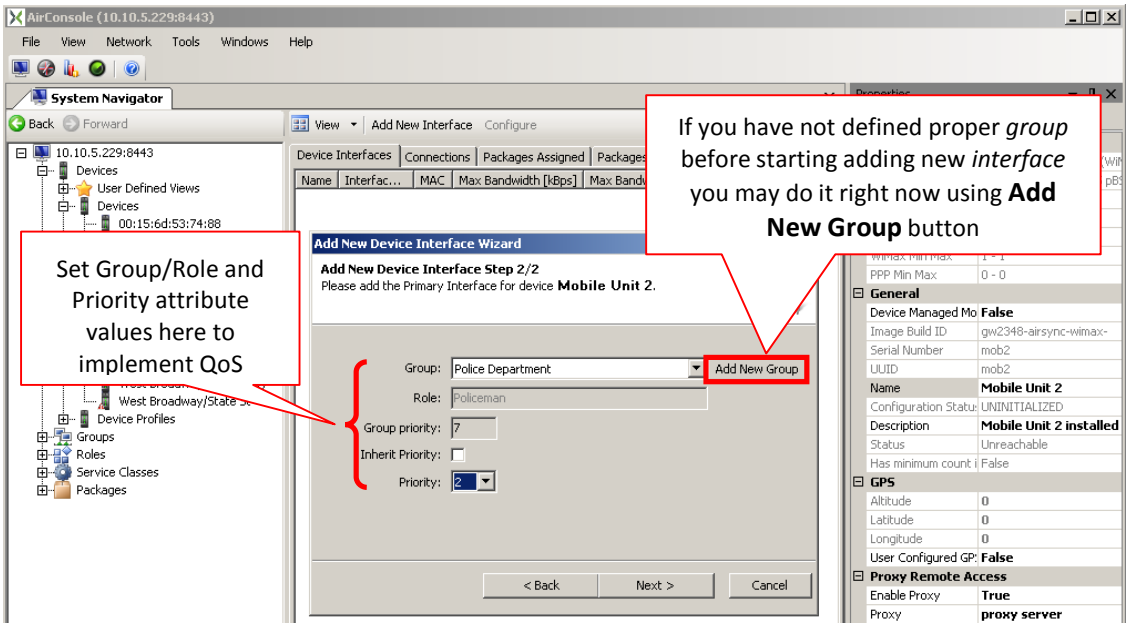
Screen Capture 95. Starting Add New Device Interface Wizard

Set proper IP Address and Mac for interface to make sure that device will work properly.



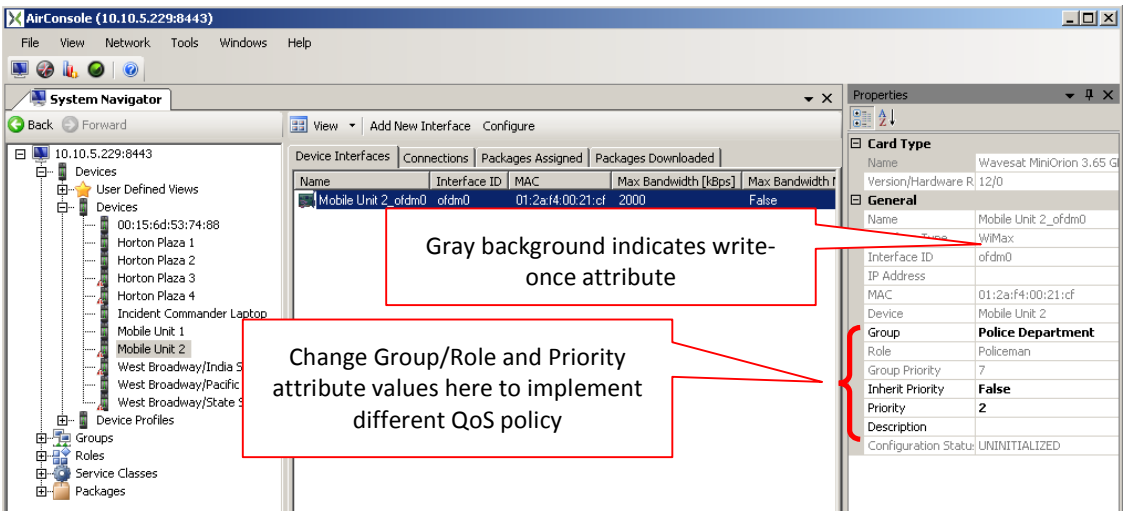
Screen Capture 96. Setting attributes for an interface

Implementing Quality of Service is possible due to assigning group and role to an interface as shown in Screen Capture 97.



Screen Capture 97. Implementing QoS

Screen Capture 98 shows the **Device Interface Properties** window after previously saving the interface information. Notice the gray background in the **Interface Type**, **Physical Interface**, and **MAC** fields indicates that these are write-once attributes. In fact, only the IP address and attributes related to QoS (notice the white backgrounds) may be subsequently modified on this tab.



Screen Capture 98. The Device Interface Properties

Registering device which was added by hand

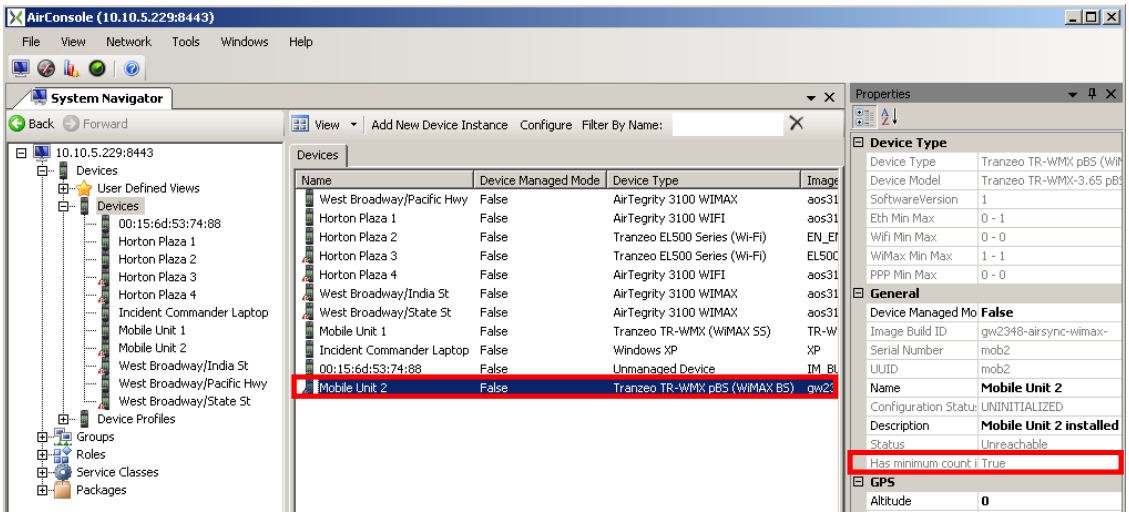
After successfully adding device with its interfaces you may plug in device in question into the network and wait until it registers. It is possible thanks to unique identification process by UUID value on device and MAC address value on interfaces.

In case you made a mistake in UUID value device will register as a new item.

If you made a mistake in MAC address device will register with new interface.

Checking whether Device is compliant with its definition

As you already know device is described by many attributes. Some of them depends on another i.e. **Device Model** depends on **Device Type**. The same situation is with type and amount of interfaces. It depends on **Device Model**. Minimum and maximum number of interfaces states about device definition. In other words to check whether device is compliant you have to check if it has minimum number of interfaces of all kinds. This issue was previously described on page 54. As shown on Screen Capture 99 there is an easy way to check whether registered device is compliant. All you have to do is to check whether **Has minimum count interfaces** attribute is set to True.

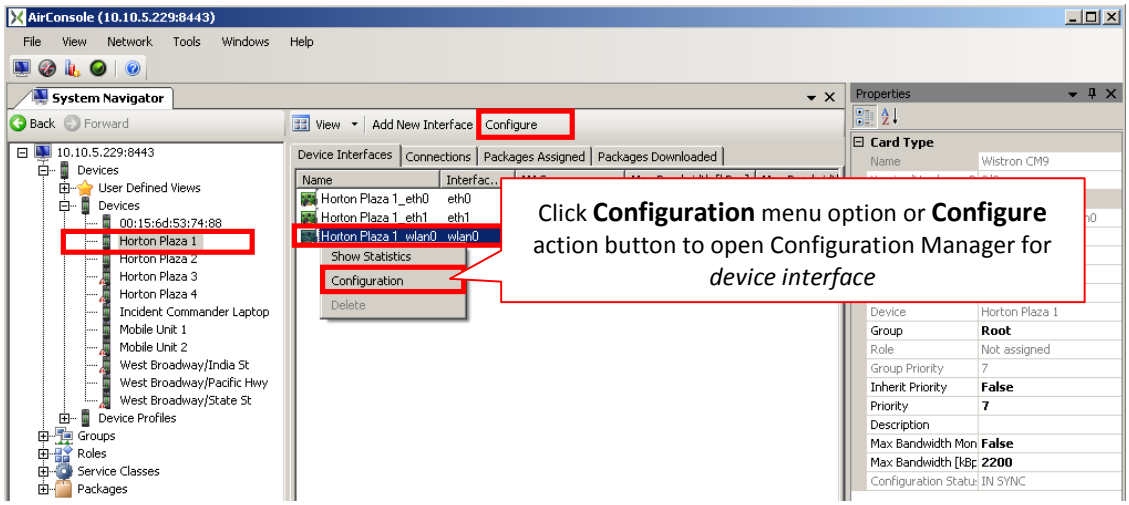


Screen Capture 99. Checking whether Device is compliant

Configuring Device Interface

As you already know device profile interface may be configured. It was described in section Configuring Device Profile Interface on page 58. However device instance interfaces may be configured as well. It was not described in section Manual Device Registration because it depends on selected Device type. For Device types which does not support AirSync Agent or are not managed via web there is no ability to use this functionality.

To open Configuration Manager for added interface select interface in question on device interfaces list view and use **Configuration** option in context menu as shown on Screen Capture 100.



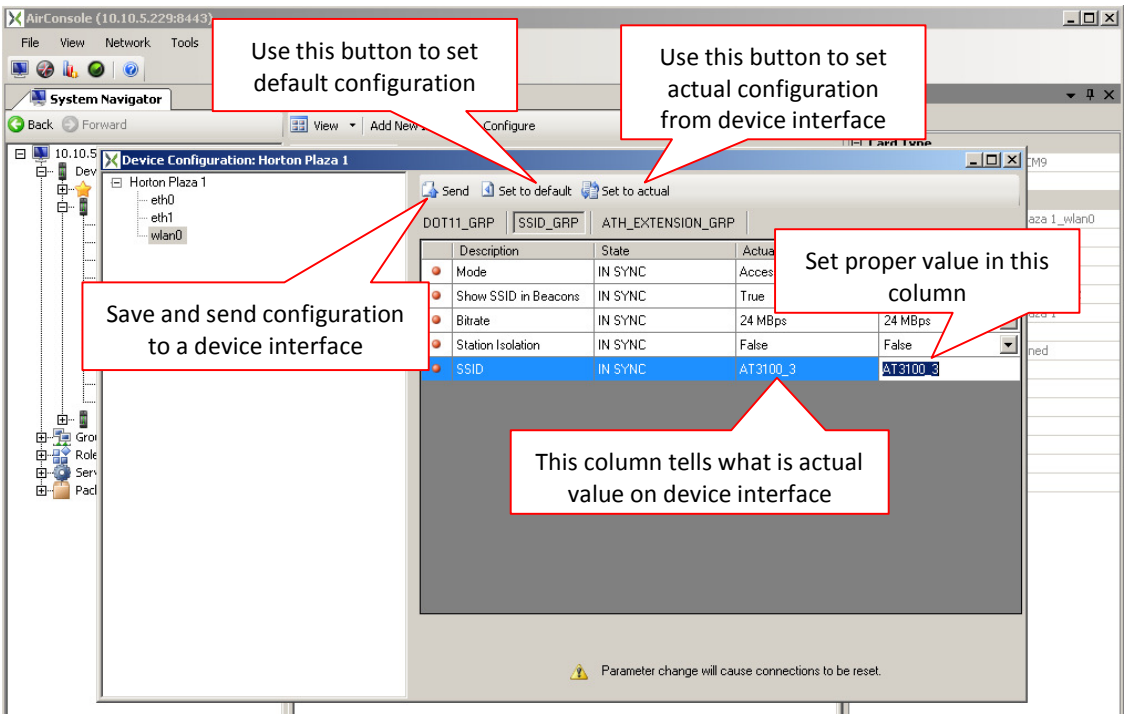
Screen Capture 100. Configuring Device Interface

The same effect you may obtain double-clicking on selected interface.

Configuration Manager displays list of parameters for interface in question. That list depends on Card Type attribute which is selected by the user when adding device interface or registered by device when it registers automatically.

Screen Capture 101 is an example of Configuration Manager for device interface which was registered automatically and AirSync Agent works on it. As you can see, except **Description** there are some others attributes of parameters displayed. **State** tells the user in what state parameter is, **Actual Value** tells what the actual value of this parameter is. This value is taken from device interface. **Desired Value** tells what value should be set. When you want to change value of some parameter set proper value in **Desired Value** field and press **Send** button. Configuration Manager will send request to AirSync Server that selected parameter should be changed. Parameter's state will change to '***REQUESTED***'. In case parameter change will be in progress, it will be illustrated in **State** field with '***IN PROGRESS***' value. When change will be succeeded then **State** changes to '***IN SYNC***'. In other case it will change to '***OUT OF SYNC***'.

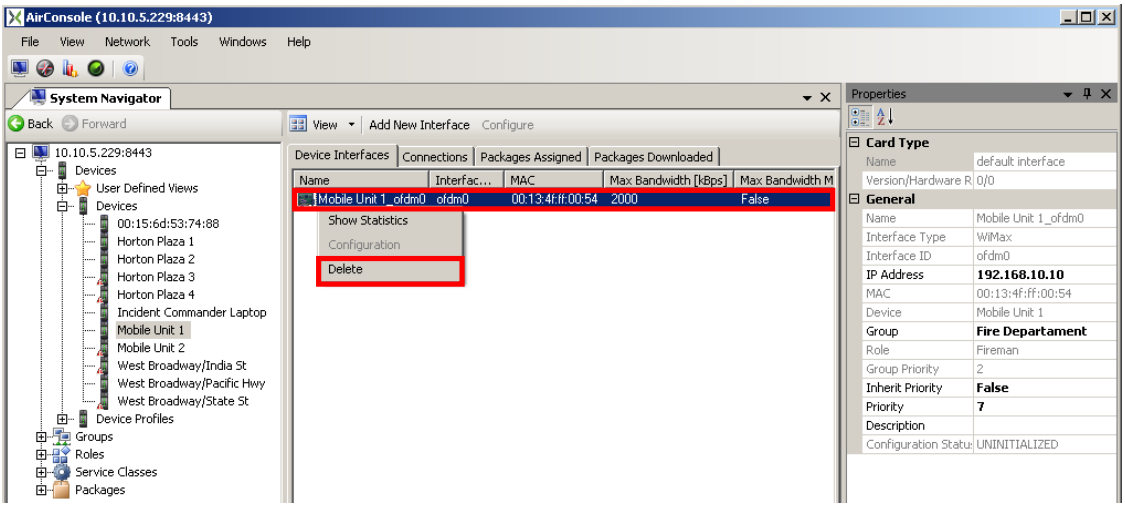
In case you want to roll back changes and set default values of all parameters use **Set to default** button. When you want to roll back changes, but actual values are proper, just press **Set to actual** button.



Screen Capture 101. Configuration Manager for working Device Interface

Deleting Interfaces

Deleting interfaces is almost as simple as deleting devices. In this case you have to select interface which will be deleted and use **Delete** option from context menu as shown on Screen Capture 102.

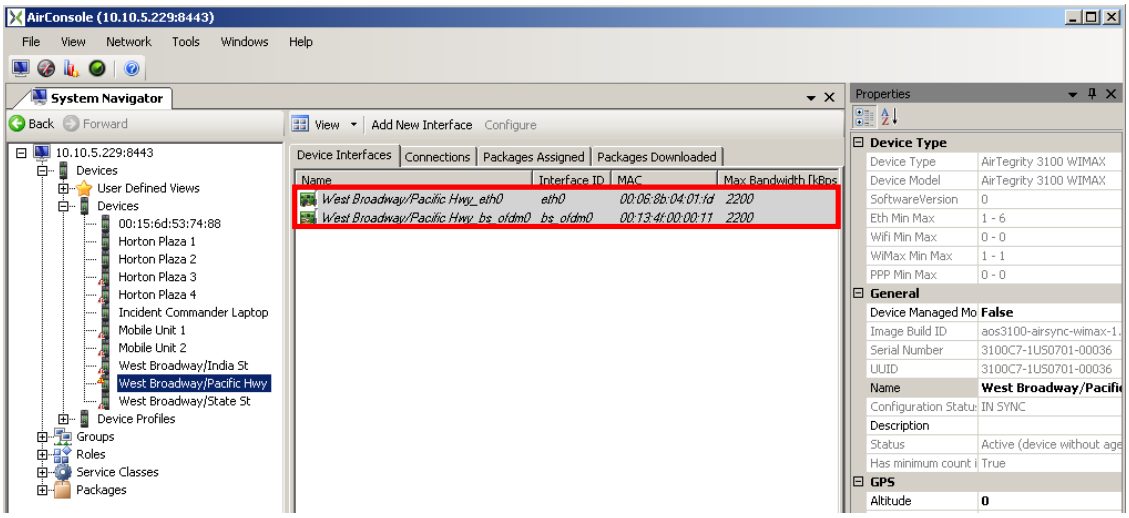


Screen Capture 102. Deleting Interface

After choosing this option Application will ask you whether you want to delete selected interface and after pressing **Yes** interface will be deleted.

Conditions of deleting interfaces

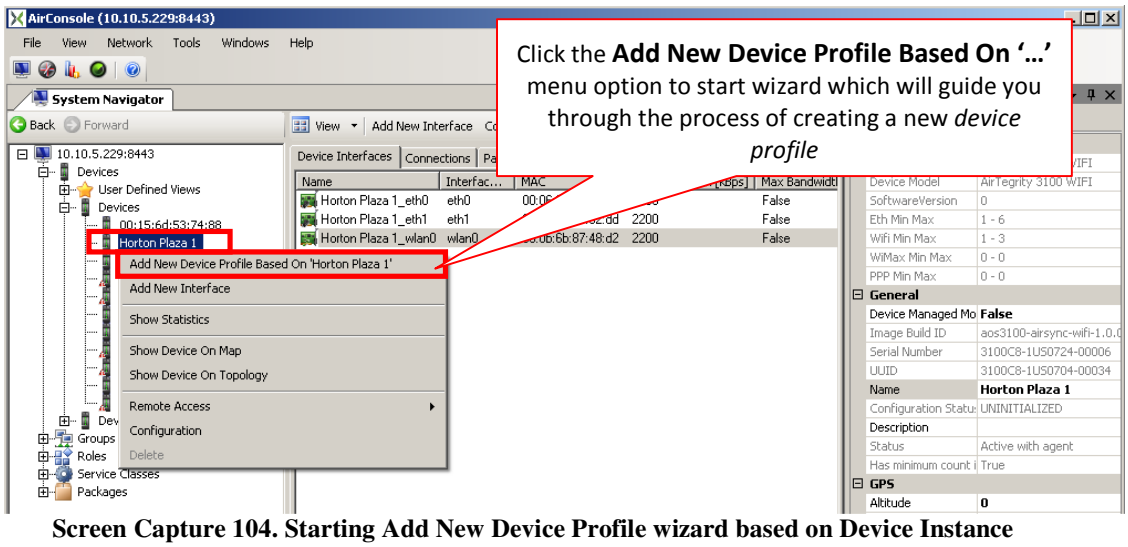
Alike in case deleting devices there are some restrictions in case deleting interfaces. First of all ability to delete interface depends on **Device Type**. In other words if it is device with AirSync Agent installed and working this action may be disabled. However that does not mean that you cannot delete interface when there is AirSync Agent installed. Yes, you can. But other condition must be met. I am talking about information whether interface in question is equipped by AirSync Agent or not. This knowledge is needed to prevent the user of deleting properly working interface. To sum up, you may delete interface always if there is no AirSync Agent installed or if it is, when interface is not equipped. To recognize whether interface is equipped or not you need only look at it. If it is grayed out and displayed *italics* as shown on Screen Capture 103 that means it is not equipped by AirSync Agent.



Screen Capture 103. Recognizing Interface which may be deleted

Adding Device Profile based on registered Device

While you have registered device you may add a device profile based on it. Generally speaking it is very similar process to adding device profile based on device profile described in section Adding Device Profile based on other Device Profile on page 59. To start this process select device in question on device list view and use **Add Device Profile Based On '…'** option from context menu as shown on **Screen Capture 104**.



Screen Capture 104. Starting Add New Device Profile wizard based on Device Instance

After selecting this menu item the **Add New Device Profile** wizard will start. This wizard will guide you through the process of creating device profile based on selected device instance. Therefore some fields in this wizard will be fulfilled with values taken from the source wizard. Those fields which are not necessary are grayed out or validation is turn off to give you the ability of filling or not those attributes.

Device Pre-provisioning

Previous sections describe different ways of adding device profiles and device instance. In this section you will find information what to do to prepare device instance to work even before device is installed in your network. To do this you have to add device profile (or device instance which will be an archetype), set proper configuration and QoS policy.

Pre-provisioning device instance

You already know how to add device instance and how to configure it. Those topics were described in previous sections Manual Device Registration starting on page 65 and Configuring Devices starting on page 71. In order to complete your knowledge you should know that mentioned functionality may be very helpful in case preparing device to work before you will install device somewhere in the field in your network. Another case when that functionality may be useful is installing a lot of devices of the same type and necessity of configuring them. If you want to do this separately it will take you a lot of time and will need a lot of effort. Thanks to previously described functionality you may add only one device (profile or instance) which you use as a base-device for provisioning rest of them with the same settings. Haw to do it is described in following sections.

Copying configuration from interface

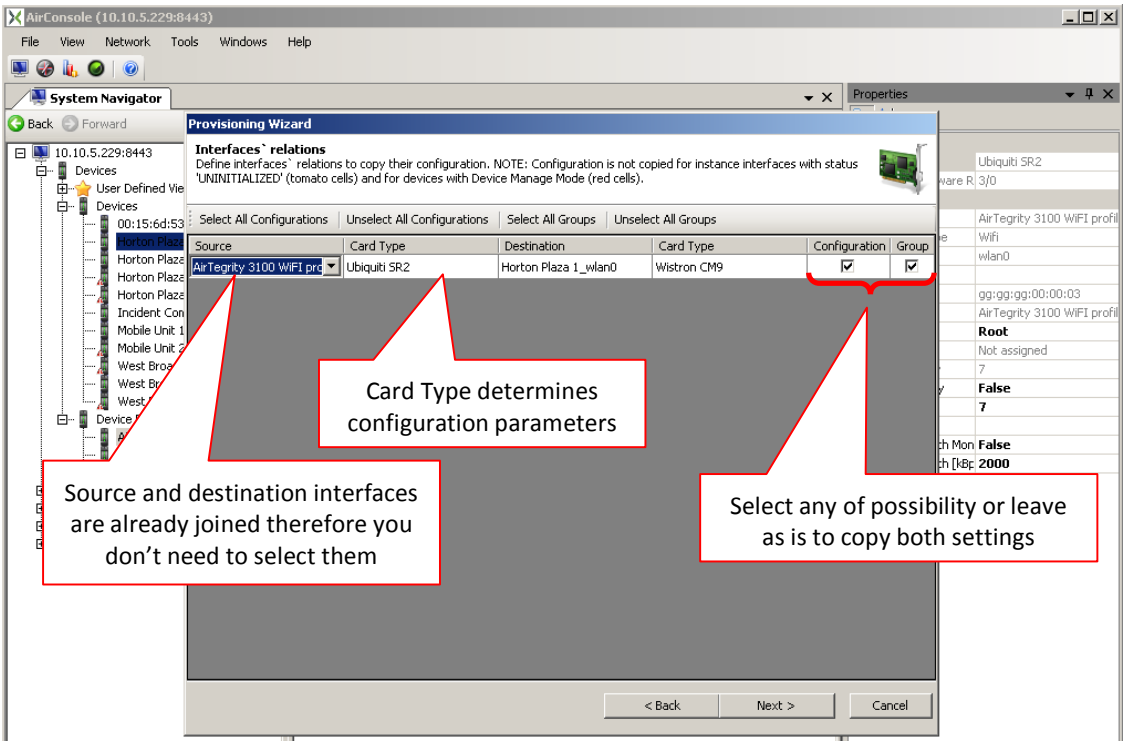
To start process of provisioning based on one interface select source interface and drop it onto destination device.

Before Provisioning wizard will start there is validation whether source interface and destination interface are the same type.

This will start the **Device Interface Provisioning** wizard which will guide you through the process of provisioning destination interfaces. As shown on Screen Capture 105 wizard will try to match source and destination interface. It will display information about interface's card type as well. This information is very helpful because during copying configuration there can be some differences caused by different source and destination card types.

In case card types are different Provisioning wizard will try to match parameters from source with destination. When some of them are missing proper message will appear.

In this step you may decide whether to copy both configuration and QoS policy (Group checkbox), or only one of them.

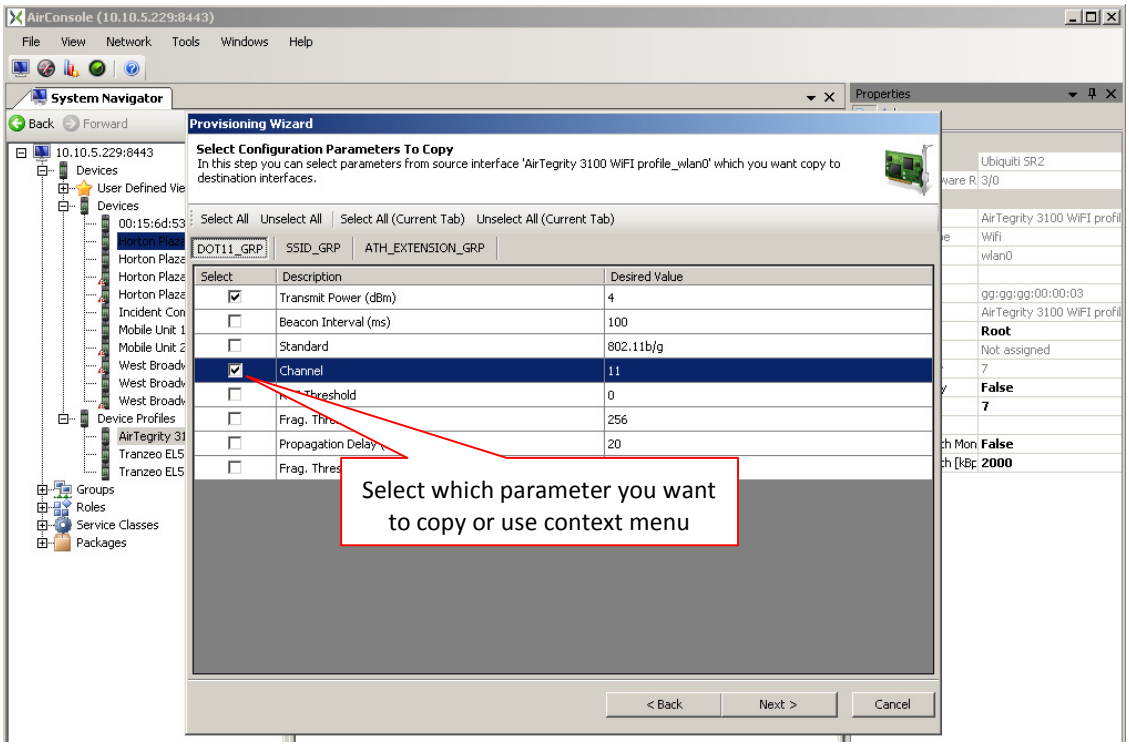


Screen Capture 105. Provisioning wizard - step 1

If destination device has Device Manage Mode set to True selected destination interface will be marked with 'tomato' color and therefore configuration cannot be copied.

As shown on Screen Capture 106 you may select which parameters from source interface should be taken into account in copying process.

Use context menu to select/unselect all parameters in the selected tab.



Screen Capture 106. Provisioning wizard - step 2

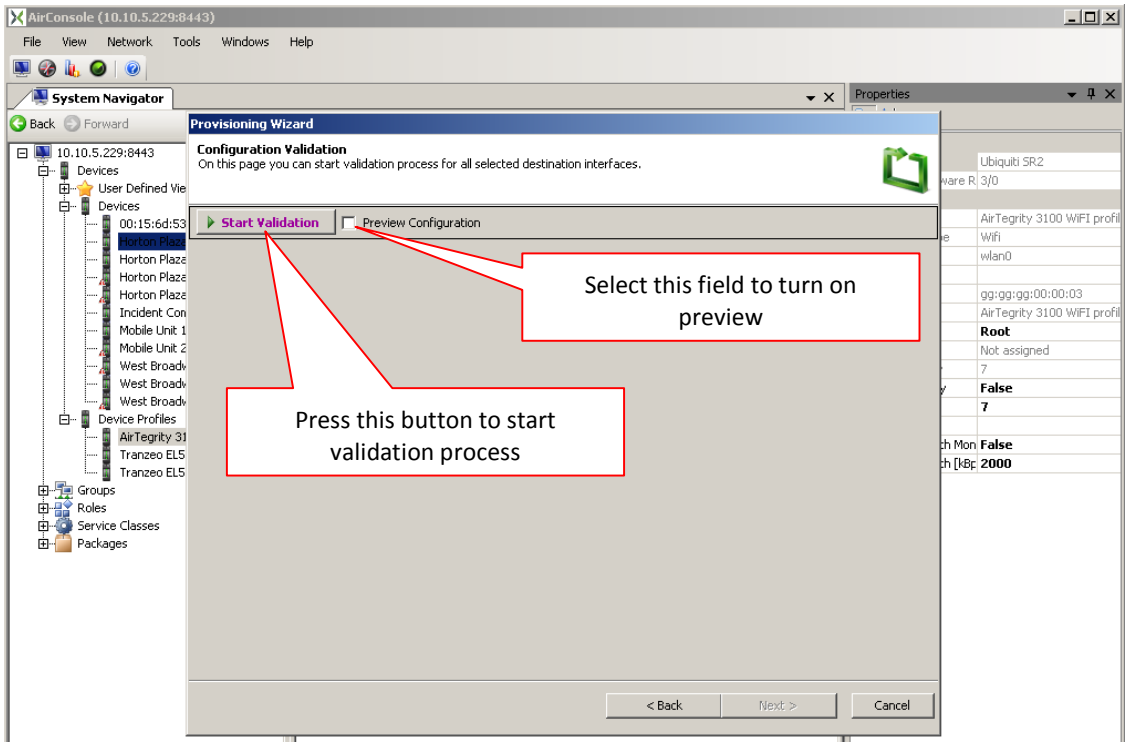
After you selected needed parameters you have to start validation process. This operation will check whether:

- Source and destination parameters matches, if so desired value from source will be copied to desired value in destination
- Destination parameter is read-only, if so proper message will appear and destination desired value will not be changed

In case any parameter is missing in destination interface proper message will appear.

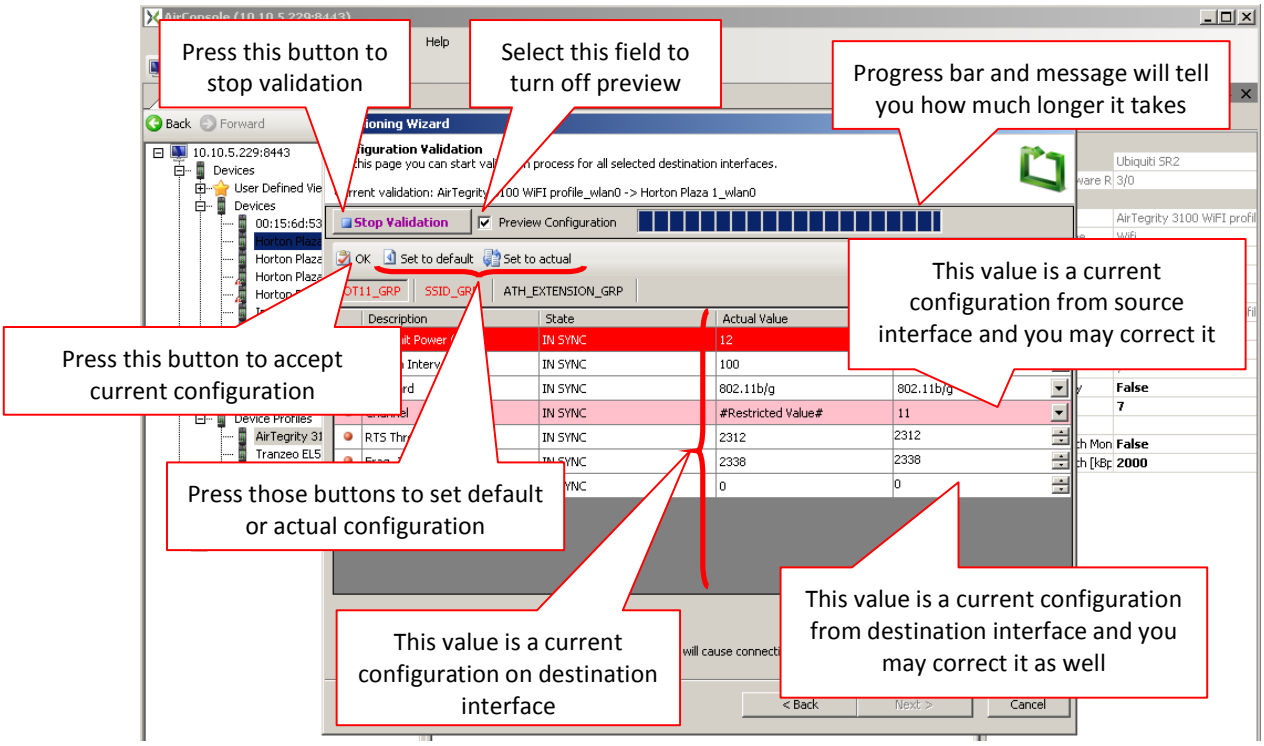
As it is shown on Screen Capture 107 you may as well choose an option to preview validation process. It gives you an ability to see validation results and if necessary correct them before you save them.

In case any parameter fail or is missing in destination you will see preview to check and correct what you need.



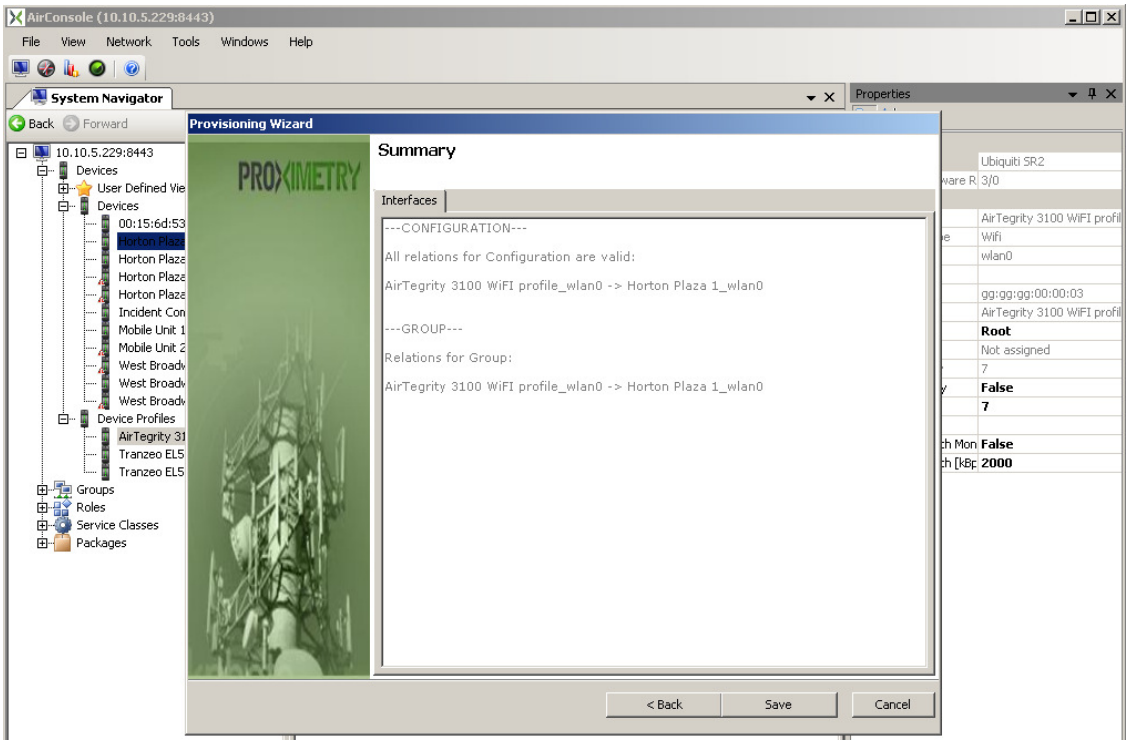
Screen Capture 107. Provisioning wizard - step 3

As shown on Screen Capture 108 you may do a lot in preview step. First of all you should check and correct any of parameters which failed. Then if everything is proper just press **OK** button to accept current configuration. You will see validation results on the next step.



Screen Capture 108. Provisioning wizard - step 4

As shown on Screen Capture 109 the wizard displays results of validation process. It gives you opportunity to go back and correct some settings or even turn off copying one of configuration or QoS settings. In case everything is fine just press **Save** button to copy configuration and QoS policy to destination interface.



Screen Capture 109. Provisioning wizard - step 5

You may drop interface onto device as well to start Provisioning wizard for several destination interfaces.

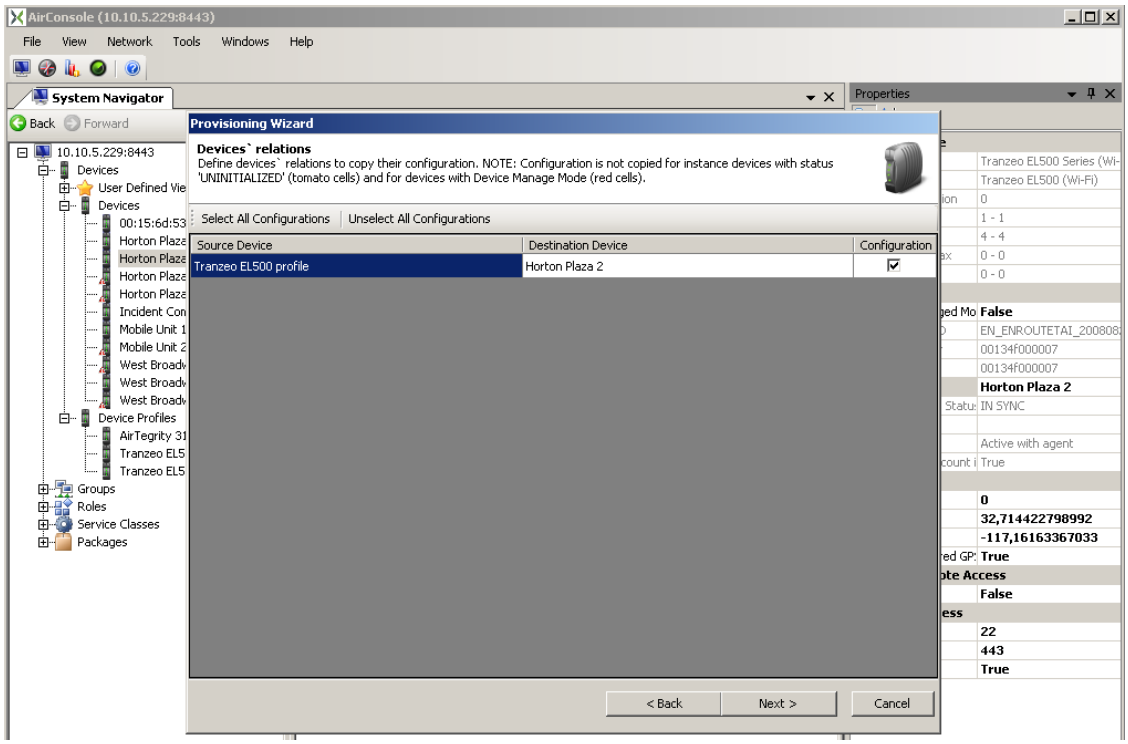
Copying configuration from device

To copy configuration from device and several source interfaces to device and several destination interfaces just drag device profile/instance and drop it onto another device profile/instance. It will start the **Device Interface Provisioning** wizard as mentioned before but you have more opportunities to copy settings from different sources to different destinations.

You may use Provisioning wizard to pre-provision group of device profiles as well.

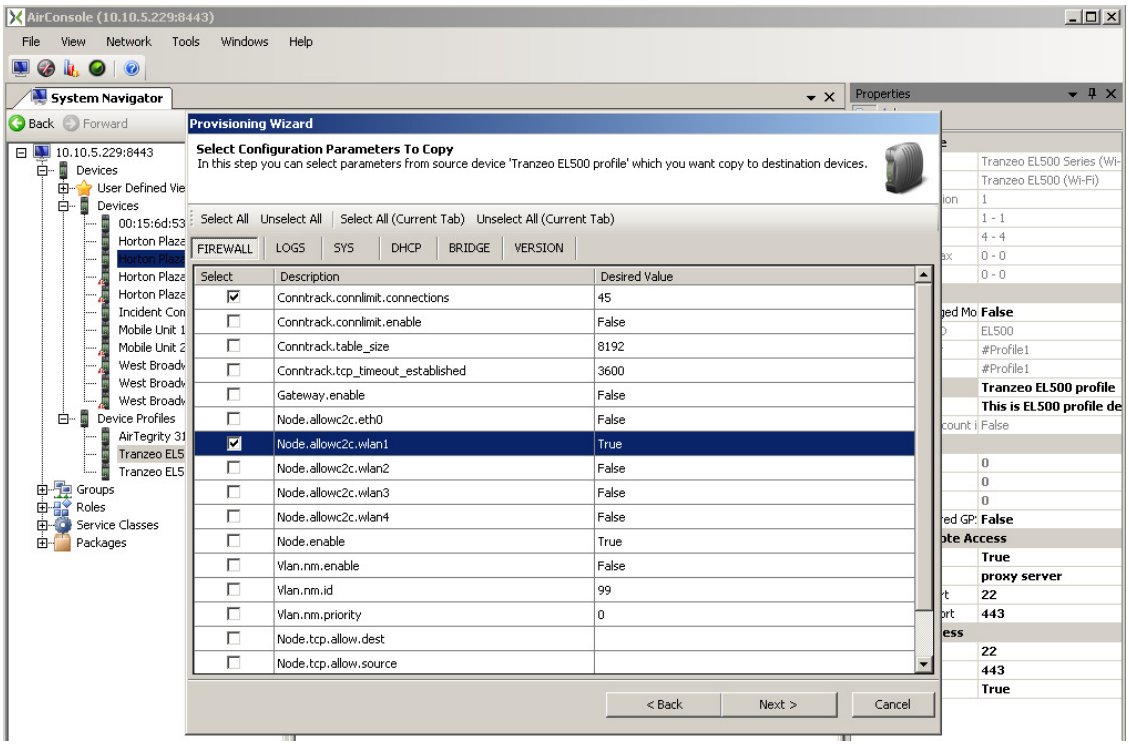
Copying device configuration

As shown on Screen Capture 110 wizard matches source and destination device. In case you do not want to copy configuration just check off Configuration field and you will go to the interfaces relations step.



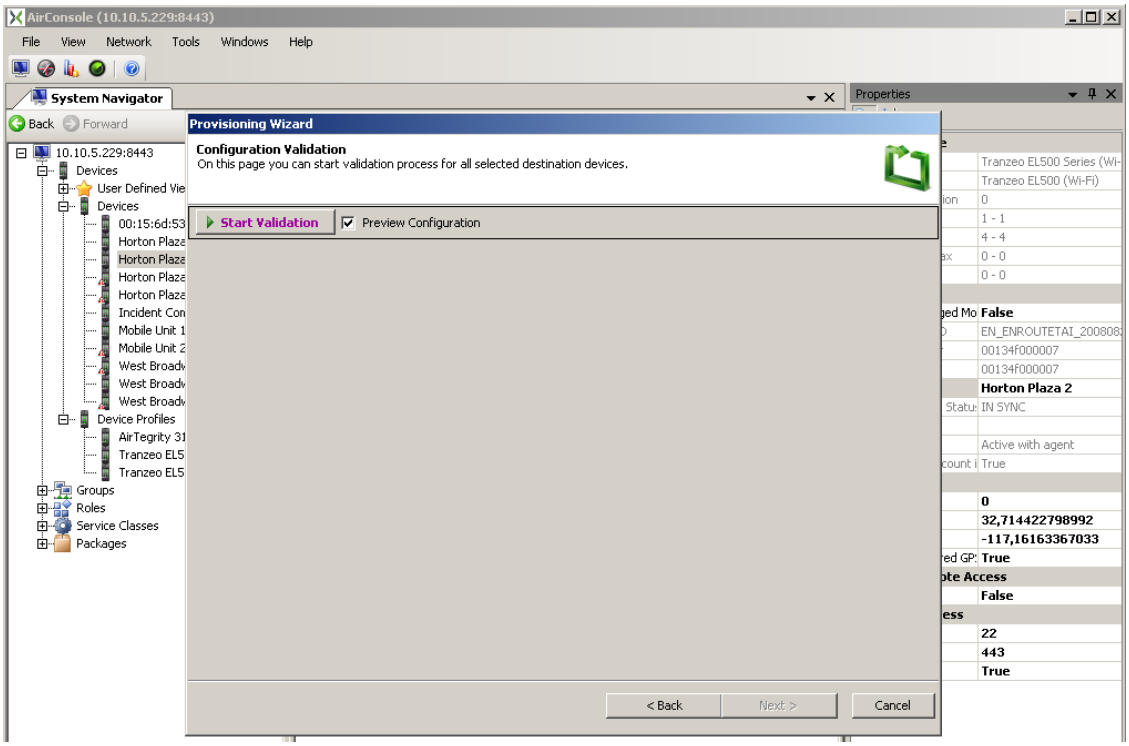
Screen Capture 110. Provisioning wizard for device and more interfaces - step 1

In case you want to copy configuration from source device to destination device in next step you may select which parameters will be copied as it is shown on Screen Capture 111.



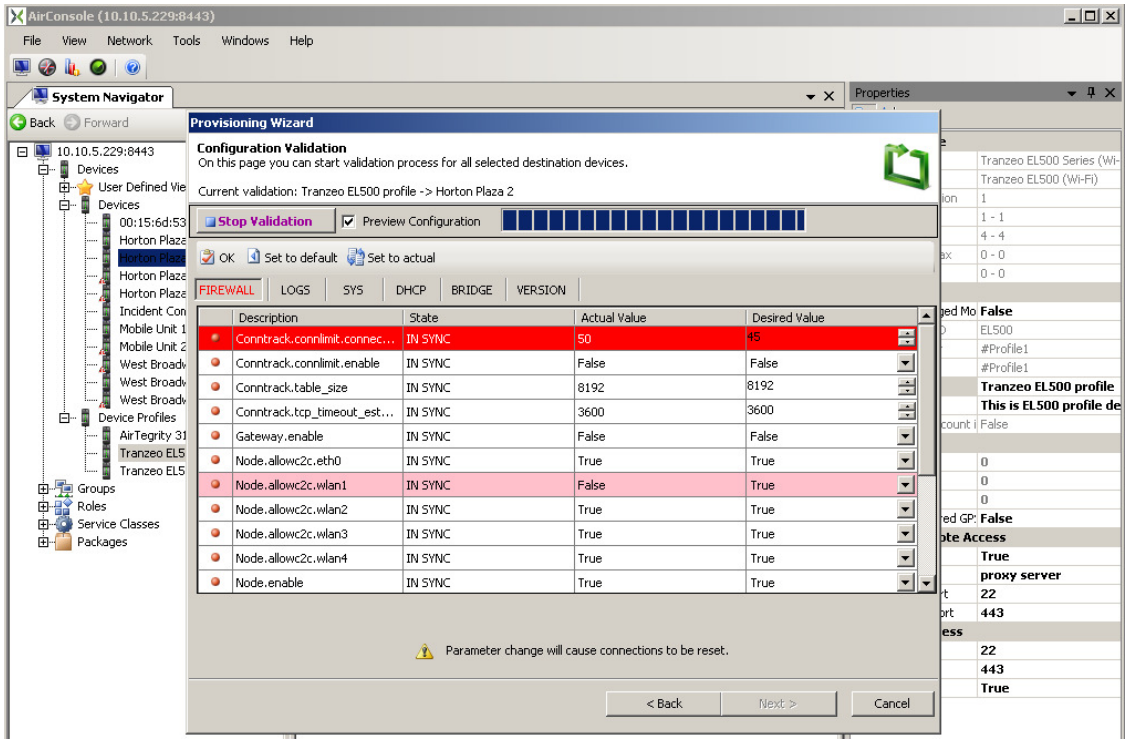
Screen Capture 111. Provisioning wizard for device and more interfaces - step 2

Alike it was previously described in next step you may decide whether to start validation with preview as it is sown on Screen Capture 112 or without it.



Screen Capture 112. Provisioning wizard for device and more interfaces - step 3

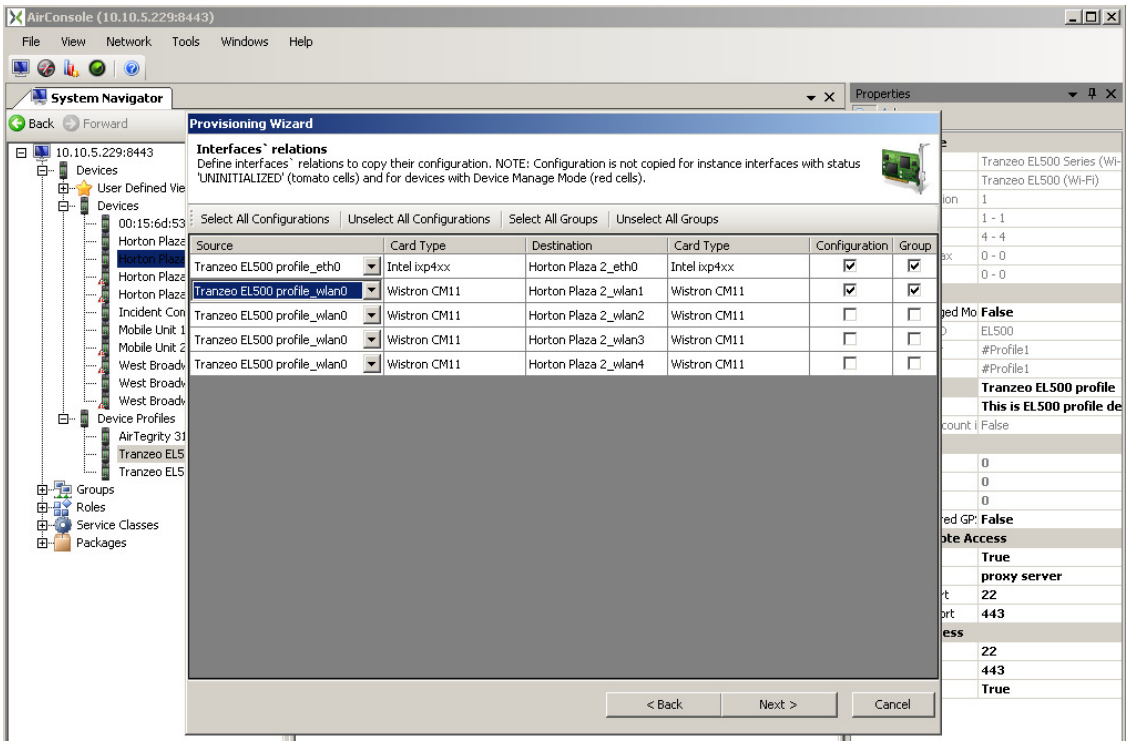
When all desired values are proper just press **OK** button as it is shown on to finish validation process for device configuration and go to interfaces relation step.



Screen Capture 113. Provisioning wizard for device and more interfaces - step 4

Copying interfaces configuration

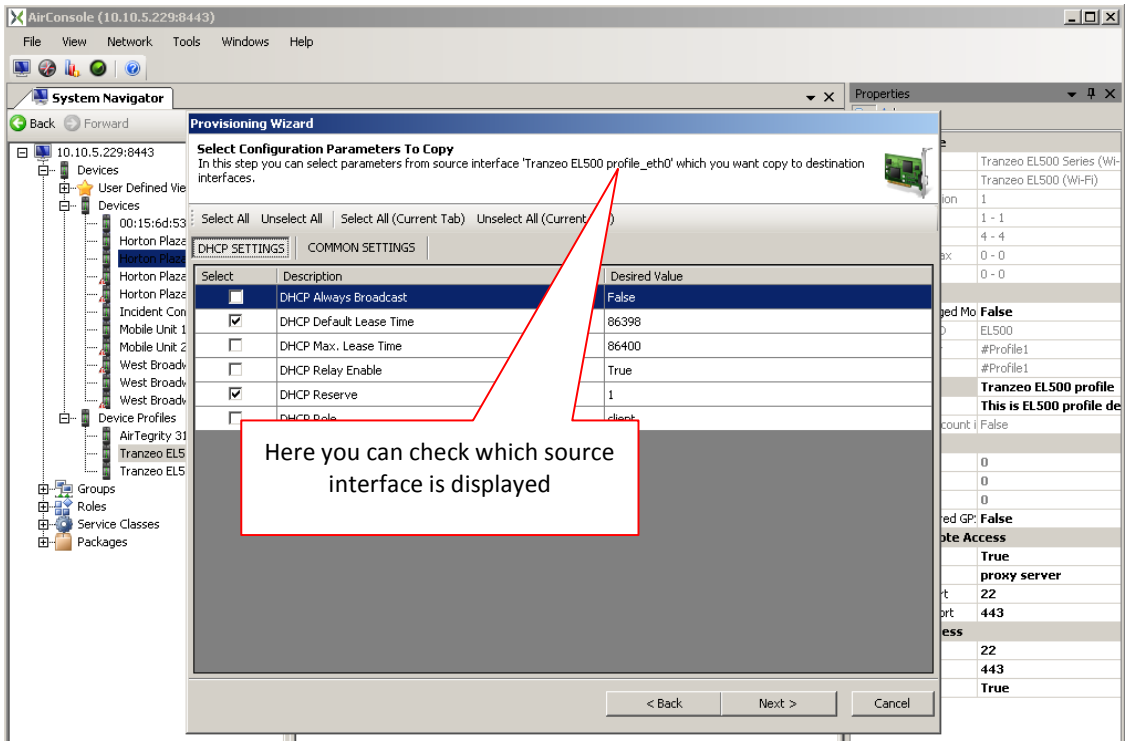
As shown on Screen Capture 114 wizard will try to match all possible source interfaces with all possible destination interfaces taking into account their types, card types and numbers. You may off course change this matching and join e.g. source interface wlan0 with destination interface wlan4. This operation will create source – destination relations. You should as well decide whether copying configuration and QoS policy for all interfaces is necessary. If not, just check off proper field.



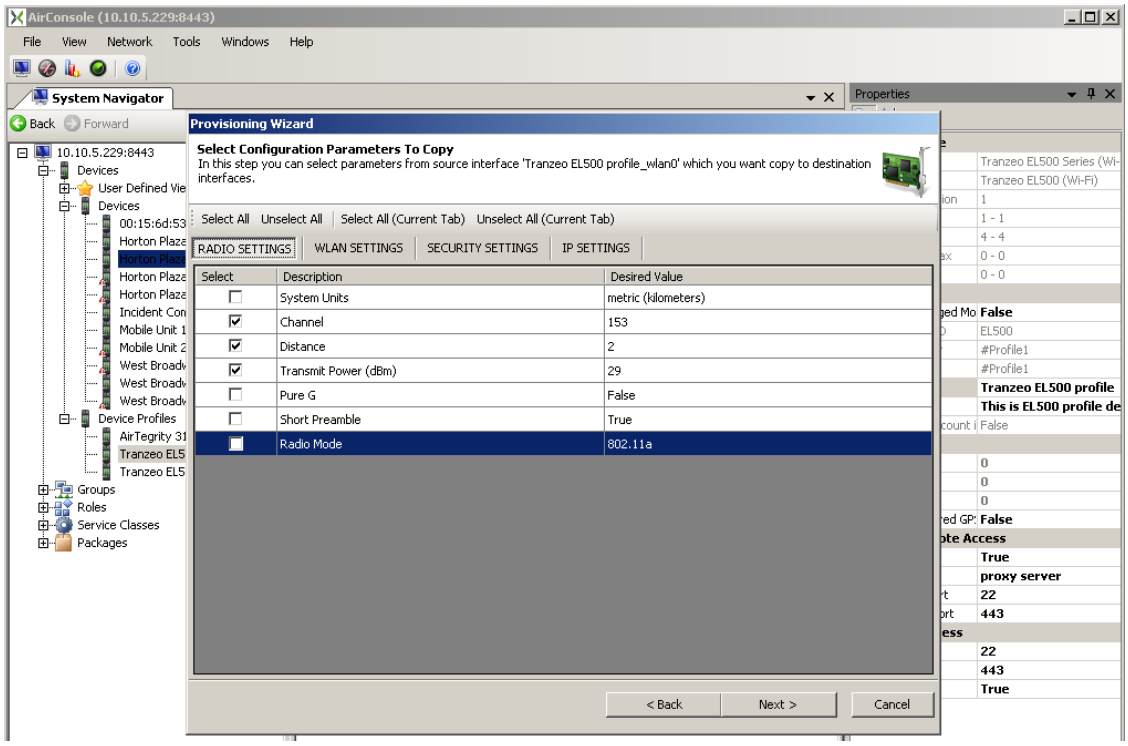
Screen Capture 114. Provisioning wizard for device and more interfaces - step 5

Wizard will try to match interfaces even though card type or interface number differs. It will just omit this criterion.

As it was mentioned before step 6 of this wizard will allow you to select which parameters should be copied from source to destination interface as shown on Screen Capture 115. The only difference is that this step is displayed as many times as many source interfaces you have chosen in previous step and what is more you may select different parameters to copy in each case.

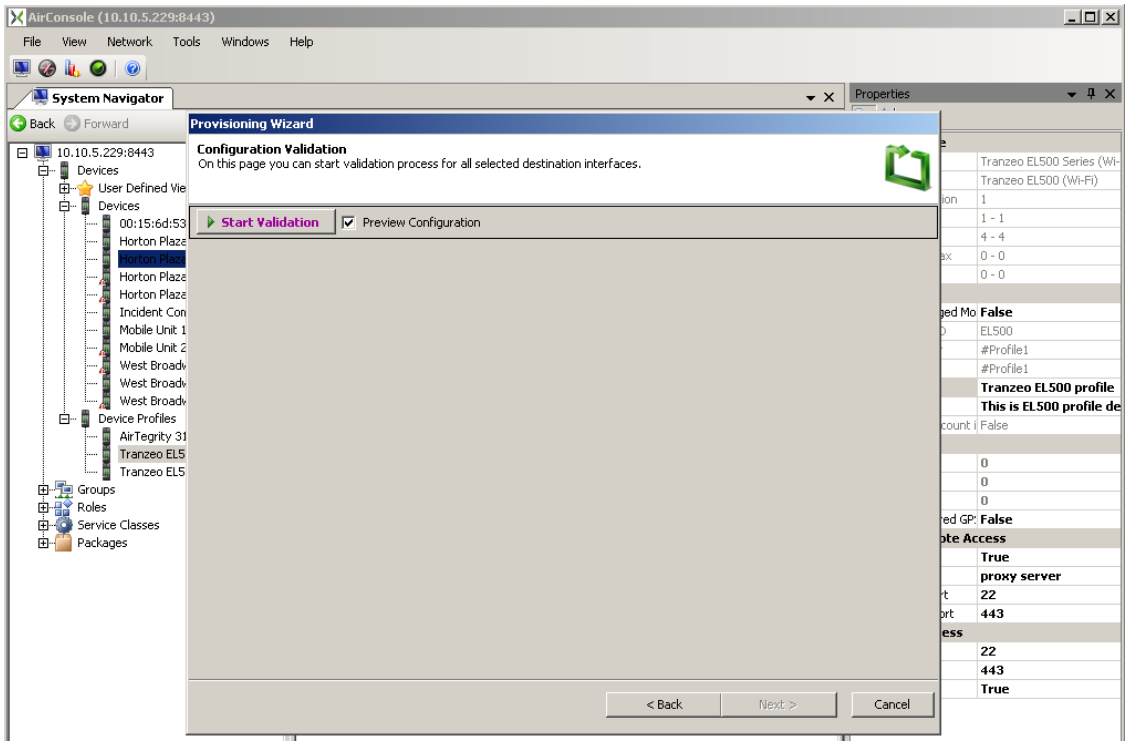


Screen Capture 115. Provisioning wizard for device and more interfaces - step 6



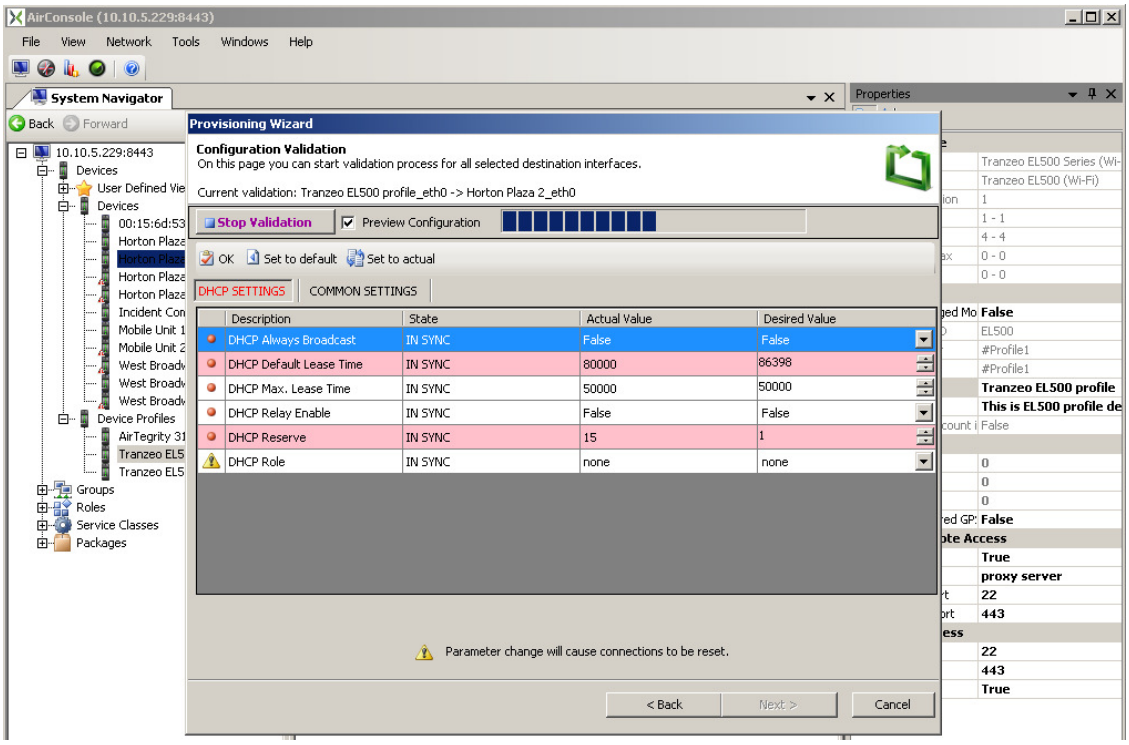
Screen Capture 116. Provisioning wizard for device and more interfaces - step 6a

As shown on Screen Capture 117 you must start validation process. It will run for all joined source – destination relations. As it was mentioned before you may turn on preview or wait till the end for summary.



Screen Capture 117. Provisioning wizard for device and more interfaces - step 7

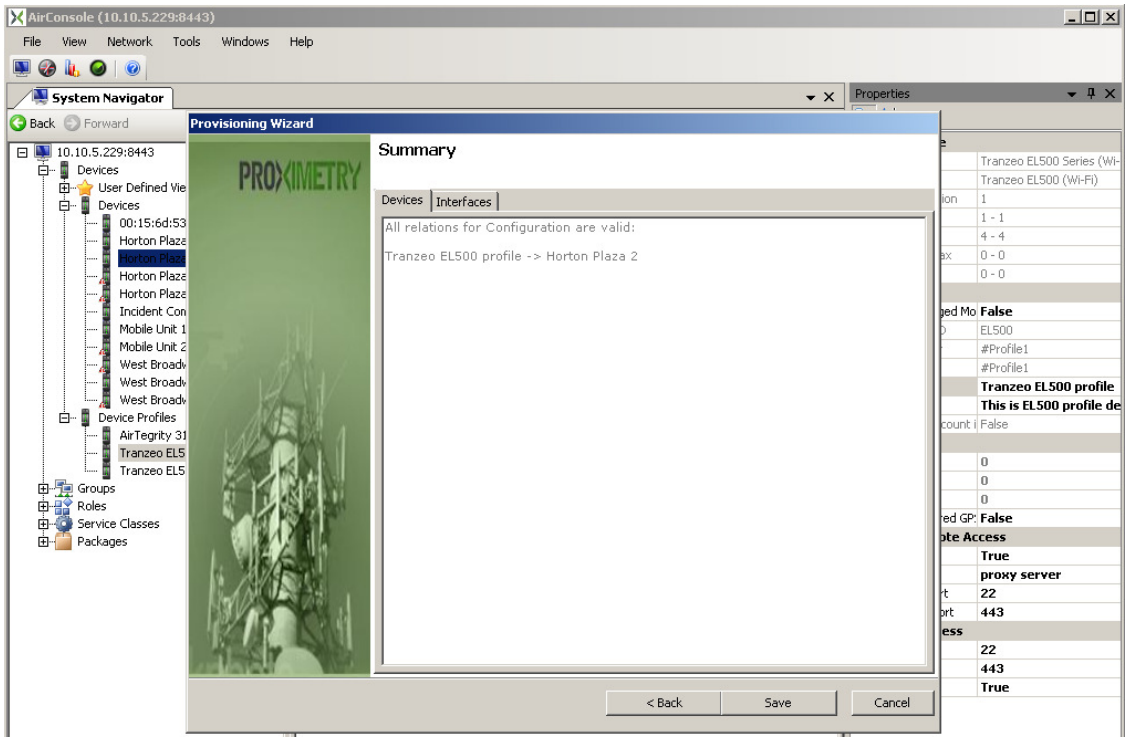
In case you turned on preview configuration or validation for any of parameters failed wizard will display step 4 as shown on Screen Capture 118. All you have to do is to check and if necessary correct configuration and accept it by pressing **OK** button for all source – destination relation. You may as well break validation process whenever you want by pressing **Stop Validation** button.



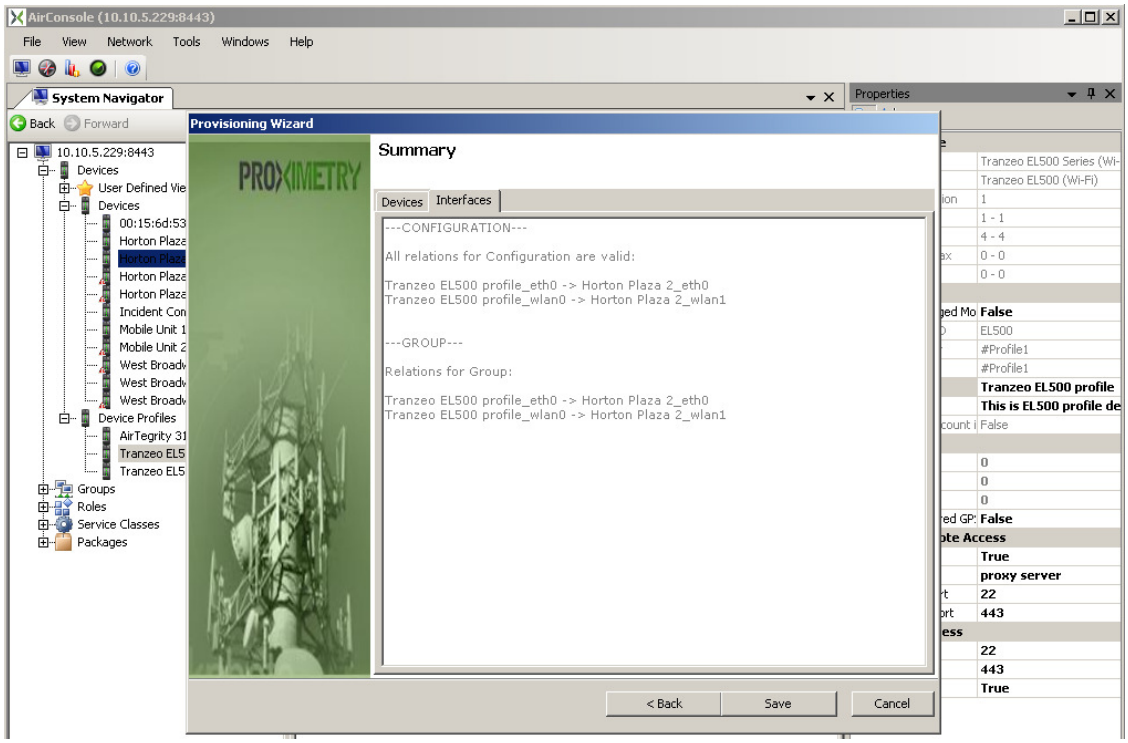
Screen Capture 118. Provisioning wizard for device and more interfaces - step 8

Drag interface and drop it onto User Defined View to start Provisioning Wizard for all selected items.

As shown on Screen Capture 119 wizard will display a short summary in which you will find information about all source – destination relations for device and as shown on Screen Capture 120 for interfaces. Pressing **Save** button will start copying process which may take a while depending on amount of device parameters and destination interfaces.



Screen Capture 119. Provisioning wizard for device and more interfaces - step 9



Screen Capture 120. Provisioning wizard for device and more interfaces - step 9a

You may use Provisioning wizard to pre-provision working device as well as device profile.

Using AirSync to Implement Quality of Service (QoS)

The ability to systematically define and overlay a structured traffic-shaping or QoS scheme onto a complex wireless network environment is probably the most beneficial feature of AirSync. This section discusses the details of implementing QoS with AirSync.

The following features, which will be discussed in greater detail below, summarize AirSync's traffic management features that have the ability to:

- Recognize and differentiate multiple distinct traffic flows.
- Treat multiple instances of the same recognized flows differently based on different organizational usage *roles* of end users using the traffic flows.
- Shape traffic both in the upstream and downstream directions.
- Shape traffic at multiple points in the network.
- Dynamically monitor and detect changes in network bandwidth capacities and automatically make appropriate QoS adjustments.
- Dynamically move QoS "rules" or *Service Level Agreements* (*SLAs*) around the network in response to the movement of mobile devices. As devices move around the network, the rules that govern traffic behavior for associated users move appropriately.
- Systematically arbitrate the allocation of excess bandwidth during periods of network under-subscription.
- Systematically arbitrate the allocation of bandwidth during periods of network over-subscription. This feature, called *Service Level Degradation* (*SLD*) allows network performance to degrade in a graceful, rules-based fashion when conditions make it impossible to meet all defined SLAs.
- Dynamically change QoS parameters "on-the-fly", but without requiring any user intervention, in response to various network trigger events, whenever they may occur. Since it's unknown when or if these events will occur, these systematically defined changes are called *AdHoc Rules*. They may occur, for instance, in response to changes in network topology (the number of stations associated to a device) or changes in signal quality (improvement or degradation of modulation scheme or bit rate).
- Support Wireless Multimedia Extensions (WME), a set of special queuing disciplines well-suited for managing latency-sensitive traffic flows.

Theoretical Building Blocks

Different Flows Have Different Network Characteristics

In the absence of AirSync's systematic QoS scheme, all network traffic gets identical best-effort service, competing for network bandwidth resources on an unmanaged "first-come-first-served" basis. Network performance and user satisfaction quickly degrade even before the network reaches total saturation in terms of raw bandwidth capacity.

Performance may suffer for a variety of reasons because different traffic flows have fundamentally different characteristics:

- **Some traffic, such as voice and video, is *delay-sensitive***. If voice or video packets don't make it through the network on a real-time or near-real-time basis, the perceived voice or video stream becomes garbled. Together with effective receive-side buffering techniques, the human ear and human eye can interpolate to smooth out perceived quality if some of the packets get lost or delayed in-transit. However, after a certain amount of delay, it's better to simply drop video or voice packets rather than transmitting and processing them if they would arrive so late as to merely waste bandwidth and garble the received signal stream. On a limited basis, this traffic could be classified as **somewhat *loss-tolerant***.

- Real-time or near-real-time traffic flows such as **voice and video are also *jitter-sensitive***. Jitter refers not to an absolute magnitude of delay, but rather to a variable rate of delay which can also garble perceptual quality.

- FTP file transfers, for example, and other traditional **data flows are *loss-intolerant* but somewhat *delay-tolerant* and *jitter-tolerant*.** By delay-tolerant and jitter-tolerant, it's meant and understood that users may meet frustration and eventually cancel the operation after a certain threshold of delay, but the transmitted data will still be usable, even if it experiences occasional brief delays and some jitter. Loss-intolerant is described as unlike a small drop or loss rate for voice or video packets that can be tolerated, every packet must be successfully received or the data file will not be usable. Of course, normal TCP and lower-level networking mechanisms will handle error detection, correction and retransmission when necessary, but every packet must be correctly received.

- Some traffic is more *bursty* in nature while other flows have a more *constant bit rate* (CBR) quality.

So even if there's still adequate link capacity, an FTP flow could disrupt a video flow in an unmanaged network, for example by creating excess jitter. Fortunately, AirSync supports multiple queuing disciplines, including special low-latency queues for voice and video flows.

Understanding the AirSync QoS Processes

The following bullets summarize the QoS implementation processes in AirSync:

- **System Administrators define/model organizational network usage policy**. The policy is articulated both in terms of traffic type and user type. To achieve this step, administrators manipulate various AirSync objects including: *patterns*, *service classes*, *services*, *roles*, and *groups*. These concepts will be defined in more detail later.

- As a result, the **AirSync server stores a set of business rules or template trees** that best reflect organizational policy. These templates will be used later to generate instructions that agents on managed devices will eventually use to build the actual packet filters and provisioned-queue structures that ultimately implement the organizational policy. AirSync supports a variety of rules including rules for controlling basic upstream and downstream traffic rates, how to allocate excess bandwidth when it is available, and how to resolve/arbitrate conflict if the network becomes oversubscribed.

- AirSync server components communicate with agents on the managed devices**.** The **AirSync Server continuously monitors the network for performance statistics and significant network events**. Some example events include a managed Wi-Fi station breaking or forming an association with a managed Wi-Fi access point, the usage role of a managed device changing, or an improvement or degradation of signal quality and/or bandwidth capacity on a managed device.

- The **network events trigger the AirSync server to determine and generate the best set of QoS instructions** for the managed devices, based on user roles and current network conditions, by consulting the rules, templates and network topology conditions stored its internal database.
- **The AirSync server sends an appropriate set of QoS instructions to the agents on the managed devices**.

- The **agents construct and activate a set of packet filters and queues** on the managed devices that implement the situationally-appropriate usage policy.

- The **agents report performance statistics and events back to the AirSync server**.

- **The Server monitors information from the agents, reacts to it and provides feedback to system administrators**.

- **System administrators periodically monitor performance and adjust policy**.

Conceptually, there are two distinct cyclical processes involved:

- The human process used by system administrators to define network policy and monitor performance:

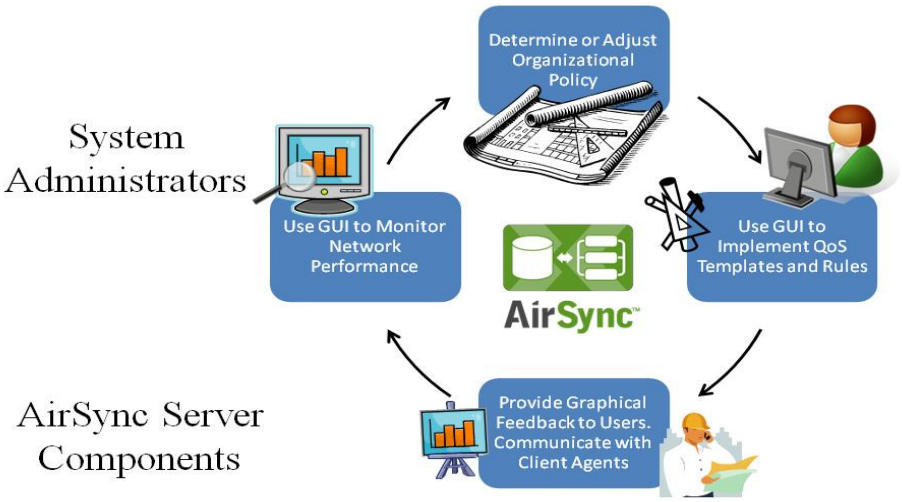


Figure 1. The AirSync QoS System Administration Process

- The near real-time machine process of interaction between the AirSync server components and AirSync agents running on managed client devices that monitor events and implement QOS:

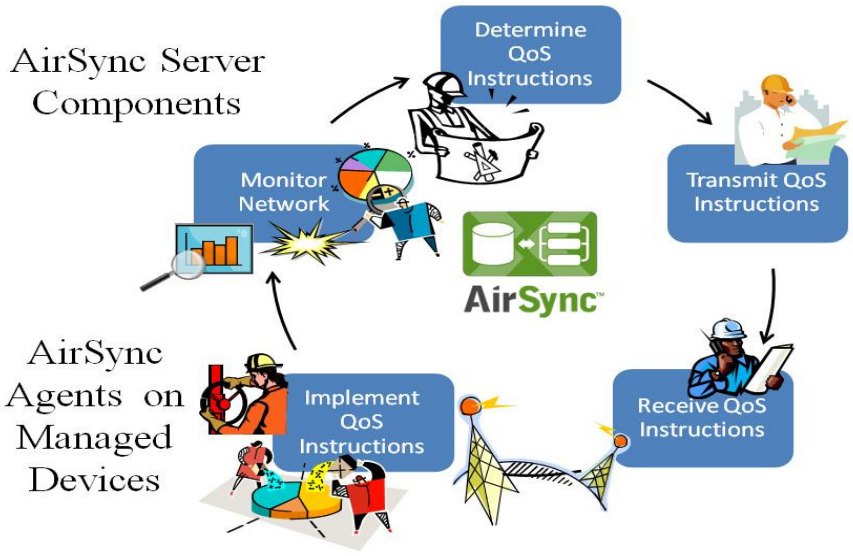


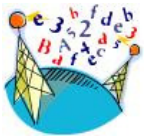
Figure 2. The AirSync Server/Agent QoS Implementation Process

Understanding How the Pieces and the Processes Fit Together

Step 1: Define QoS Goals, Organizational Policy

Implementing QoS starts with understanding what application traffic flows will traverse the managed network:

- What kinds of data will transit the network?
- What are the protocols?
- What are the bandwidth characteristics of each stream, for example, true-color full-screen video at thirty frames-per-second compared to a single VoIP phone call using G.729 vocoding/compression and silence suppression? Is the traffic mostly upstream, mostly downstream, or balanced?
- When are given flows more likely to occur? Will there be surges of email activity at the beginning of the day, at lunch, and at the end of the day? What about batch/bulk file-transfer operations during off-peak hours?
- Is the traffic client-server oriented or more peer-to-peer in nature?
- Between which network end-points will a given flow stream?
- Where are the servers? Where are the clients?



In addition to understanding the application traffic to be used over the network, the implementation of QoS involves understanding differences in users' roles and circumstances:

- Are some jobs more important than others under different circumstances? Are there times when one job function or role should get priority above or below others? Consider a municipal network. During normal operations the network may carry a significantly different traffic flow than during special events (such as city parade, large convention) or during public safety emergencies (such as natural disaster, act of terrorism).

- What jobs do different users perform over the network? During normal operations and even during special operations it may be possible to define different user roles for the network. For example, during a public safety emergency, Firefighters could use the network to download building blueprints or check weather forecasts. Police might use the network to monitor or transmit special camera feeds to or from city hall or remotely control traffic devices. Medical personnel may need to access healthcare information or perhaps send or receive real-time bio-metric information from special devices worn by injured parties. If the network gets congested, how should the traffic get prioritized?

Once traffic characteristics and user needs have been contemplated, you have enough information to define basic service level agreements (SLA) that articulate the organizational usage policy for the users of your managed network.

For example, during normal operations city maintenance engineers should get between 100-300 kBps for web traffic to the internal web server at city hall. General web service to all external web sites will be allocated from 50-150 kBps. The system will allocate between 200-400 kBps for connecting to a special city street maintenance database application. Other users could get vastly different bandwidth allocation profiles based on their differing job roles within the organization.

Step 2: Define *Service Classes* to Recognize Distinct Traffic Flows

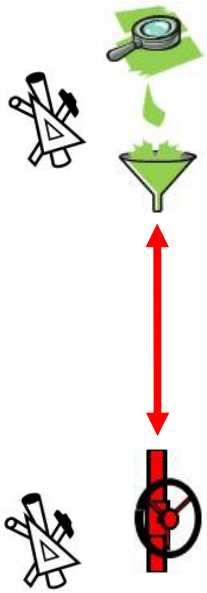
After gaining an understanding of the traffic patterns, priorities, and intended user network usage roles, the information can be modeled as organizational policy in AirSync causing AirSync to generate appropriate QoS instructions and distribute them to the correct managed devices. **But before distinct traffic can be managed with differentiated service level agreements, there must be a way to recognize the various distinct traffic streams** so that AirSync can provide differentiated service to them.

Service Classes give AirSync a mechanism to recognize and sort (classify) packets from different traffic flows as shown in Figure 3. Think of a service class as a template for generating packet filters. The filters will eventually be built and used on managed devices to sort packets into specific "buckets" or "funnels" that buffer and guide packets to specific queues. The queues will empty at independently-provisioned rates to provide differentiated service to different types of traffic.

Figure 3. *Service classes* are templates for building packet filters to sort network traffic flows

Note that **a service class doesn't define how the packets in the class will get treated** (i.e., how much bandwidth should be provisioned, etc). It merely defines a template for recognizing a given traffic flow. **Each service class contains one or more *patterns* that will classify (include) matching packets** based on items such as source IP or network address, transport protocol (TCP/UDP) and port number. In the case of generic web traffic, there would most likely be two patterns, one for HTTP (on TCP port 80), and one for HTTPS (on port 443). The actual QoS parameters governing bandwidth allocation are provisioned elsewhere.

Step 3: Define *Services* that Provision QoS Parameters



Don't confuse the names! Recall that *service classes*, discussed above, are templates for constructing filters that sort flows of packets into specific buckets or funnels called traffic classes. On the other hand, ***services* define templates for provisioning QoS parameters for a traffic class**. AirSync uses *services* to construct the basic SLAs that implement organizational usage policy.

Each *service* references a *service class* and associates it with a specific SLA that establishes how to treat the traffic type for a class of user. **The *service* template defines rate and priority characteristics** that will be factored into the instructions that client agents will eventually use to build provisioned queues for a given class of user on a given device interface. So when you think about services, you can visualize valves on queues for specific traffic flows provisioned to flow at a specific rate for specific users. This constitutes a basic form of an SLA.

Figure 4. *Services* are templates for provisioning basic Service Level Agreements

So why make a distinction between a service class and a service? Reusability is one reason. The same packet classifier (service class) can be reused in multiple services, each provisioned to appropriately reflect different user needs for the same type of traffic.

For example, you could define a single service class called "Generic Web – Any Source" that classifies all HTTP and HTTPS packets to/from any web server. Then you could define distinct services such as "Web – Gold Users," "Web – Silver Users," or "Web – Bronze Users" that could provision different SLAs for three different classes of web users. All three services could be based on the same service class because the web traffic is *recognized* the same way for all three types of users, but defining three distinct services allows the traffic to be *treated* three different ways depending upon the role of the traffic user.

Step 4: Assign *Services* to *Roles*

A *service* defines the way a specific class of traffic gets treated from a QoS perspective for a given class of user. But most users generate and consume more than one type of traffic. A user's traffic usage pattern varies according to the user's tasking or *role* within the organization.

As examples, a call center operator would generate VoIP traffic, probably some email and a fair degree of web traffic from a specific web site, for instance to fulfill orders from a catalog. A doctor might generate or consume a large volume of high-resolution x-ray images or high-definition video. A user in a coffee shop might consume low-resolution streaming videos, read some email and visit a broad spectrum of web sites. As shown in Figure 5, different organizations may have vastly different sets of user roles.

Figure 5. User roles vary between and within organizations

In AirSync, *roles* provide a template to specify a set of provisioned services that reflect the traffic usage policy for a given class of user (or device) within an organization. For example, a fireman may generate FTP, VoIP and web traffic on the job. Figure 6 depicts an AirSync role defining a template for provisioning three services according to the organizational network usage policy for the "Fireman" class of users.

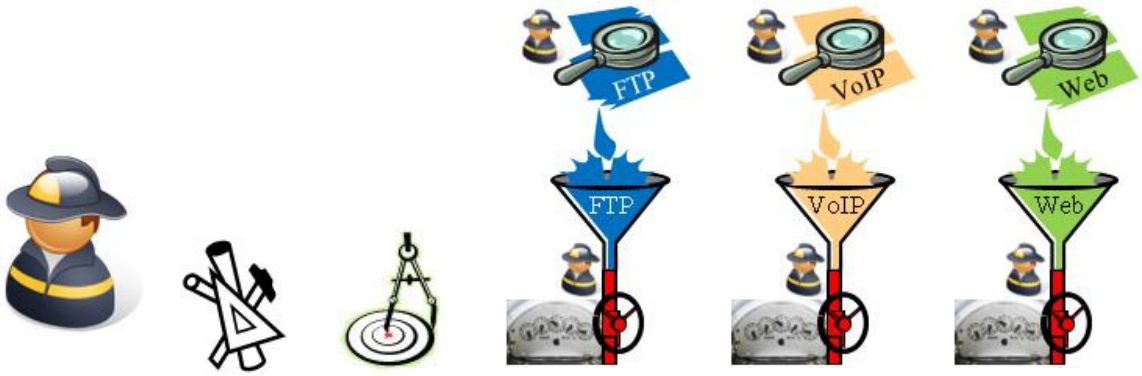


Figure 6. The Fireman role template (on the AirSync Server) defines provisioning for three services

The set of all defined service classes, services and roles creates a "template tree" indexed by user type or role. As described in the process depicted by Figure 2. The AirSync Server/Agent QoS Implementation Process, when AirSync detects users associated with managed devices, a server component consults this template tree to generate QoS instructions appropriate for the user role(s) assigned to the associated devices. The AirSync Server sends the instructions to AirSync agents on the managed devices for implementing the actual packet filters and queues to control traffic as depicted in Figure 7.

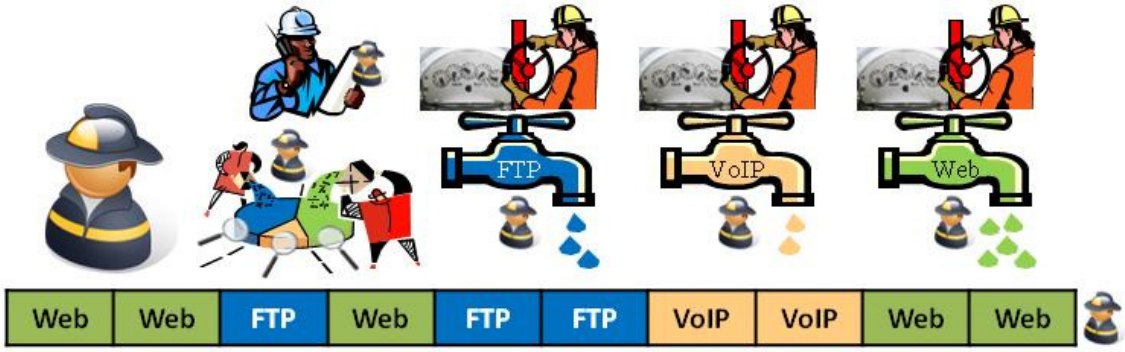


Figure 7. AirSync agents implement packet filters and output queues on managed devices

In the following series of template tree diagrams, notice the pointer relationship between the various objects.

Figure 8 shows a more detailed look at the "Fireman" role showing how all the related parts fit together. Looking from the bottom up on the template tree structure, notice that the *role* references *services* which reference *service classes* which reference *patterns*.

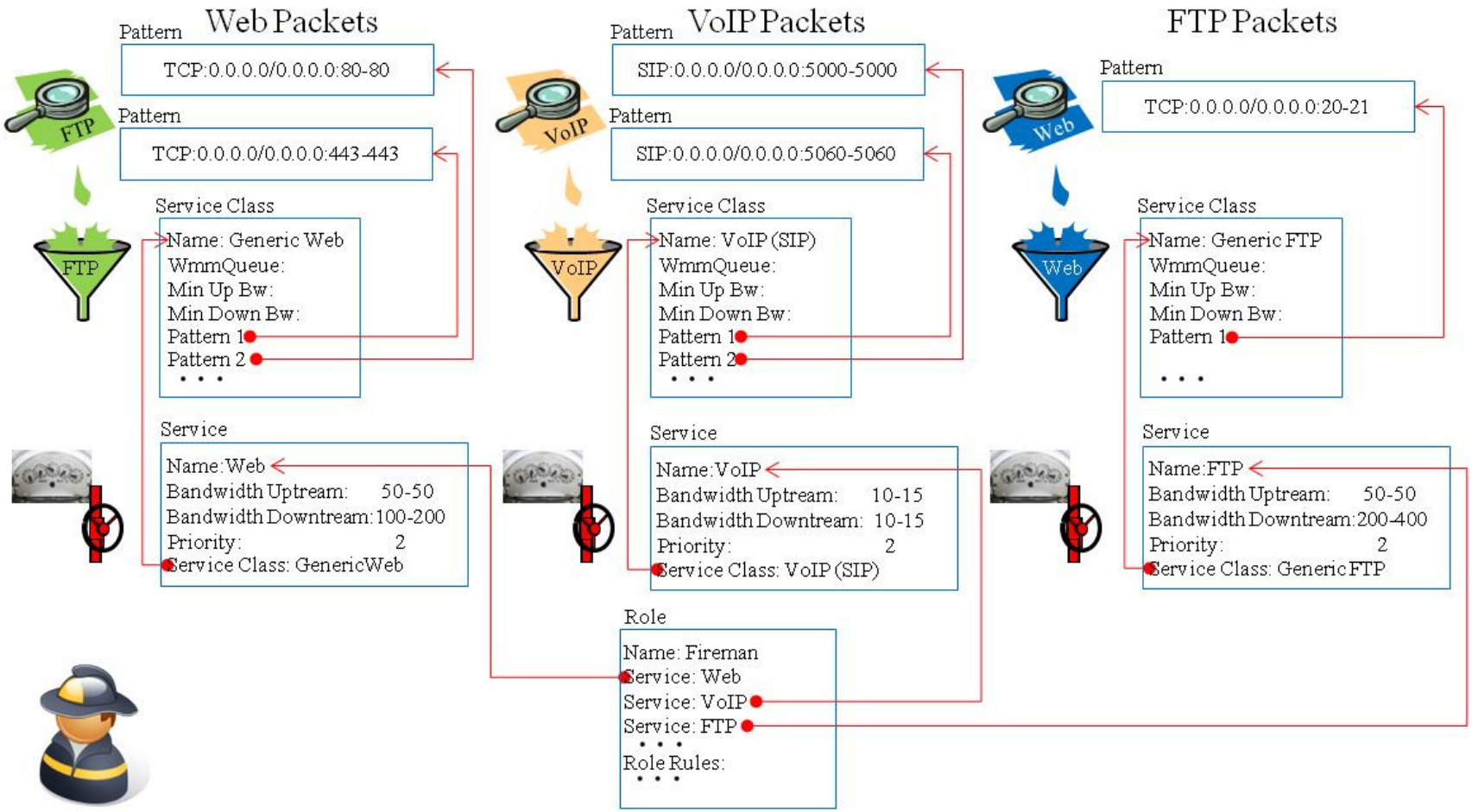


Figure 8. A detailed look at the Fireman Role

An organization could define distinct "Fireman" and "Policeman" roles which may (or may not) rely on common service classes, for example "Generic Web Traffic." The organization could define one set of provisioned services, say, Web, VoIP, and FTP for the "Fireman" role and another set, such as Web, Video, and Email for the "Policeman" role. If the organizational policy dictates that the "Fireman" and "Policeman" user classes should get identical bandwidth allocations (think *service*) for generic web traffic, which is the one type of traffic (think *service class*) both roles have in common, a common "Web – Public Safety (50K-100K)" *service* could be used in both roles as depicted by the template tree shown in Figure 9.

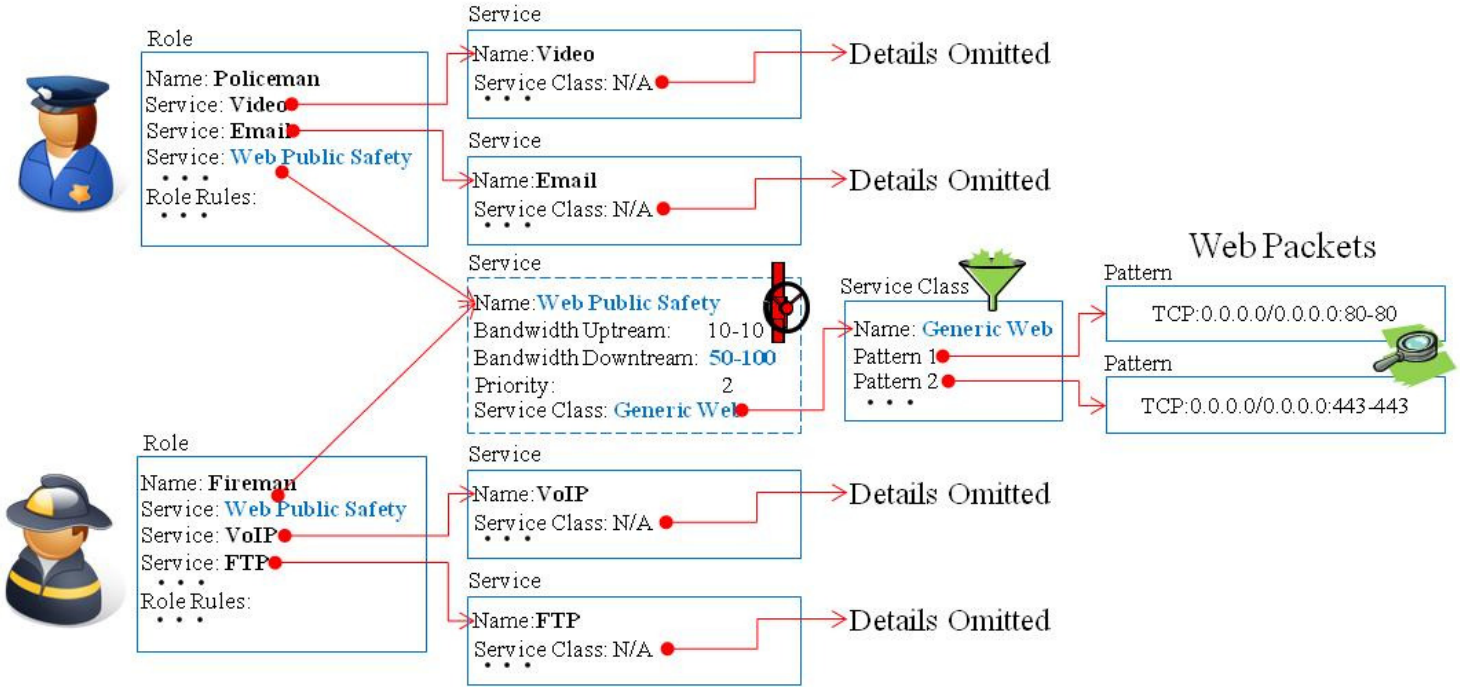


Figure 9. A template tree where distinct roles share an identically provisioned web service

If the organization wanted to provision different web traffic SLAs for firemen and policemen, it could define two distinct services, say "Web – Fire Dept (100K-200K)" and "Web – Police Dept (250K-350K)" and refer to the different web services in the respective user roles as depicted by the template tree shown in Figure 10. In either case, as long as the rule for recognizing web traffic was the same, all the web services could reference the same service class, "Generic Web Traffic – Any Source."

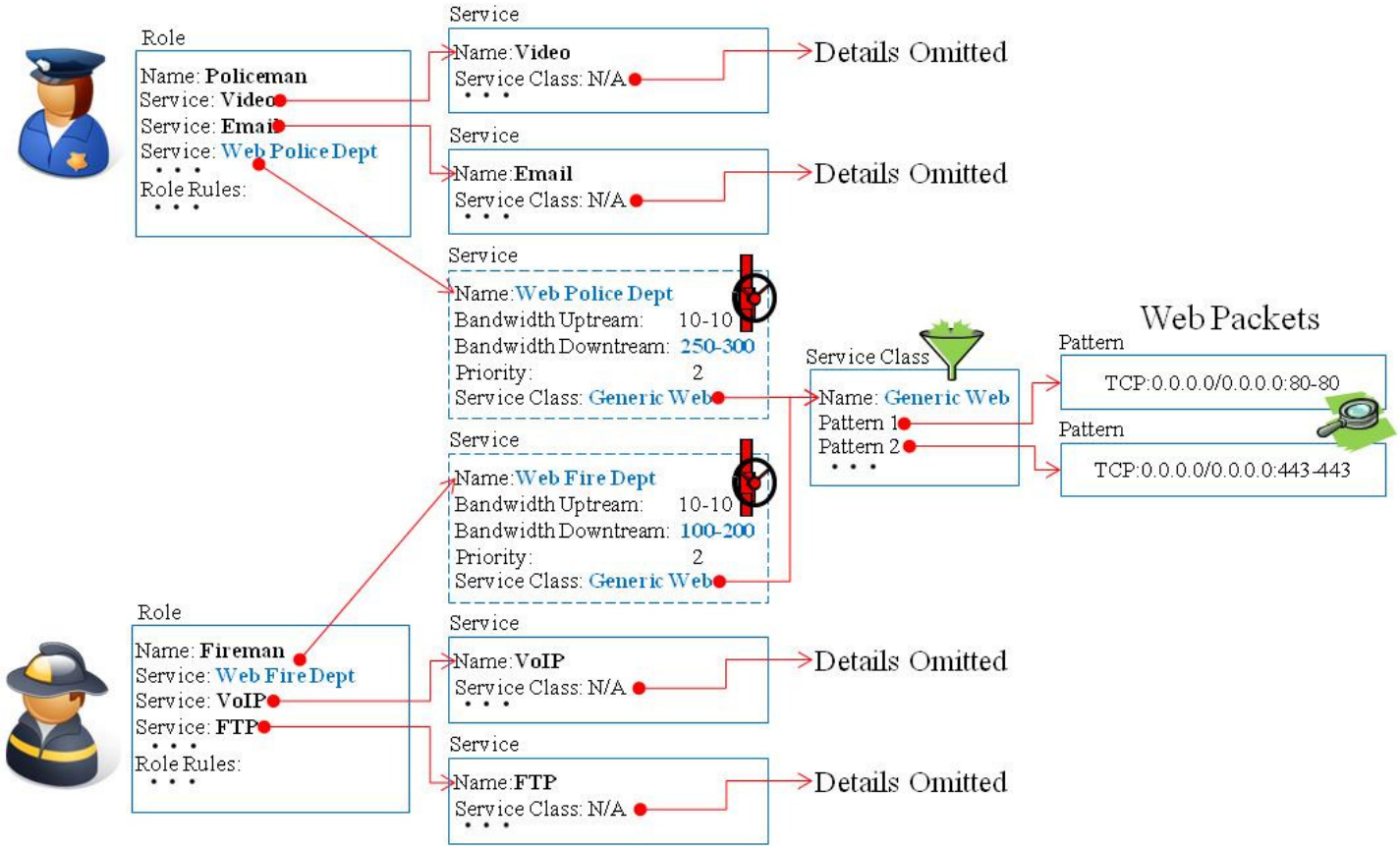


Figure 10. A template tree where distinct roles each have individually provisioned services for identical web traffic flows

If one of the user classes, say "Policeman" needed specially-provisioned access to a specific departmental server, however, it may be more appropriate to use the two distinct web services and also have them reference distinct service classes, too. In this case the "Web – Fire Dept (100K-200K)" service might still reference the "Generic Web Traffic – Any Source" service class, but the "Web – Police Dept (250K-350K)" service might reference a new "Web – Police Server" service class that matches only web traffic to the departmental server as depicted by the template tree shown in Figure 11.

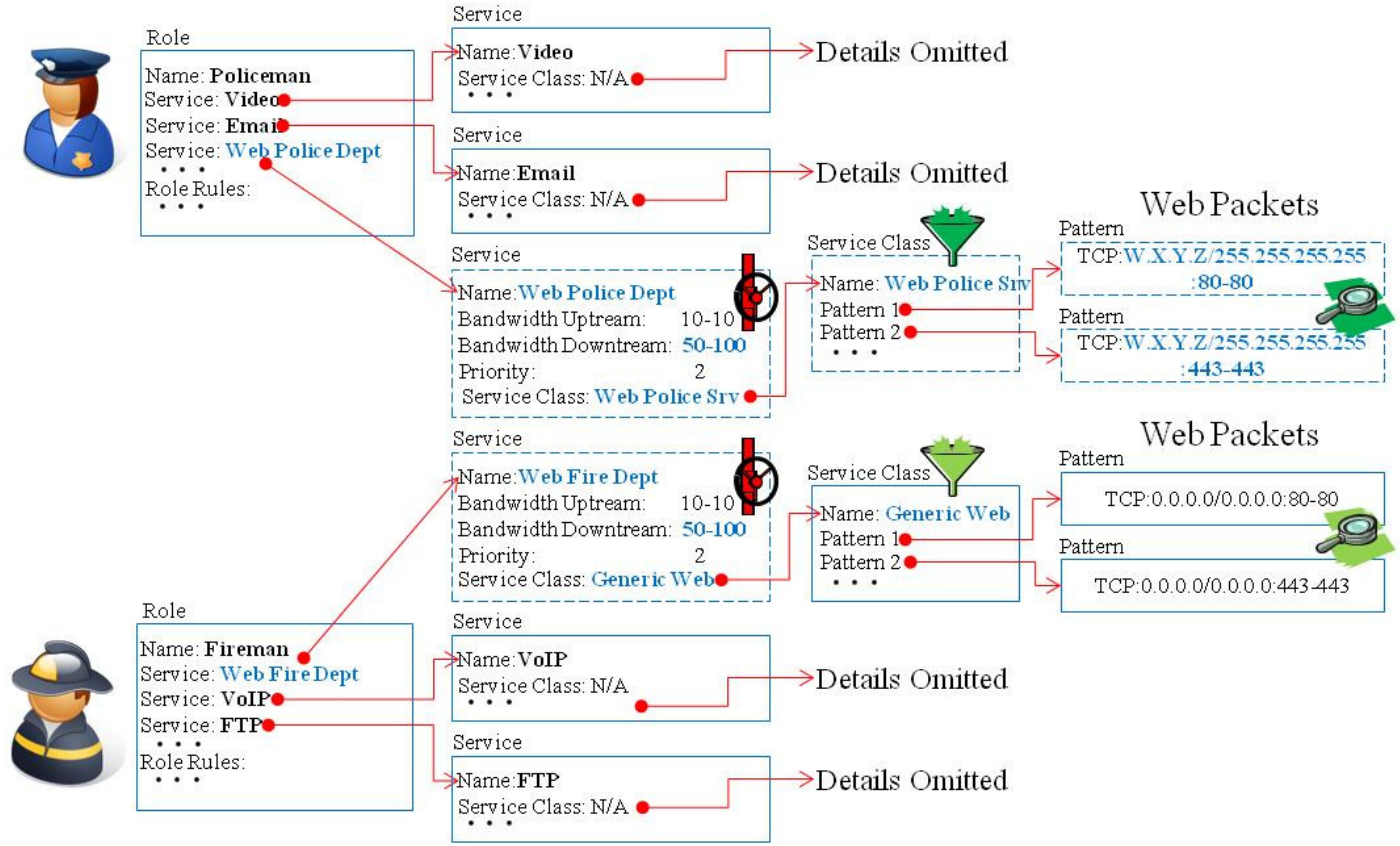


Figure 11. A template tree where distinct roles each have individually provisioned services for different web traffic flows

You could even define two different web services in the "Policeman" role if you wanted to provision, for the policeman user class, internal web traffic to/from the departmental web server independently from other web traffic to/from all other sources as depicted by the template tree shown in Figure 12. There are many possible combinations. The key point is that **AirSync uses service classes, services, and roles to give you reusability when you want it, but flexibility when you need it**.

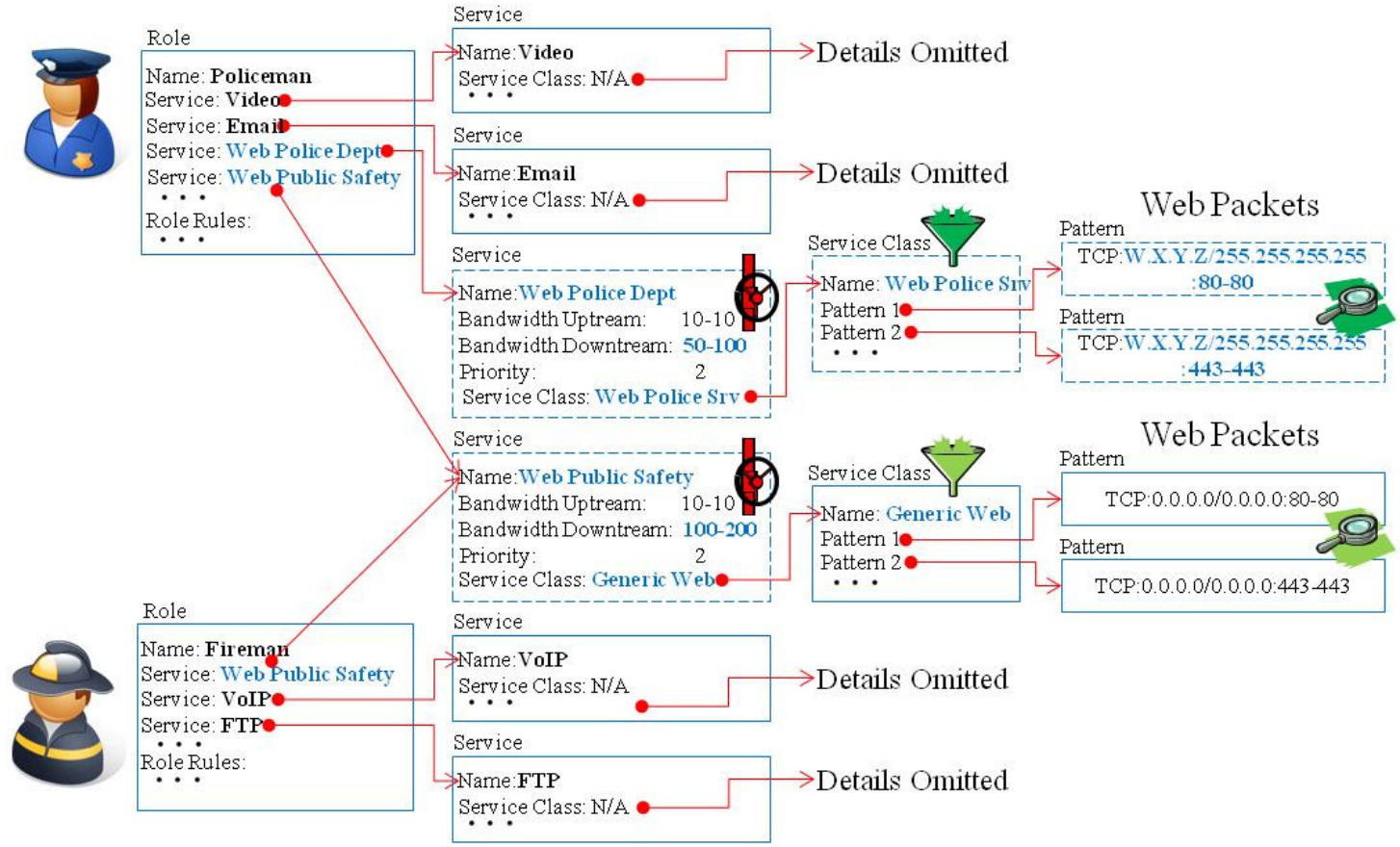


Figure 12. A template tree where one role has multiple individually provisioned services for different web traffic flow

What's in a Naming Convention?

Hint: Notice that the naming convention for services in the examples above, for example, "Web – Policeman (250K-350K)," included traffic type (Web), user class (Policeman) and provisioning information (250K-350K). This can be good and bad. It makes it easy to understand what the services are for, but if you often adjust provisioned bandwidth parameters, you create a maintenance burden of adjusting the service name. If you fail to keep up with the maintenance, the names become misleading.

Devices Personified

Hint: It is perfectly appropriate to **define one or more roles, services and/or service classes for devices as well as users**. For example, a municipal network may include several traffic camera devices that generate traffic. In this case, each camera device functions as a network user (generates traffic).

Step 5: Define *Groups* for Associating *Device Interfaces* with a *Role*

Within AirSync, groups are containers with which you can relate other AirSync objects, such as device interfaces and roles. Groups function as an association or assignment operator and provide a mechanism for efficiently managing a large number of items. In simple terms, **groups associate device interfaces with roles**.

In practice, groups are often created and in a one-to-one relationship to the roles with which they will be associated, for example, a group named "Fireman" that is always associated with a role named "Fireman" - there may also be other naming conventions that make more sense for a given organization. If you assigned several device interfaces to a group called "Mobile Units," you could provision appropriate QoS parameters for the whole set of units in a single operation by assigning the role "Policeman" to the "Mobile Units" group. If you subsequently reassign a different role, say "Fireman" to the group, AirSync will generate new QoS instructions (based on the template tree indexed by the "Fireman" role) and send them to the appropriate units to be implemented.

With respect to provisioning QoS, a group can be referenced or "be pointed to" by zero one or more device interfaces. A group can reference or "point to" zero or one role. The key point for this section is to understand that **a group associates zero or one user role with zero or more device interfaces**. Groups have a few other interesting attributes that will be discussed in more detail later.

Note: you may perform Step 6 and Step 7 below in any order.

Step 6: Assign *Device Interfaces* to *Groups*

A device interface can only be a member of one group, but **a group can have several different device interfaces associated with it**. If a device interface is assigned to the "Fireman" group, that same device interface can't be simultaneously associated with any other group, but the Fireman group can be associated with many device interfaces.

Step 7: Assign *Groups* to *Roles*

A given group can only be associated with one role, but **a role may have more than one group associated with it**. If a group is assigned to the "Fireman" role, that same group can't be simultaneously associated with any other role, but the "Fireman" role can be associated with many groups.

After completing both Step 6 and Step 7, you will then have a template tree structure similar to the one shown in Figure 13. Device Interface "Ath0" on device Mobile 1 (upper left portion of the tree) has been assigned to the "Fireman" group. Notice that device "Mobile 1" has multiple interfaces. Device interface "Ath1" of device "Mobile 1" (upper middle portion of the tree) could be independently assigned to a different group.

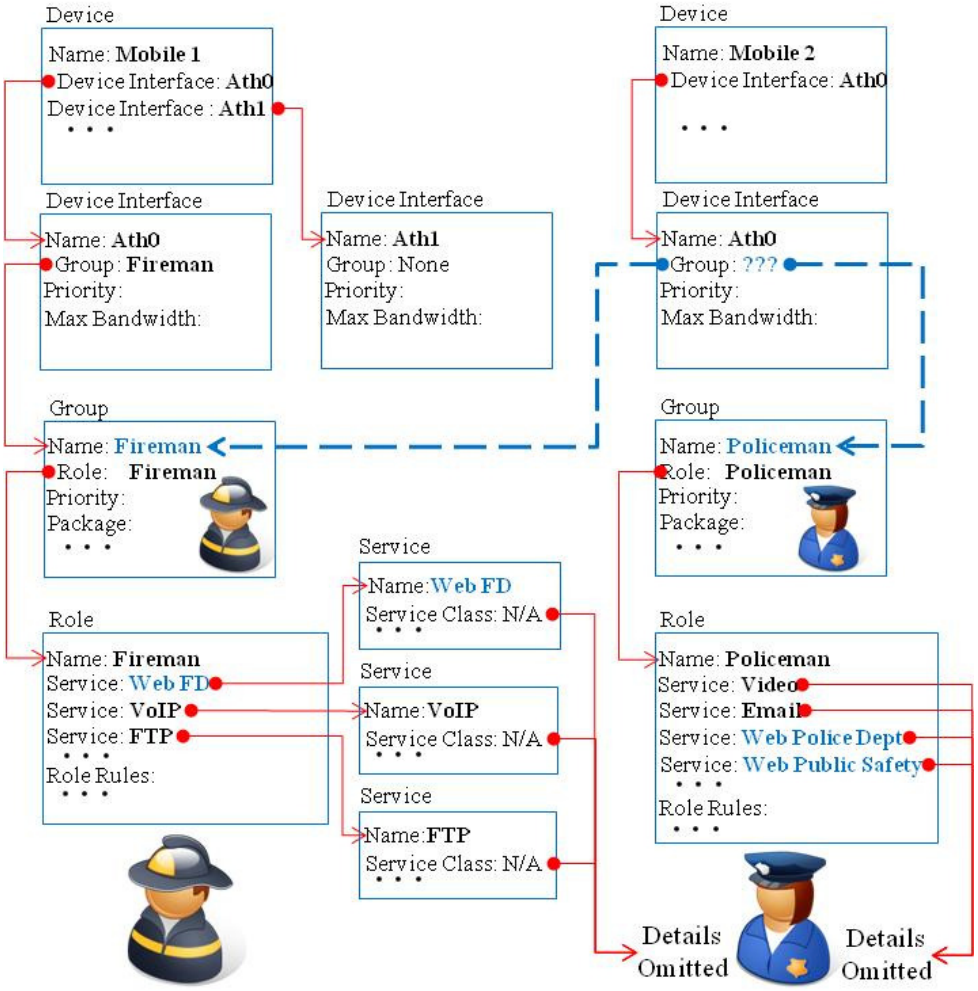


Figure 13. Template Tree structure shows relationship between Device Interfaces, Groups and Roles

Still referring to Figure 13, notice that Device Interface "Ath0" on device Mobile 2 (upper right portion of the tree) has been assigned to group "???", with blue dashed arrows pointing to either the "Fireman" group or the "Policeman" group. This device interface can only point to one group. The arrows represent the one-to-many relationships. There can be only one source (tail-end) for every arrow, but multiple arrows (head-end) can point to a common target object.

Try to visualize how AirSync's behavior would differ if the device interface pointed to one group instead of the other. If this device interface pointed to the Fireman group, AirSync would generate instructions to create three distinct queues (per traffic direction) for this interface - one queue for each of the services defined in the "Fireman" role - whenever it establishes an association with another managed wireless device, for example a radio mounted on a city lamppost. If this device interface pointed to the Policeman group, AirSync would generate instructions to create four distinct queues (per traffic direction) for this interface

Step 8: Use AirSync to Monitor and Adjust Policy Compliance.

The final step involves using AirSync's statistical visualization tools to periodically monitor performance and adjust policy as needed.

Summary

In summary, the human administration process involves:

- Gaining an understanding of network traffic flows and characteristics.
- Defining user needs and organizational priorities.
- Modeling them as business rules (building template trees) in AirSync.
- Monitoring network performance and making adjustments as necessary.

Figure 14 shows the high-level, end-to-end relationship between the AirSync objects used to implement QoS.

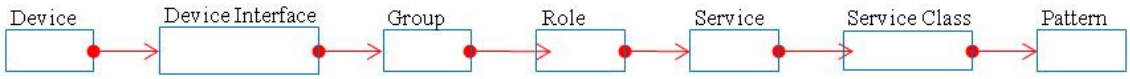


Figure 14. The High-Level Relationship between AirSync objects

An End-to-End QoS Example

The following example assumes that the QoS template tree has been created in accordance with Figure 13. A multi-interface Wi-Fi bridge device has been installed on a municipal lamppost at the corner of Broadway St. and Main St. It has three interfaces. Ath0 is not currently in use, but could function in the future as a wireless backhaul link to city hall. Interface Eth0 is a wired backhaul link to city hall. Interface Ath1 runs in Wi-Fi "access-point" mode, as shown in Figure 15.

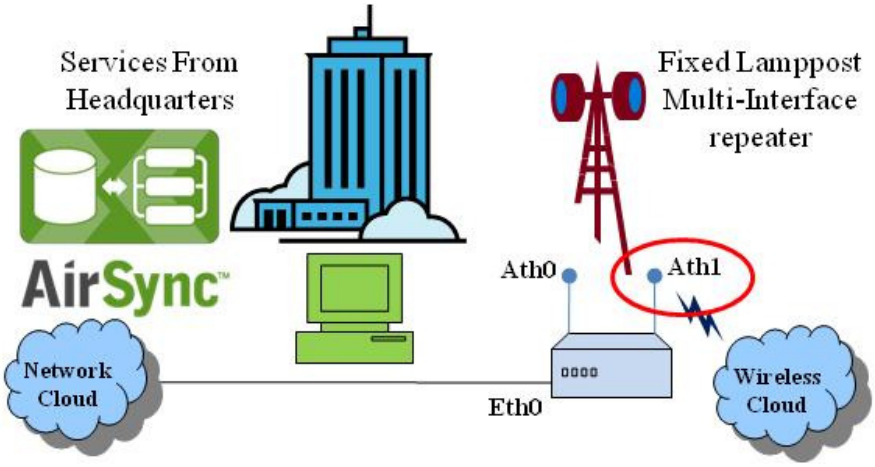


Figure 15. A Municipal Lamppost on Broadway and Main with no Devices Associated

Device "Mobile 1" is mounted in a fire engine. It has three device interfaces: Interface Ath0 runs in Wi-Fi station mode ready to associate with any Wi-Fi access point(s) in range. Interface Ath1 runs in Access Point mode to support any wireless devices (handhelds, or PCs) near the fire engine. Interface Eth0 supports PC devices wired into the fire engine. Interface Ath0 has been assigned to the "Fireman" group which in turn has been assigned to the "Fireman" role as shown in Figure 16.

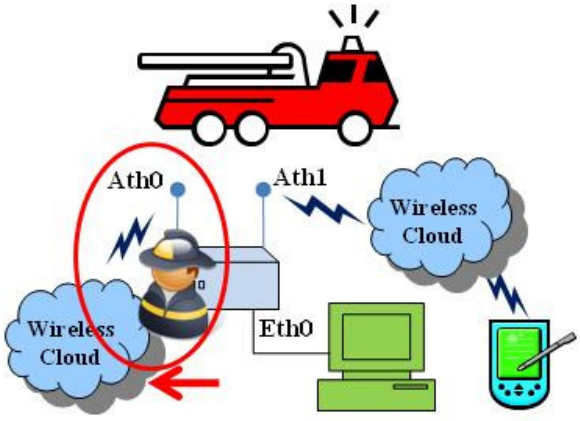


Figure 16. Device Mobile 1 has three interfaces. Ath0 has been assigned to the Fireman Group/Role

Both the lamppost radio at Broadway and Main and the radio mobile 1 mounted in the fire engine have been registered as "managed devices" in AirSync. Assume at first that the fire engine is parked in the station with the radio powered off and that no other units have associated with the lamppost radio. At his point in time, there are no QoS structures (filters, queues) present on either radio device. The AirSync system is monitoring the network waiting for a significant network event to occur.

Now the fire engine leaves the station and proceeds in response to an event near Broadway and Main. The fire engine gets close enough to associate to the lamppost radio at Broadway and Main as shown in Figure 17.

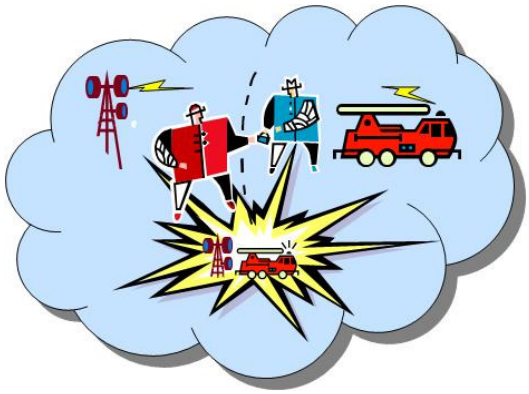


Figure 17. Mobile Device Association with Lamppost Triggers AirSync QOS Mechanisms

Soon after the association event, AirSync detects and reports it as shown in **Figure 18**. It recognizes that the lamppost radio now has a registered device associated with it. It determines by MAC address that device interface "Ath0" on device "Mobile 1" is now associated with device interface "Ath1" on (lamppost) device "Broadway and Main".

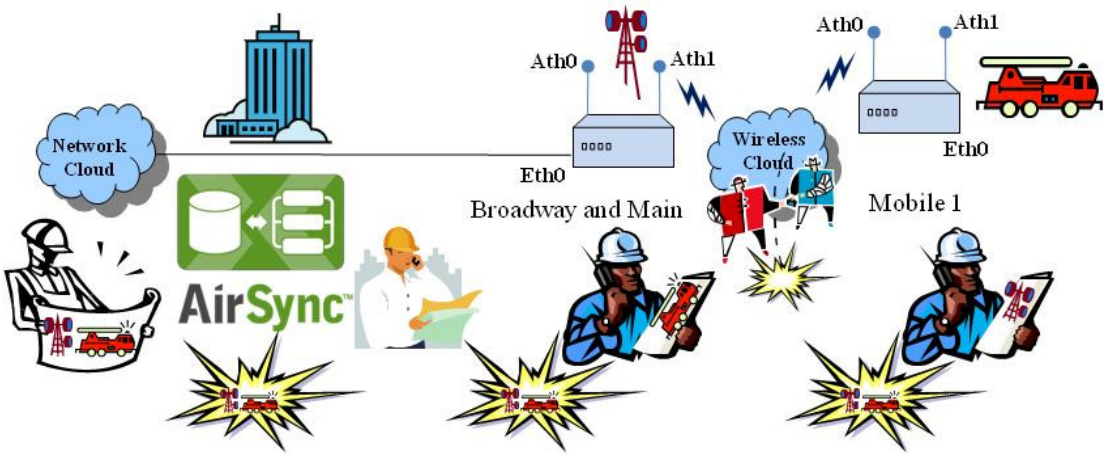


Figure 18. AirSync Monitors Detects and Reports Network Events such as Device Associations

AirSync consults its template tree and determines that interface "Ath0" in device "Mobile 1" is associated with group "Fireman" and that group "Fireman" is associated with role "Fireman." **Prior to generating any QoS instructions, AirSync evaluates the current network conditions**. AirSync considers many factors including whether any other devices are associated to the lamppost at Broadway and Main, what roles are assigned to other associated devices, link quality, modulation rate. AirSync computes bandwidth allocation parameters **starting from the values stored in the templates, but modified as appropriate due to current network conditions**.

AirSync generates a set of QoS instructions for building queues, based on the QoS parameters retrieved from the Web, VoIP, and FTP services defined for the role "Fireman," but adjusted for the current state of the network. AirSync also includes instructions for building the appropriate packet filters (patterns) for recognizing each type of traffic flow (service class), as shown in **Figure 19**.

Figure 19. AirSync generates instructions based on templates, network conditions, roles of devices

The AirSync server sends instructions to agents on the lamppost radio, as well as to agents on the mobile unit as shown in **Figure 20**.

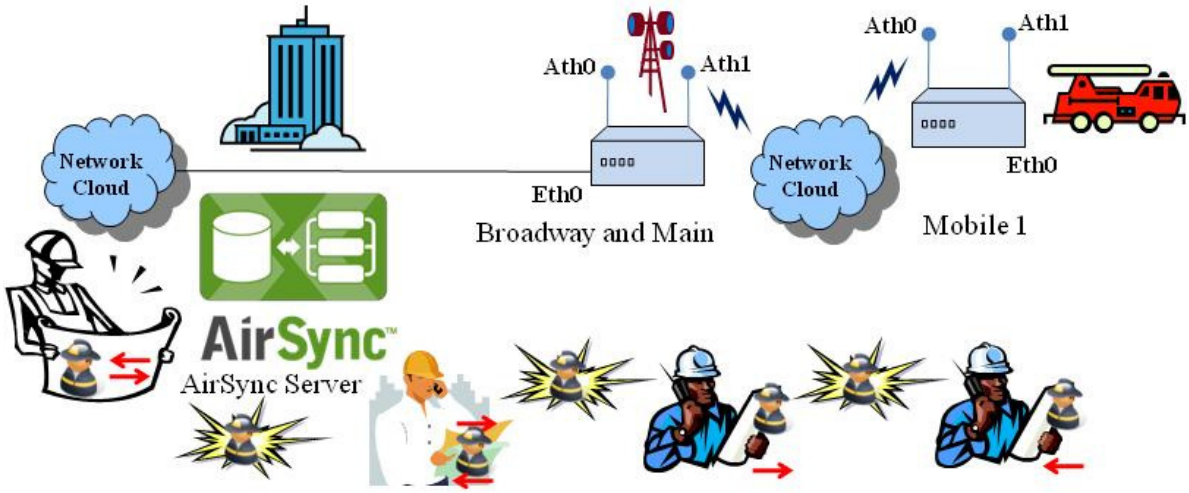


Figure 20. The AirSync server communicates QoS instructions to agents on managed devices

Agents on the managed devices receive the instructions and implement appropriate packet filters and queues for upstream and downstream interfaces, based on the roles of the associated devices and the network conditions at the time of association.

As shown in **Figure 21**, the agents on **the lamppost device will build downstream shaping rules** for egress (outgoing traffic) interface Ath1 based on the downstream QoS parameters defined for each service referenced by the role "Fireman" (Web, VoIP, FTP), and the patterns in the service classes referenced by each service (one queue and one set of packet filters for each service). The agents on **the mobile device will build upstream shaping rules** (packet filters and queues) for egress interface Ath0 based on the upstream QoS parameters and the same pattern definitions.

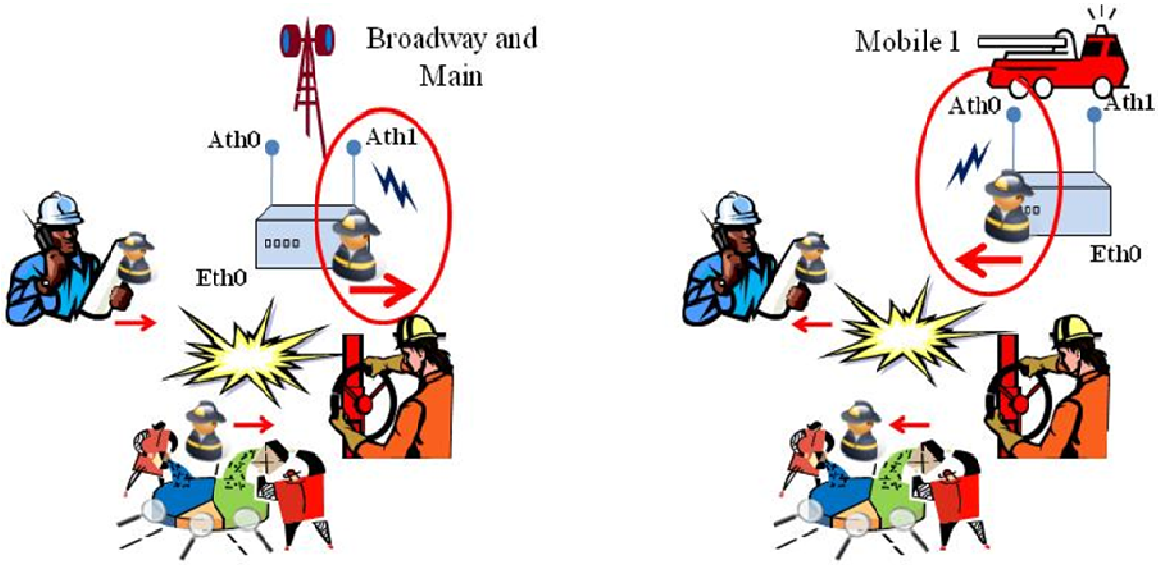


Figure 21. AirSync client agents implement packet filters and queues according to instructions

As other devices establish and tear down radio associations with the lamppost device, AirSync will again follow the bandwidth allocation/arbitration process shown previously in **Figure 19. AirSync generates instructions based on templates, network conditions, roles of devices**, the stored business rules (SLAs) but may make adjustments if necessary, for instance if the network is undersubscribed (there is excess uncommitted bandwidth after all the minimum SLAs have been satisfied) or oversubscribed (too many devices have associated and AirSync cannot meet the minimum SLAs).

AirSync's QoS / bandwidth allocation algorithms have some interesting implications:

- Note that the templates stored on the server do not consume or allocate any bandwidth so **no bandwidth is statically allocated or "nailed-up"**. The templates are just blueprints representing the organization's network usage / QoS policy.

- Bandwidth is allocated dynamically, based on user role, and current network conditions, in near real-time but only after a device association occurs.
- When the device association ends, the bandwidth allocation commitments are returned to the pool of available bandwidth and AirSync reconsiders how to allocate it, and any other available bandwidth, between devices that are still associated with the lamppost radio.

- As a result, AirSync provides built in QoS support for roaming mobile devices. QoS rules or instructions will follow a mobile device around the network as it changes its associations between various intermediate access point devices.

The AirSync Bandwidth Allocation Process

You can think of a service level agreement (SLA) as a commitment or a promise to deliver at least the specified minimum amount of bandwidth to the AirSync *service class* object associated with the *service* object that defines the particular SLA.

Note that the SLA commitment applies to the entire *service class* in the aggregate (a set of traffic flows), not to each individual traffic flow within it. For example, consider the "Web Public Safety" service provisioned with 100-200 kBps of downstream bandwidth in Figure 12 on page 113. A user could start zero, one or many simultaneous web sessions that match the patterns of the associated service class. The SLA applies to the service class as a whole, not to each individual web session.

At any point in time, depending on instantaneous user load, the network either has enough bandwidth available to satisfy the sum of promised bandwidth allocations in the set of all relevant SLAs (*services*) or it doesn't. This section explains how AirSync intelligently manages bandwidth allocation in either case, and how to control AirSync's bandwidth allocation mechanism in accordance with an organization's network usage policy.

Understanding the Bandwidth Allocation Range

Services are provisioned with a range of bandwidth such as 100-200 kBps, in each direction and a priority for the service. To simplify this discussion we will consider only the downstream direction for now. Also since AirSync provisions bandwidth in terms of **Kilobytes per second (kBps)**, assume kBps as the unit of measure whenever units are omitted.

The first part of the bandwidth range determines SLA compliance. In the example above, 100 represents a *minimum* bandwidth guarantee. The system meets the SLA when it can successfully allocate this minimum bandwidth level to the traffic in the *service class* associated with the *service* defining the SLA. The system fails to meet the SLA when it fails to allocate at least this coefficient of bandwidth

The second part of the bandwidth range controls the allocation of excess bandwidth. This enables the traffic in a service class to burst a controlled amount above its provisioned minimum bandwidth allocation. In the example above, 200 represents a maximum boundary on bandwidth allocation for the service. When excess bandwidth is available, it may be allocated to traffic in the service class allowing it to burst only up to this specified value. **This value serves as a cap that limits the excess bandwidth allocated to a service** such that if excess bandwidth still remains after meeting this cap, it will be made available to other services, in effect controlling the relative degree that traffic flows in different service classes will be able to burst above the minimum SLA values.

Consider the total guaranteed downstream bandwidth, for a given access point or base station device interface, to be the sum of all minimum bandwidth commitments in the relevant SLAs for all connected subscriber station (or CPE device) interfaces. More specifically, it's the sum of the minimum bandwidth values defined in each *service* template defined in each *role* template (if any) assigned to each remotely connected subscriber/CPE device interface.

The Three Bandwidth Allocation Cases

There are three possible cases when attempting to allocate bandwidth. In two of the cases it is possible to meet SLAs, in one of them it is not:

- **Demand is less than capacity**. It is possible to satisfy all SLAs. The network is undersubscribed. There is excess bandwidth available to allocate to traffic flows allowing them to burst above their minimum provisioned SLAs. Bandwidth can be freely dispensed, according to the user-defined rules.
- **Demand is equal to capacity**. It is possible to satisfy all SLAs. The network is fully subscribed. There is no additional bandwidth available to allow traffic flows to burst above their minimum provisioned SLAs. This is a rare case and not very interesting in terms of intelligent bandwidth allocation.
- **Demand is greater than capacity**. It is impossible to satisfy all SLAs. The network is oversubscribed. How should the insufficient bandwidth capacity be allocated? **Which SLAs should be honored? Which should not?** This state is called Service Level Degradation (SLD), because AirSync must resolve which of the SLAs it will meet and which it will not. AirSync has an SLD algorithm that performs this arbitration on a priority basis. When it's impossible to meet all relevant SLAs, AirSync's algorithm ensures that service degrades in an orderly rules-based fashion consistent with organizationally defined priorities.

Understanding Link Capacity

AirSync must know the capacity of a given link before it can determine which of the three bandwidth allocation cases above applies. AirSync determines how to allocate bandwidth based on the relationship between current link capacity and current demand. AirSync has an embedded bandwidth estimator that will attempt to dynamically discover the approximate bandwidth capacity of a link, or alternatively, a system administrator can statically set the maximum bandwidth capacity for the link.

Understanding How Priorities affect Bandwidth Allocation

AirSync uses a priority system to allocate excess bandwidth when the network is either undersubscribed or over-subscribed. Priorities range in value between 1 (most preferred) and 7 (least preferred). In the AirSync GUI, priorities can be set in multiple objects:

- Each service can have a priority assigned to it. **The priority values set for *services* govern how excess bandwidth is allocated** during periods of network under-subscription.
- Each group can have a priority assigned to it. **The priority values set for *groups* govern how insufficient bandwidth resources get allocated** during periods of network over-subscription.

Service Level Degradation (SLD) – Unable to Honor Minimum SLAs

In this example scenario, we will examine how AirSync allocates bandwidth in situations when there is not enough bandwidth to satisfy all SLA for all the relevant services provisioned for a particular device interface. Consider the topology in Figure 22 and the data in Table 3. The link has a capacity of 1000 kBps.

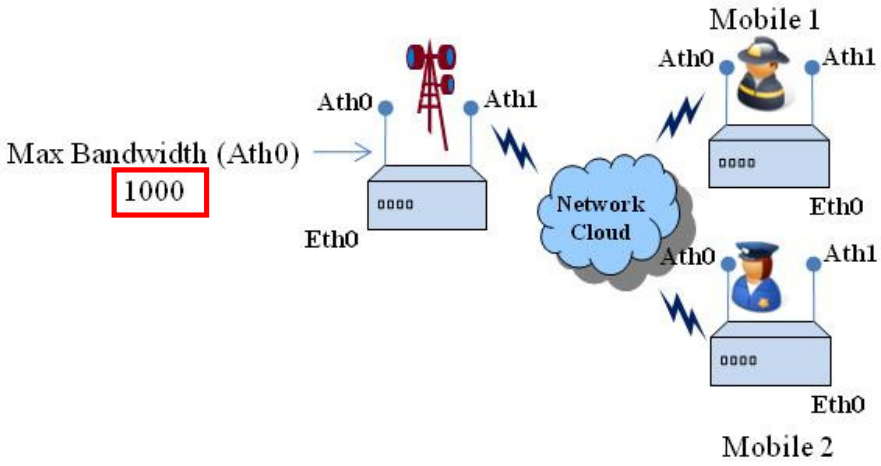


Figure 22. A bandwidth allocation example with SLD

Minimum Link Bandwidth 1000 kBps						
Group (ath0)	Group Priority	Role (ath0)	Service	Service Priority	Min BW	Max BW
1	1	1	App A	2	200	300
			App B	3	300	500
			App C	5	400	450
2	2	2	App D	1	500	800
			App E	4	100	300
			App F	6	50	250

Table 3. Bandwidth characteristics for SLD example

A police department unit and a fire department unit have associated with the lamppost's ath1 interface. Reviewing Table 3, notice that each mobile unit's ath0 interface (which have associated with the lamppost's ath1 interface) has been assigned to a distinct group with a distinct role. Each group has a distinct group priority and each role has three distinctly provisioned services. Each service has a distinct service priority.

AirSync consults its templates and retrieves the QoS parameters in an attempt to generate QoS instructions. By summing the minimum bandwidth requested for each instance of each service, AirSync determines that demand exceeds capacity. As summarized in Table 4, there will not be enough bandwidth to meet all SLAs. AirSync must invoke its SLD algorithm to arbitrate bandwidth allocation.

Service	Prio-g	Prio-s	Min	Max	Spread
App A	1	2	200	300	100
App B	1	3	300	500	200
App C	1	5	400	450	50
App D	2	1	500	800	300
App E	2	4	100	300	200
App F	2	6	50	250	200
Totals			1550	2600	1050

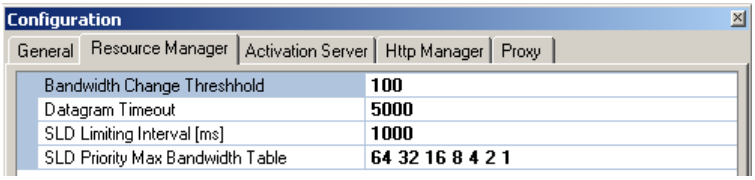
1000	Max BW
0	Excess BW
550	Shortage BW

Table 4. Summary of Bandwidth Allocation Characteristics

Note that by design, the AirSync SLD algorithm is not a strict priority-based queuing algorithm. In strict priority-based algorithms, no lower priority services (for example, those with group priority 2) would get any bandwidth allocated until all the higher priority services (those with group priority 1) have been allocated their minimum bandwidth allocations. In these schemes, less important flows may be subject to queue starvation and receive zero bandwidth.

In contrast, the AirSync algorithm protects lower priority services from queue starvation, but heavily weights the allocation in favor of the higher priority services. The net result is that the high priority services get the lion's share of what they need to meet SLAs, but lower priority services still get a measure of bandwidth, as well.

AirSync retrieves the parameter **SLD Priority Max Bandwidth Table** from the database. (This value is a use-adjustable configuration item available from the **Resource Manager** tab of the **System Configuration** item available from the **Tools** menu as shown in Screen Capture 121.) This string represents the relative weighting assigned to each group priority level by the SLD algorithm. We recommend that you leave it at its default value, 64 32 16 8 4 2 1, until you become familiar with SLD behavior.



Screen Capture 121. The SLD priority weighting table

Without getting into all of the details of the SLD algorithm, suffice it to say that AirSync relies on group priority to arbitrate bandwidth allocation during periods of network oversubscription. It orders the relevant services by group priority and multiplies each minimum allocation value (retrieved from the templates in the database) by the appropriate weighting factor for that group's priority. After a few minor adjustments, it performs a linear scaling operation to finalize the QoS instructions that it generates and sends to the affected device(s). The results are shown in Table 5 and charted in Figure 23.

Service	Prio-g	Prio-s	Min	Max	Spread	Multiplier	SLA pct	Burst	adm 4
App A	1	2	200	300	100	64	83.00%	0	166
App B	1	3	300	500	200	64	81.33%	0	244
App C	1	5	400	450	50	64	81.50%	0	326
App D	2	1	500	800	300	32	40.80%	0	204
App E	2	4	100	300	200	32	40.00%	0	40
App F	2	6	50	250	200	32	40.00%	0	20
Totals			1550	2600	1050		64.52%		1000

Table 5. Bandwidth Allocation after SLD algorithm

Note in Table 5 and Figure 23 that none of the services had its SLA totally satisfied, but that it has been satisfied between 81.5 and 83 percent for the services with a group priority 1 and between 40 - and it satisfied 40.8 percent for services with group priority 2. Note that true to the weighting values (64 and 32), services in group priority 1 got about twice the percentage of their SLAs met (~80, ~40).

AirSync service classes have attributes called Minimum Uplink Bandwidth and Minimum Downlink Bandwidth described on page 136 and shown in Screen Capture 124. By setting values for these attributes, AirSync will avoid allocating any bandwidth whatsoever if the value specified here cannot be allocated. This allows higher priority services to pass bandwidth to other services if this specified value cannot be achieved during SLD.

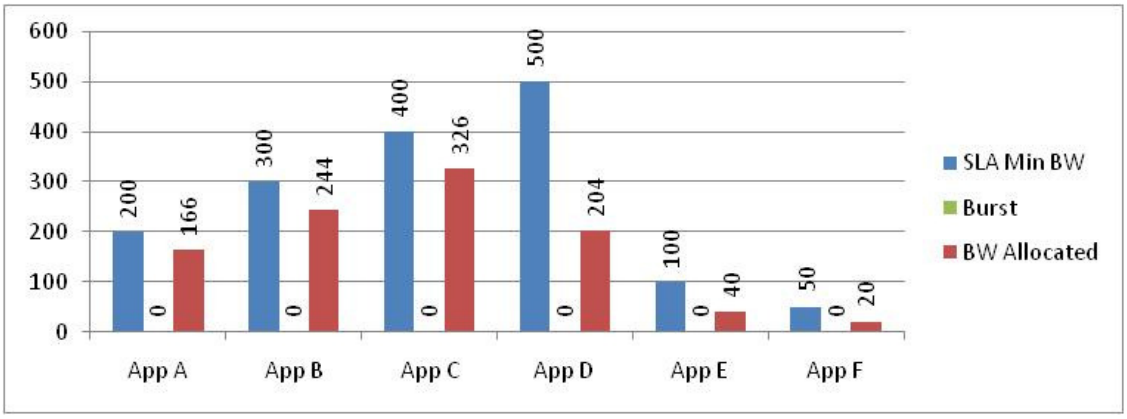


Figure 23. Final Arbitration of Bandwidth Allocation after SLD algorithm

Allocation of Extra Bandwidth After Honoring Minimum SLAs

In the next example scenario, we will examine how AirSync allocates bandwidth in situations when extra bandwidth remains available after satisfying all minimum SLAs for all the relevant services provisioned for a particular device interface. Consider the topology in Figure 24 and the data in Table 6. Link capacity has doubled to 2000 kBps.

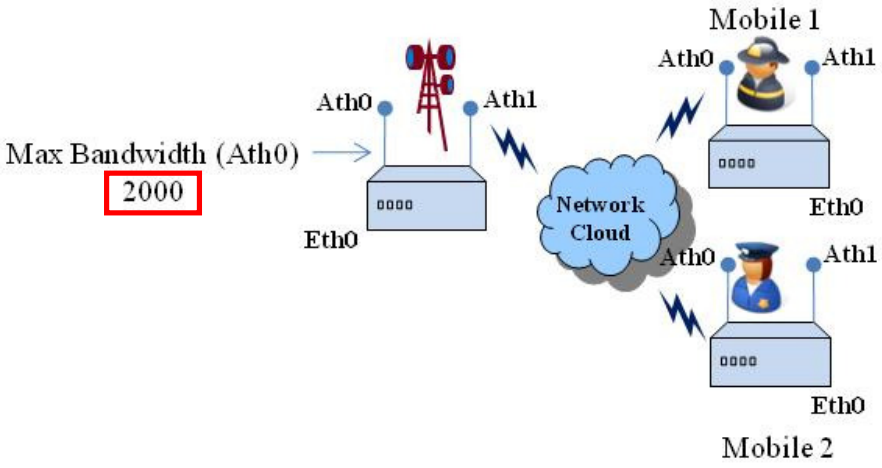


Figure 24. A bandwidth allocation example with excess bandwidth available for bursting

Minimum Link Bandwidth 2000 kBps						
Group (ath0)	Group Priority	Role (ath0)	Service	Service Priority	Min BW	Max BW
1	1	1	App A	2	200	300
			App B	3	300	500
			App C	5	400	450
2	2	2	App D	1	500	800
			App E	4	100	300
			App F	6	50	250

Table 6. Bandwidth characteristics for SLD example

AirSync consults its templates and retrieves the QoS parameters in an attempt to generate QoS instructions. By summing the minimum bandwidth requested for each instance of each service, AirSync determines that capacity exceeds demand. There will be extra bandwidth available to allow some services to get an additional burst of bandwidth capacity.

AirSync uses the service priority to determine how to allocate this excess bandwidth. The services are sorted by their service priorities and then extra bandwidth is allocated to each service in order until all the excess bandwidth has been allocated or the maximum bandwidth value for the service (the higher number in the bandwidth range) has been reached. Table 7 summarizes the results charted in Figure 25.

Service	Prio-g	Prio-s	Min	Max	Spread	Multiplier	SLA pct	Burst	adm 4
App D	2	1	500	800	300	32	100.00%	300	800
App A	1	2	200	300	100	64	100.00%	100	300
App B	1	3	300	500	200	64	100.00%	50	350
App E	2	4	100	300	200	32	100.00%	0	100
App C	1	5	400	450	50	64	100.00%	0	400
App F	2	6	50	250	200	32	100.00%	0	50
Totals			1550	2600	1050		100.00%		2000

Table 7. Bandwidth allocation with excess available bandwidth for bursting

Notice that App D, and App A (service priority 1 and 2) were allowed to burst up to their maximum configured values. App B (service priority 3) was allowed to burst, but only by 50 kBps because that exhausted all excess bandwidth. None of the apps with lower service priorities (App E, priority 4; App C, priority 5; App F, priority 6) got any extra burst capacity.

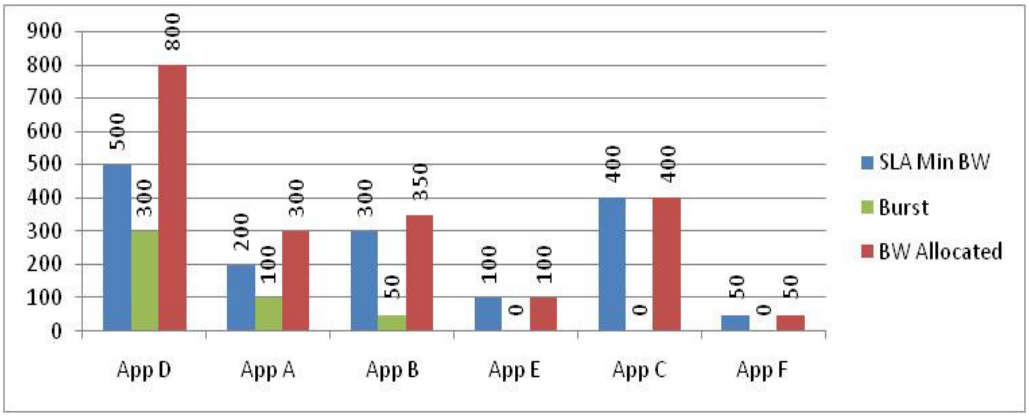


Figure 25. Final Bandwidth allocation with excess available bandwidth for bursting

How does AirSync handle resolution between items with identical priority

AirSync uses an internal heuristic to order service items, for example by order of MAC address (of the associated interface) or by the order in which connections were established. For practical purposes, this tie breaking mechanism should be considered non-deterministic. If it's really important, try to manipulate the priority assignments such that there could never be a tie.

The Default Queue and the Management Queue

What happens to traffic flows that do not match any specific pattern and therefore do not get any specifically provisioned bandwidth? AirSync maintains a default queue for all traffic flows that don't match any service class. These flows can still traverse the network, but without any specifically provisioned bandwidth guarantees. AirSync also maintains a special queue for its own internal management traffic so system administrators won't need to worry about the provisioning details for AirSync management traffic between nodes.

Understanding AdHoc Rules

AdHoc Rules allow an administrator to specify certain "trigger conditions" that will cause AirSync to manipulate QoS settings on the fly, based on network events such as topology changes and signal changes. In near real time, and without human intervention, they conditionally modify the basic SLAs defined in services. These rules are defined as part of the AirSync **Role** object. The user interface details for working with AdHoc Rules are discussed in the section beginning on page 149.

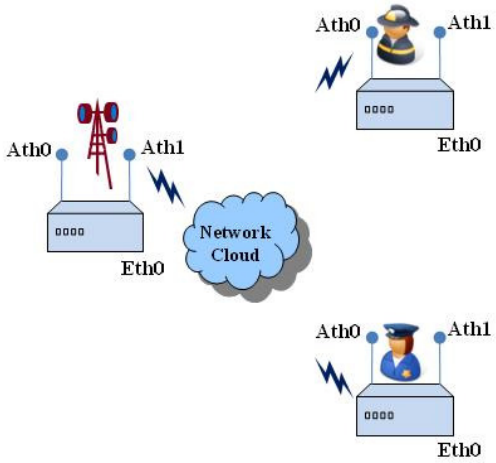
- AdHoc Rules can automatically be triggered in response to the following stimulus events:

- Network Topology changes as indicated by changes in the number of stations associated with a device.
- Signal degradation or improvement as indicated by changes in the bit rate or modulation scheme used over a link.

- AdHoc Rules can select which services to modify based on:
  - The role assigned to one or more device interfaces
  - The bit rate (modulation scheme) reported by one or more devices

- AdHoc Rules can modify the parameters of one or more services by:
  - Disabling one or more services while the trigger condition is true
  - Increasing or decreasing the bandwidth allocation in either direction for one or more services
  - Increasing or decreasing the priority for one or more services

Consider the following example. Initially two mobile devices have associated to a fixed lamppost access point unit. One unit has been assigned the Fireman role, the other has been assigned the Policeman role. The Fireman and Policeman Roles each have three services provisioned as indicated in Figure 26.

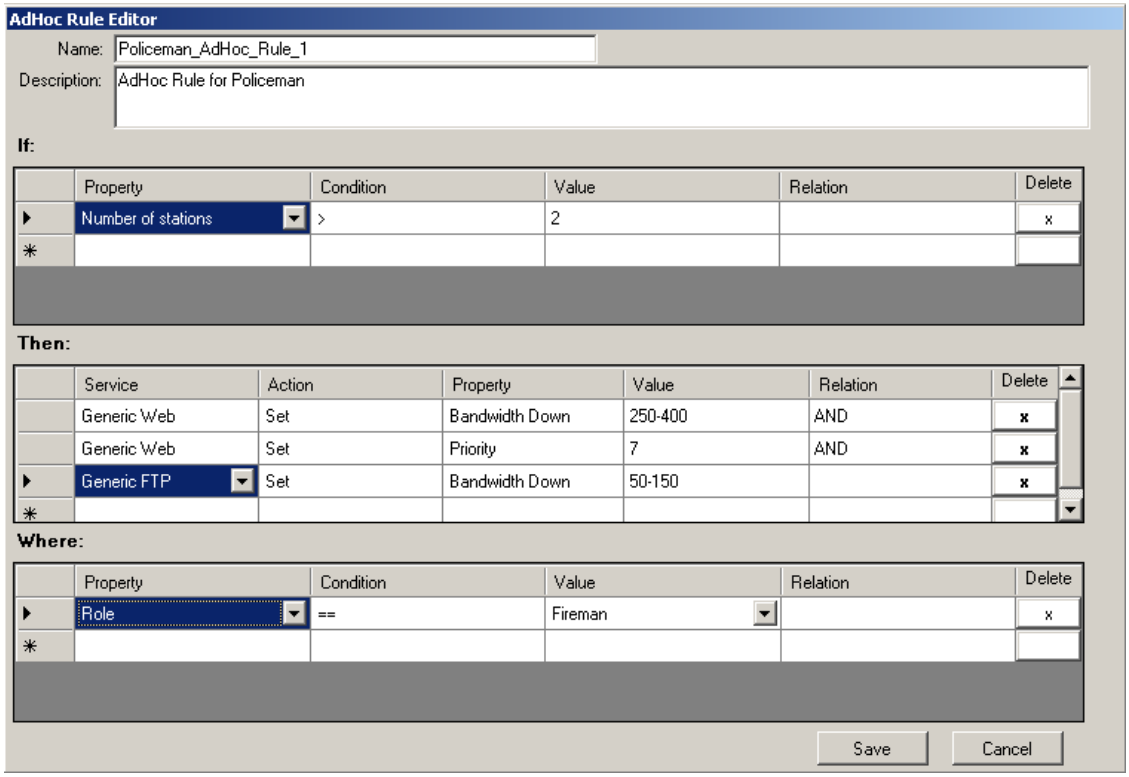


Service	Web	VoIP	FTP
BW Up	50-80	20-20	10-30
BW Down	500-800	20-20	100-300
Priority	1	4	6

Service	Web	Video	Email
BW Up	40-45	30-50	20-30
BW Down	400-450	300-500	200-300
Priority	5	3	2

Figure 26. A simple scenario before an event triggers AdHoc Rule

A simple AdHoc Rule has been created for the Policeman role as shown in Screen Capture 122. The rule states that whenever there are more than two stations associated to the lamppost, and at least one of the connected stations has the Policeman role (implied because this rule is part of Policeman role), adjust the parameters for stations in the Fireman role. More specifically, cut the downstream rate for web from 500-800 to 250-400, change the priority from 1 to 7, and cut the downstream rate for ftp from 100-300 to 50-150.



Screen Capture 122. A Simple AdHoc Rule for the Policeman role affects services for the Fireman role

Now a third mobile device, which has also been assigned the Fireman role, forms an association to the same lamppost access point. This association event triggers AirSync to regenerate new QoS instructions. The association event triggers the AdHoc condition (number of stations > 2) for the rule on the Policeman. The QoS instructions are modified as described above to give a bias to the Policeman unit, consistent with organizational policy. The Fireman units effectively split bandwidth between themselves without affecting the Policeman unit as shown in Figure 27.

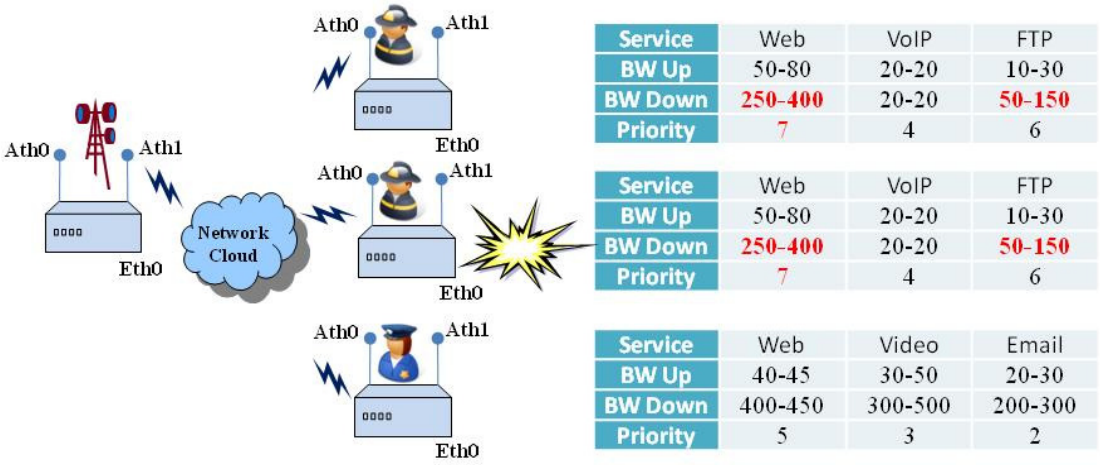


Figure 27. Event triggers AdHoc Rule on Policeman role to change services for Fireman Role

When the Policeman unit disassociates, the two firemen get their original provisioned values as shown in Figure 28.

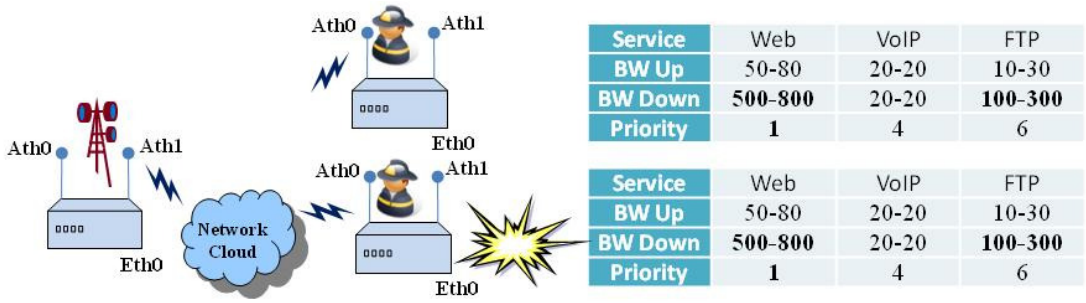
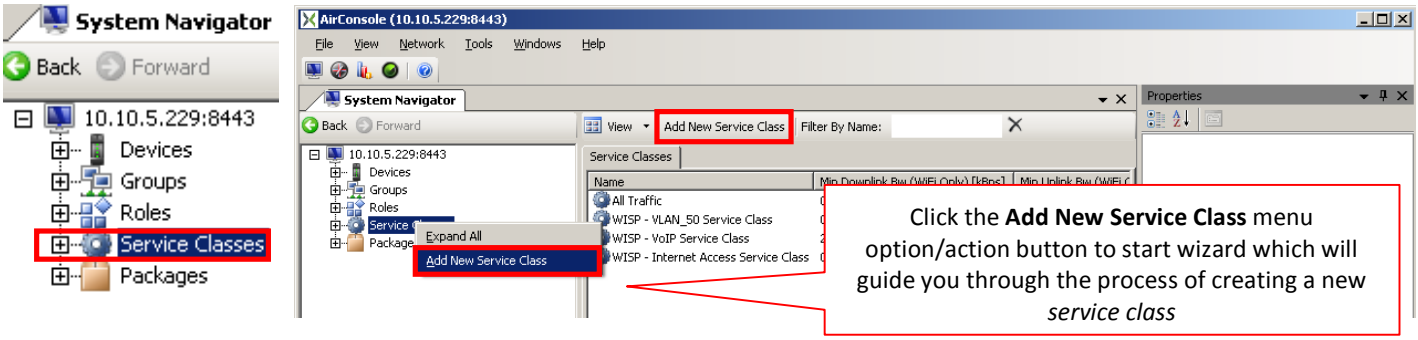


Figure 28. Police unit disassociates, AdHoc Rule no longer applies, Fireman services restored

The GUI Mechanics of Implementing QoS

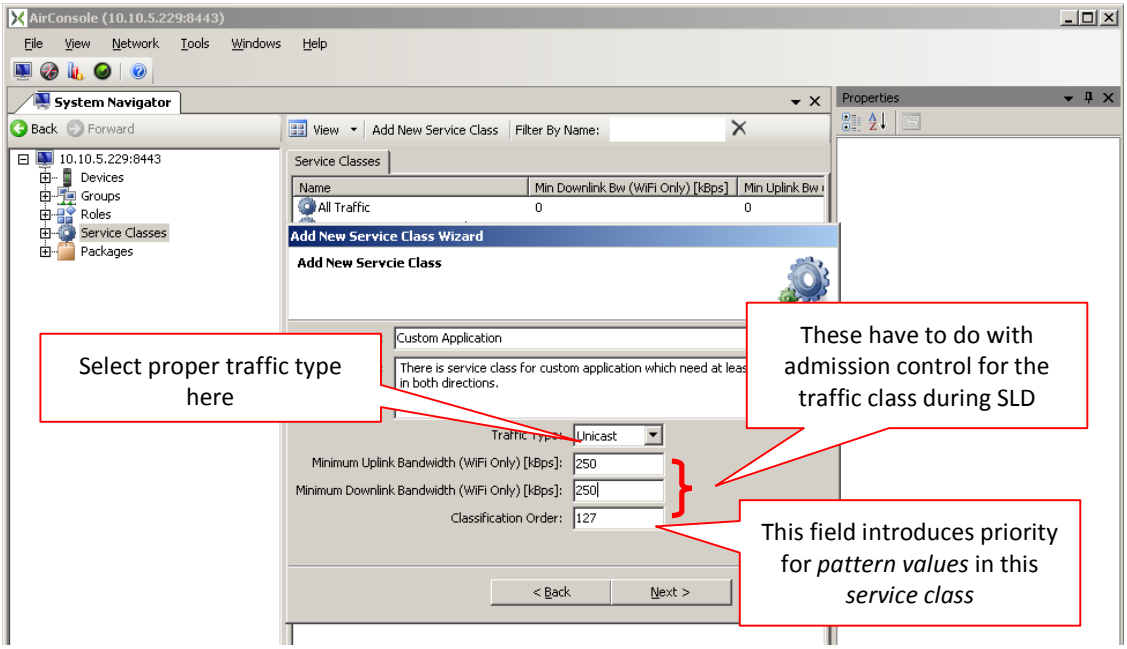
Working with Service Classes

Service classes are discussed starting on page 105. To add, edit or delete a service class select the **Service Classes** item from the **System Navigator** tree as shown in Screen Capture 123.



Screen Capture 123. Running the Add New Service Class Wizard

Clicking the **Add New Service Class** context menu option/action button runs the **Add New Service Class Wizard** as shown in Screen Capture 124. An example of adding a service class for a custom application follows.



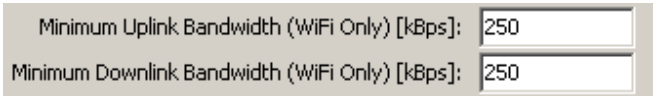
Screen Capture 124. Adding a Service Class

Traffic Types

You must select whether service class which is being added has unicast or multicast traffic type. This information is needed to enable you possibility of defining proper pattern values for selected traffic type.

The Minimum Uplink Bandwidth and Minimum Downlink Bandwidth attributes

For each service class, you can specify optional values for the Minimum Uplink Bandwidth and/or the Minimum Downlink Bandwidth attributes. **These values provide a type of traffic admission control or conditional bandwidth allocation functionality** for the traffic class based on minimum bandwidth requirements, if specified, for either direction.



Screen Capture 125. The Minimum Up/Down Bandwidth attributes

For example, assume that you have a special application that needs at least 250 kBps in both directions to run effectively. Then, application performance begins to degrade to the point where users no longer consider using the application if it can't get at least this minimum amount of bandwidth in both directions. **Setting these values causes AirSync to conditionally generate QoS instructions** such that anytime it can't meet the minimum specified values (250 kBps downstream, 250 kBps upstream), it won't allocate any bandwidth for the class, even a compromised amount. Instead, the bandwidth will be made available for allocation to other traffic classes that can use it effectively, rather than wasting the bandwidth by allocating an insufficient amount that would only result in unacceptable application performance for the original application.

Assume that due to currently-congested network conditions, AirSync only has 175 kBps of uncommitted bandwidth left to allocate. Instead of allocating an insufficient amount of bandwidth (only 175 kBps of the 250 kBps required), the system will refrain from allocating any bandwidth to an instance of this service class and instead keep it for allocation to instances of other traffic classes. When the congestion conditions improve to the point where AirSync could allocate the minimum specified values, it would allocate the bandwidth as normal.

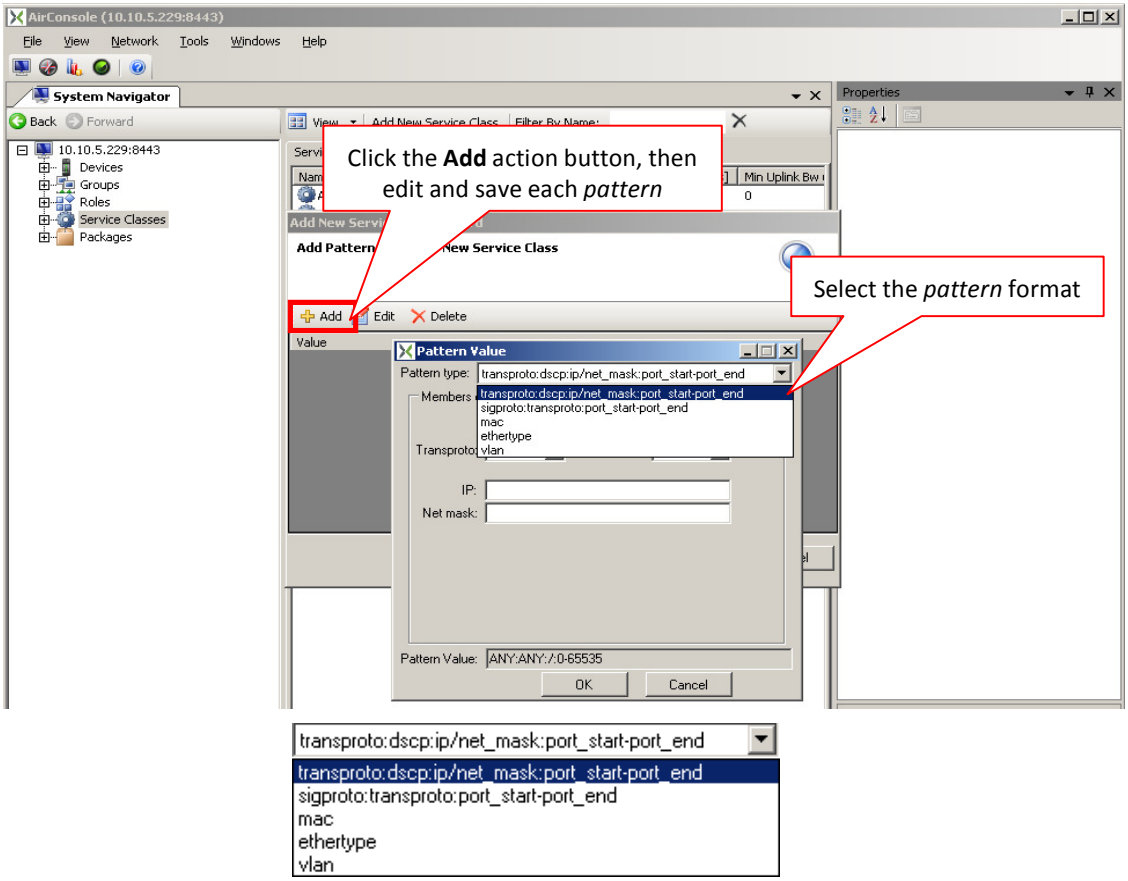
Note that although these *service class* attributes are related to bandwidth allocation, they are not the primary controls for specifying bandwidth allocation parameters. The primary bandwidth allocation controls are the attributes available for each *service* (review page 106).

Classification Order

Classification Order introduces priority for all patterns in this service class. This value is delivered to an AirSync Agent on a device together with patterns applied in services. The priority allows for ordered (from higher priority – which is 0, to lowest priority – which is 255) analyze of the patterns at the time of packet matching. Since the priority is introduced the service class patterns with different priority may overlap each other, the one with higher priority will take precedence.

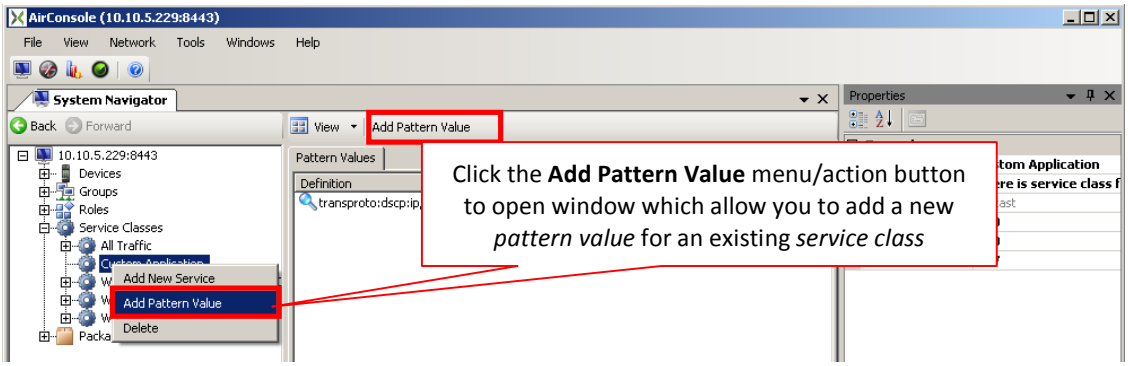
Adding Classification Patterns

Recall from the discussion on page 105 that service classes use patterns to classify distinct traffic flows. After entering the basic attributes of service class record, add one or more packet classification patterns to it on **Add Pattern Values to new Service Class** wizard step. The process involves clicking the **Add** action button, selecting the appropriate pattern format, then editing and saving each pattern as shown below in Screen Capture 126.



Screen Capture 126. Adding Pattern Values to the Service Class

The same effect you may obtain using **Pattern Value** window started for an existing service class.



Screen Capture 127. Adding Pattern Values for an existing Service Class

Choosing A Pattern Format for Packet Classification

Depending on selected traffic type there are five distinct pattern formats for classifying matching packets for unicast traffic type and two for multicast traffic type:

1. Unicast traffic type
   - The pattern format transproto:dscp:ip/net_mask:port_start-port_end is appropriate for many applications.
     - Transproto field can be equal to "TCP", "UDP", "ICMP", "IGMP", "PIM", "OSPF" or "ANY" value. It matches packets by 4th layer transport protocol.
     - DSCP field is a 6 bits number covered in IP packet and is used by application with QoS support. It can be equal to decimal number from range 0 – 63 (0 means lowest and 63 highest priority) or "ANY".
     - IP address and netmask field with port range field determine service source socket.

See Table 8. Transproto pattern example for more details.

Pattern example	Description
TCP:0:172.20.1.1/255.255.255.255:80-80	HTTP traffic between 172.20.1.1 host and subscriber
UDP:28:10.10.1.0/255.255.255.0:1-65535	any UDP traffic, with DSCP=28, between 10.10.1.0/24 network and subscriber
ANY:ANY:0.0.0.0/0.0.0.0:1-65535	any traffic

Table 8. Transproto pattern example

   - The sigproto:transproto:port_start-port_end pattern is appropriate for protocols that operate at higher stack layers such as SIP-based VoIP. Transproto and port range field have same role like in first pattern. For example, SIP:UDP:5060-5061 matches UDP, SIP traffic (service is available on any host, on ports 5060 and 5061).
   - The mac pattern format classifies packets based on layer 2 (mac) addresses. For example, 00:00:12:ac:23:21 matches traffic between subscriber and host with 00:00:12:ac:23:21 MAC address.
   - The ethertype pattern matches traffic due ethertype field in ethernet frame. This field can be equal to 4-chars, hexadecimal number (without 0x prefix) For example: 0800 pattern matches IPv4 traffic. For more details see Ethernet II (DIX Ethernet) specification.
   - The vlan pattern matches traffic across specified vlans. Available range is 0 – 4095. For more information check IEEE 802.1Q specification.

2. Multicast traffic type

- The ethertype pattern matches traffic due ethertype field in ethernet frame. This field can be equal to 4-chars, hexadecimal number (without 0x prefix) For example: 0800 pattern matches IPv4 traffic. For more details see Ethernet II (DIX Ethernet) specification.
- The multicast pattern is appropriate for audio and video broadcasting.
    - Transproto field can be equal to "UDP", "ICMP", "IGMP", "PIM", "OSPF" or "ANY" value. It matches packets by 4th layer transport protocol.
    - DSCP field is a 6 bits number covered in IP packet and is used by application with QoS support. It can be equal to decimal number from range 0 – 63 (0 means lowest and 63 highest priority) or "ANY".
    - Source IP address and netmask field with port range field determine service source socket.
    - Destination IP address and netmask field with port range field determine service destination socket.

See Table 9. Multicast pattern example for more details.

Pattern example	Description
UDP:ANY:172.20.1.1/255.255.255.255:0-65535:239.0.0.2/255.255.255.255:2233-2234	UDP traffic between 172.20.1.1 host and subscribers in multicast group with 239.0.0.2 IP Address
UDP:ANY:192.168.0.1/255.255.255.255:46772-46772:224.20.0.0/255.255.255.0:0-65535	UDP traffic between 192.168.0.1 host port 46772 and multicast IP addresses group from 224.20.0.0 IP subnet

Table 9. Multicast pattern example

Here are some useful pattern specification hints:

Hint: Don't forget the punctuation mark ":" for mac pattern

Hint: When AirSync generates QoS instructions for downstream traffic, the patterns reference source protocols, ports and addresses. AirSync inverts the source and destination when it generates instructions for the upstream direction, so the patterns reference destination protocols, ports and addresses in the upstream direction.

Hint: The pattern format is a Write-Once attribute for the pattern. If you need to modify a pattern's format, delete the pattern and add it again.

Hint: To specify a specific IP host type its address and use a full length network mask such as 192.168.10.100/255.255.255.255. To specify any host use 0.0.0.0/0.0.0.0. To specify all hosts on the 192.168.10.0 / 24 network, use "192.168.10.0/255.255.255.0"

Hint: You must use dotted decimal notation when specifying a mask. You can't use CIDR notation such as 192.168.10.0 / 24

Hint: You can use ANY as a wildcard for transport protocols. For example, Domain Name Service (DNS) traffic can use TCP or UDP at layer 4, but generally runs on port 53, so ANY:ANY:172.16.1.100/255.255.255.255:53-53 matches all DNS traffic from the specific host 172.16.1.100 regardless of whether it's TCP or UDP as a transport protocol.

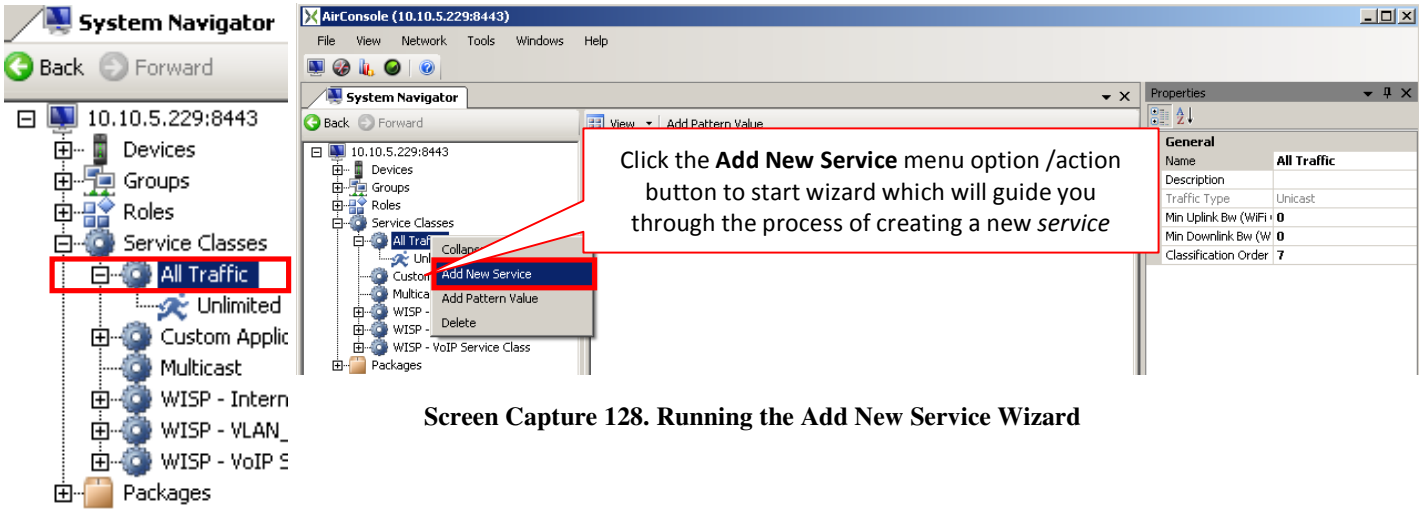
Hint: To specify a wildcard for ports, use a range like 0-0 or 0-65535.

Hint: To match traffic that uses a non-contiguous port range such as web traffic including HTTP on port 80 and HTTPS on port 443, simply specify two distinct patterns such as shown in Figure 12 on page 113.

Hint: To add multicast patterns first you must add Service Class with multicast Traffic Type.

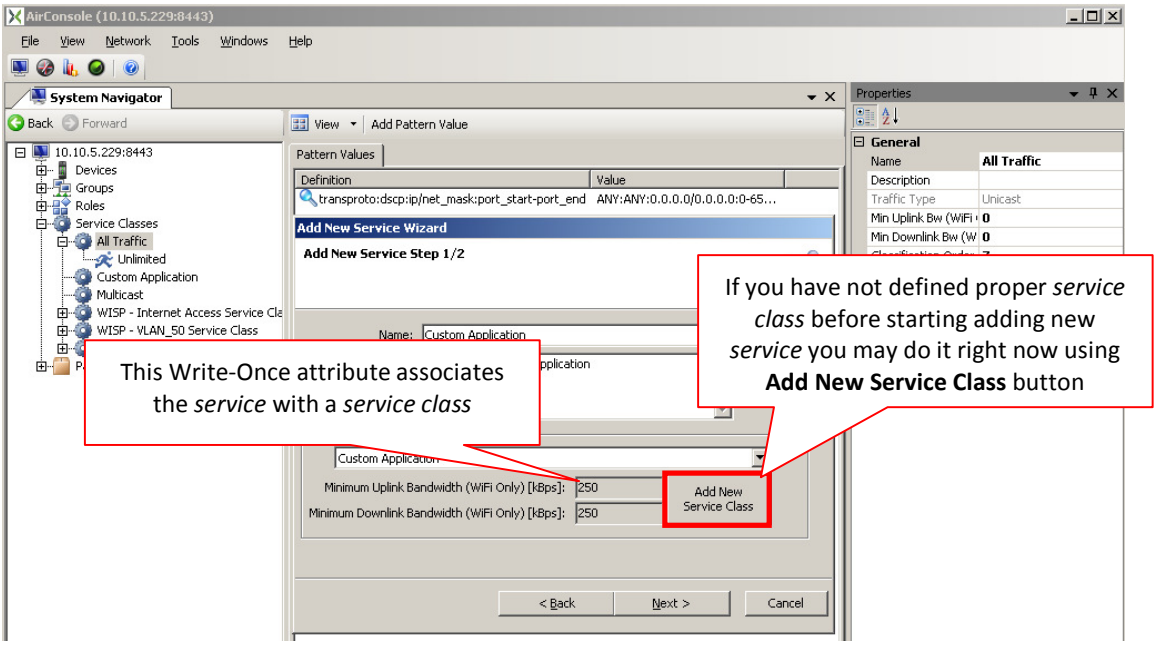
Working with Services

To add, edit or delete a service, select the **Service Classes** item from the **System Navigator** tree and then select one of the listed service classes as shown in Screen Capture 128.



Screen Capture 128. Running the Add New Service Wizard

Clicking the **Add New Service** context menu option/action button runs the **Add New Service Wizard** as shown in Screen Capture 129.



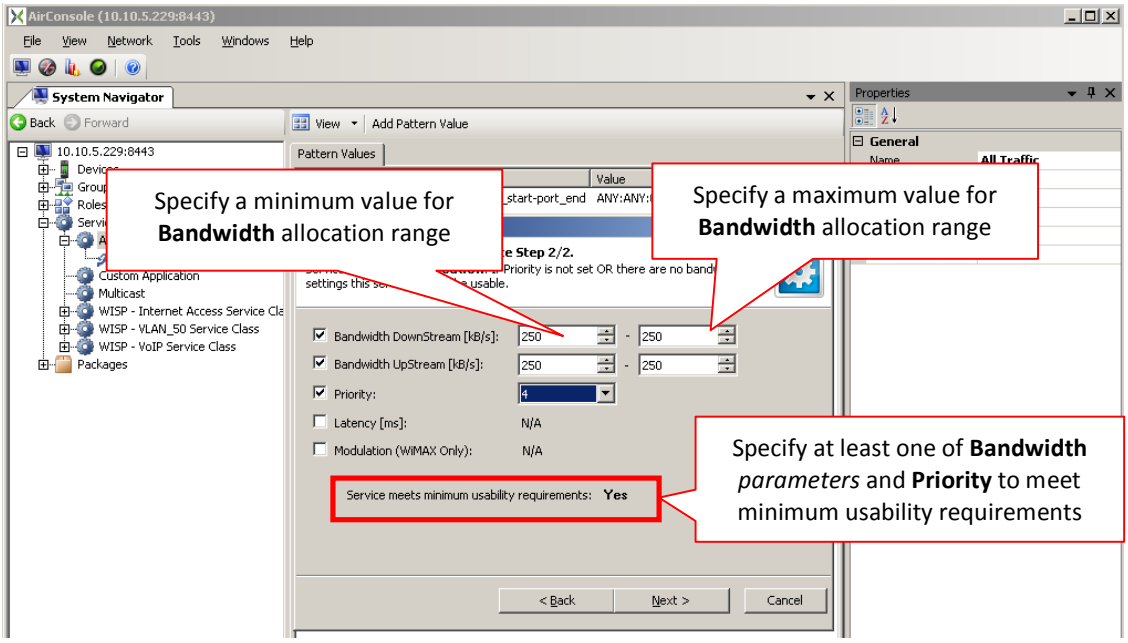
Screen Capture 129. Adding a Service for an Application

Associating a Service with a Service Class

The **Service Class** attribute can be assigned by selecting an existing service class from a drop-down list box. This Write-Once attribute determines the *service class* to which this *service* will be linked. You may create the service class you need before creating a service that relies on it or you may start **Add New Service Class Wizard** during adding new service by using **Add New Service Class button**. If you subsequently want to use another value, delete this service and re-add it using the desired value for its **Service Class** attribute.

Provisioning the Service Parameters

To provision QoS parameters for the service select the parameters you wish to provision on the **Configure Parameters for Service** wizard step as shown in Screen Capture 130.

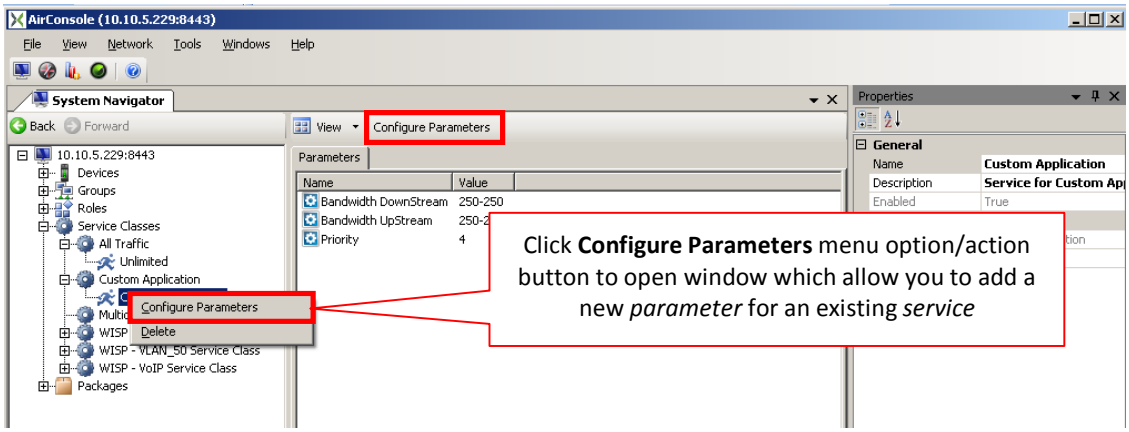


Screen Capture 130. Selecting a QoS Parameter to provision for the service

On this step you will have an opportunity to enter a bandwidth allocation range. Specify a minimum value followed by a maximum value as shown in Screen Capture 131. The meaning of this bandwidth range specification is discussed starting on page 123.

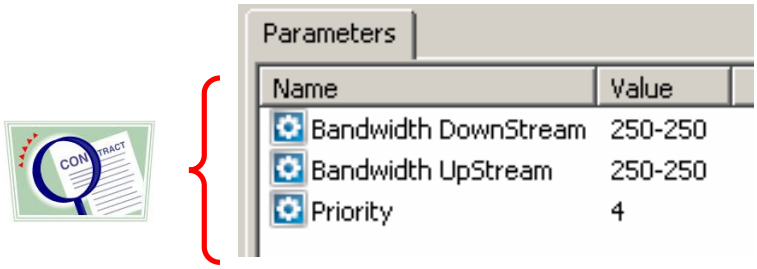
Screen Capture 131. Specifying a range value for the "Bandwidth DownStream" parameter

The same effect you may obtain using **Configure Parameters** window started for an existing service.



Screen Capture 132. Adding Parameters for an existing Service

Add parameter values for the **Bandwidth Upstream**, **Bandwidth Downstream** and **Priority** parameters to the service. As you add the parameter values you will see them listed on the **Parameters** sub pane for the service as shown in Screen Capture 133. If at any time you wish to change a provisioned value (modify the terms of the SLA), you can select the parameter value and edit it.



Screen Capture 133. Specify Bandwidth Upstream, Bandwidth Downstream, and Priority

WiMAX QoS classes and WLAN WMM access categories, both depend of Bandwidth Upstream, Bandwidth Downstream and Latency parameters. For details see Table 10. WiMAX QoS classes definition as AirSync Service parameters and Table 11. WiFi WMM access categories definition as AirSync Service parameters.

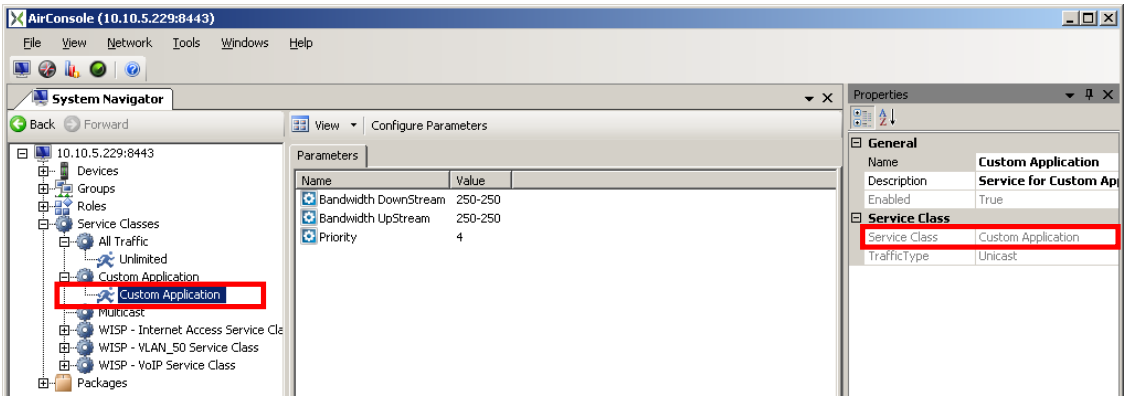
WiMAX QoS classes:	AirSync Service Parameters:
UGS (Unsolicited Grant Service)	Latency defined and maximal bandwidth equal to minimal bandwidth.
RTPS (Real Time Polling Service)	Latency defined and maximal bandwidth higher than minimal bandwidth.
NRTPS (Non Real Time Polling Service)	No latency defined and minimal bandwidth higher than zero.
BE (Best Effort)	No latency defined and minimal bandwidth equal to zero.

Table 10. WiMAX QoS classes definition as AirSync Service parameters

WiFi QoS access categories:	AirSync Service Parameters:
VI (voice)	Latency defined and maximal bandwidth equal to minimal bandwidth.
VO (video)	Latency defined and maximal bandwidth higher than minimal bandwidth.
BE (Best Effort)	No latency defined and minimal bandwidth higher than zero.
BG (Background)	No latency defined and minimal bandwidth equal to zero.

Table 11. WiFi WMM access categories definition as AirSync Service parameters

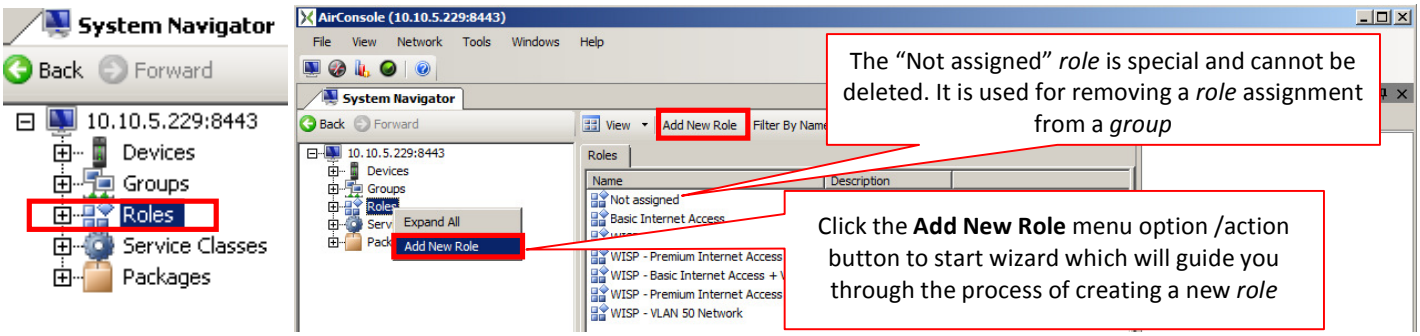
Note that the **Enabled** attribute on the **Services** pane will show as checked or true as shown in Screen Capture 134 if and only if at least 2 (Priority and one of Bandwidth) of four QoS parameters have been provisioned for this service. Specifying the set of three QoS parameters defines a basic SLA for service.



Screen Capture 134. Service will show as enabled if and only if at least two QoS parameters are defined

Working with Roles

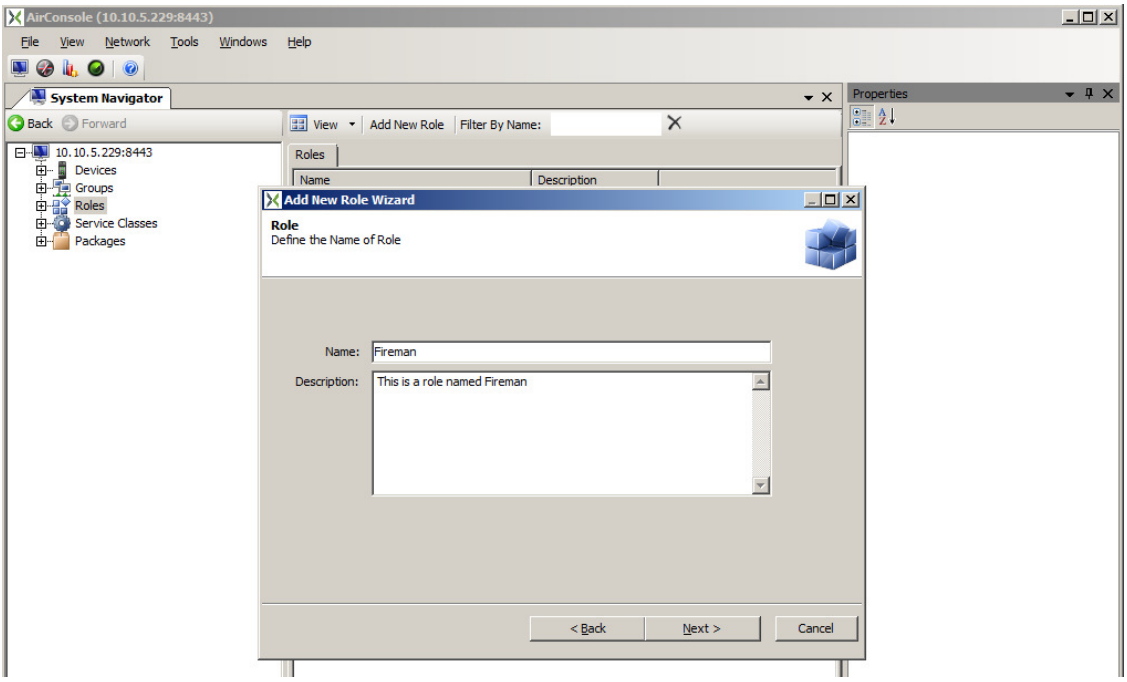
To add, edit or delete a role select the **Roles** item from the **System Navigator** tree as shown in Screen Capture 135. An example of adding a role for a custom application follows.



Screen Capture 135. Running the Add New Service Wizard

Note that the **Not Assigned** role is a special and can't be deleted. It is used for removing a role assignment from a group.

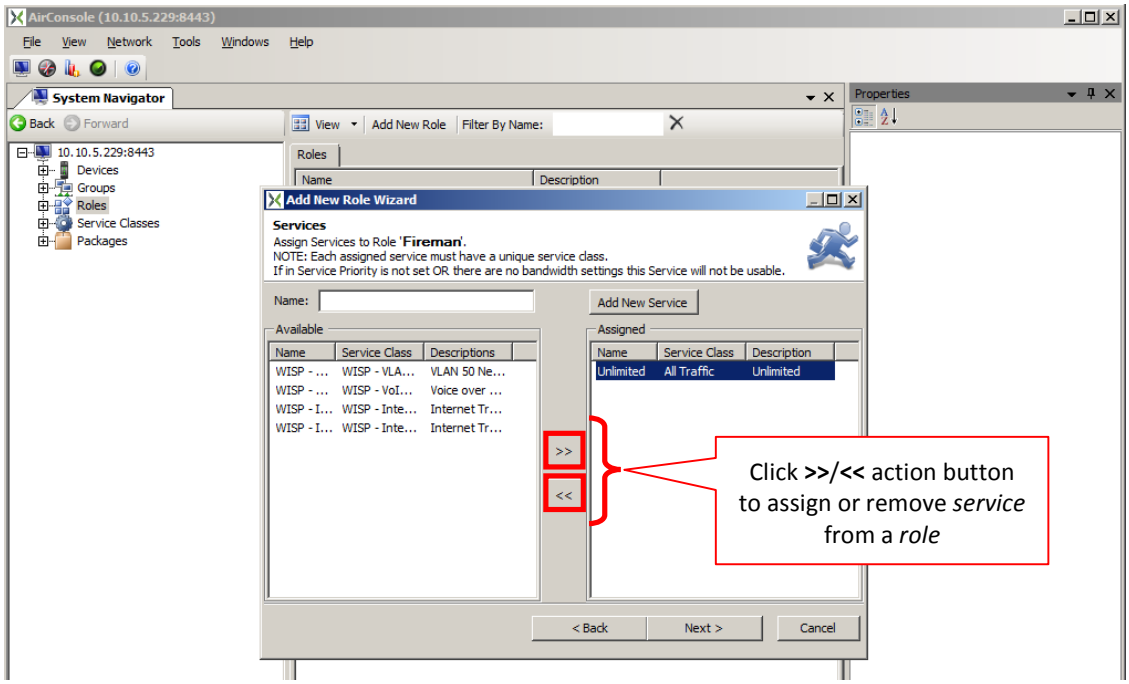
Clicking the **Add New Role** context menu option/action button runs the **Add New Roel Wizard** as shown in Screen Capture 136.



Screen Capture 136. Adding a Role

Associating services with a role

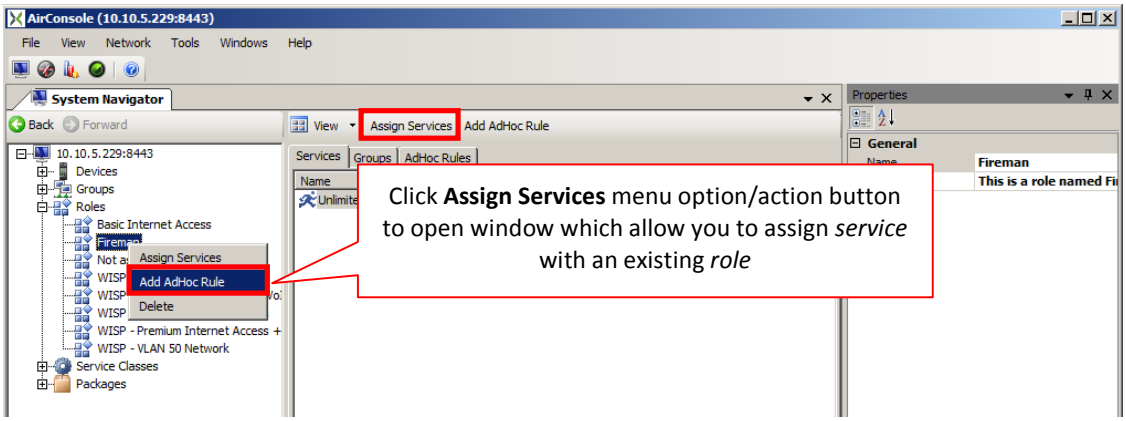
To associate one or more services with a role use the **Services** wizard step and select the desired service from the list of available services. Click on the **>>** action button as shown in Screen Capture 137. Recall from the discussion starting on page 107 that a role can be associated with zero or more services.



Screen Capture 137. Assigning Services with a Role

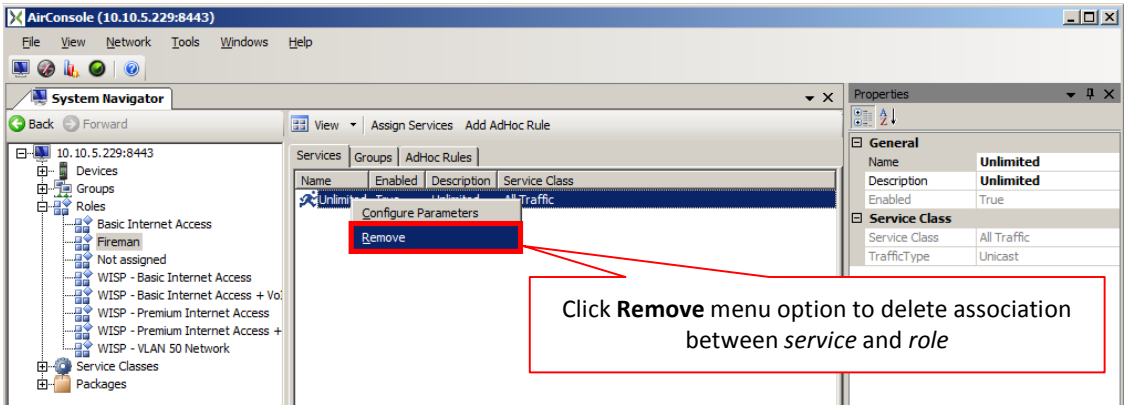
Alternatively, you can drag and drop a service object (from **Service Classes tree** or **Services list**) onto a defined role object in the System Navigator. The section titled "Drag 'n' Drop" Operations with the System Navigator Window" beginning on page 33 shows examples of drag 'n' drop operations. See also Screen Capture 37. Dragging and Dropping a Service from Service Classes tree to Roles on page 33.

The same effect you may obtain using **Assign Services to a Role** window started for an existing role.



Screen Capture 138. Assigning Services with an existing Role

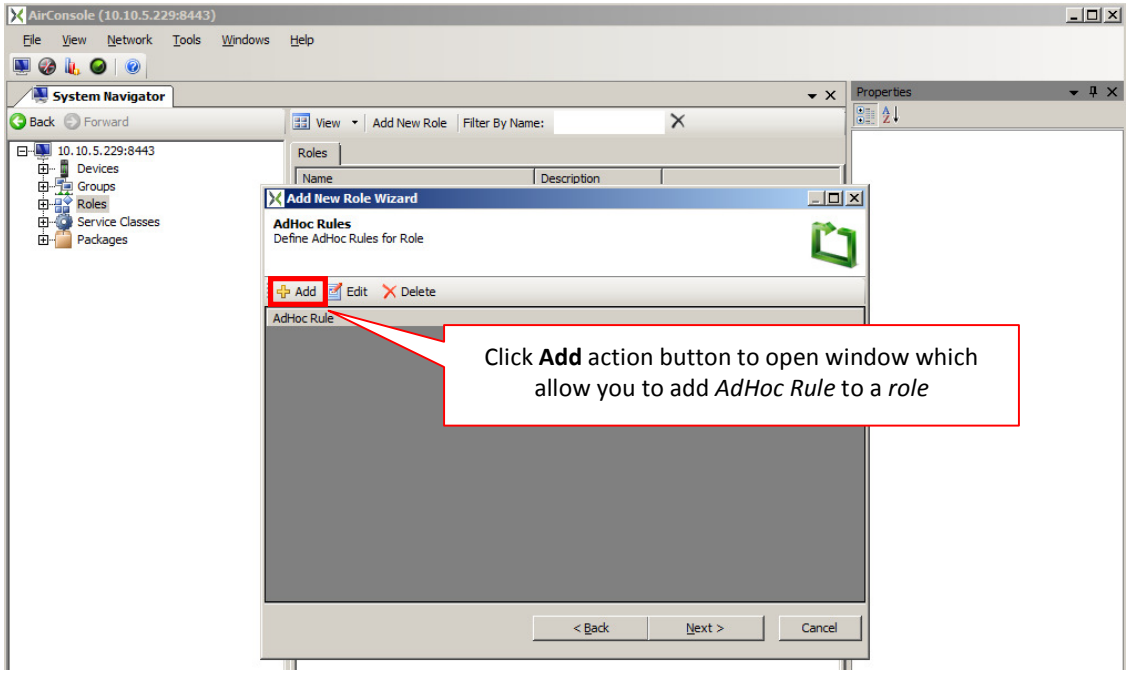
To disassociate a service from a role, select the service item from the sub pane and click the **Remove** action button as shown in Screen Capture 139. You cannot disassociate a service attribute value from a role by dragging it from the **Roles** list view area.



Screen Capture 139. Removing a service from a role

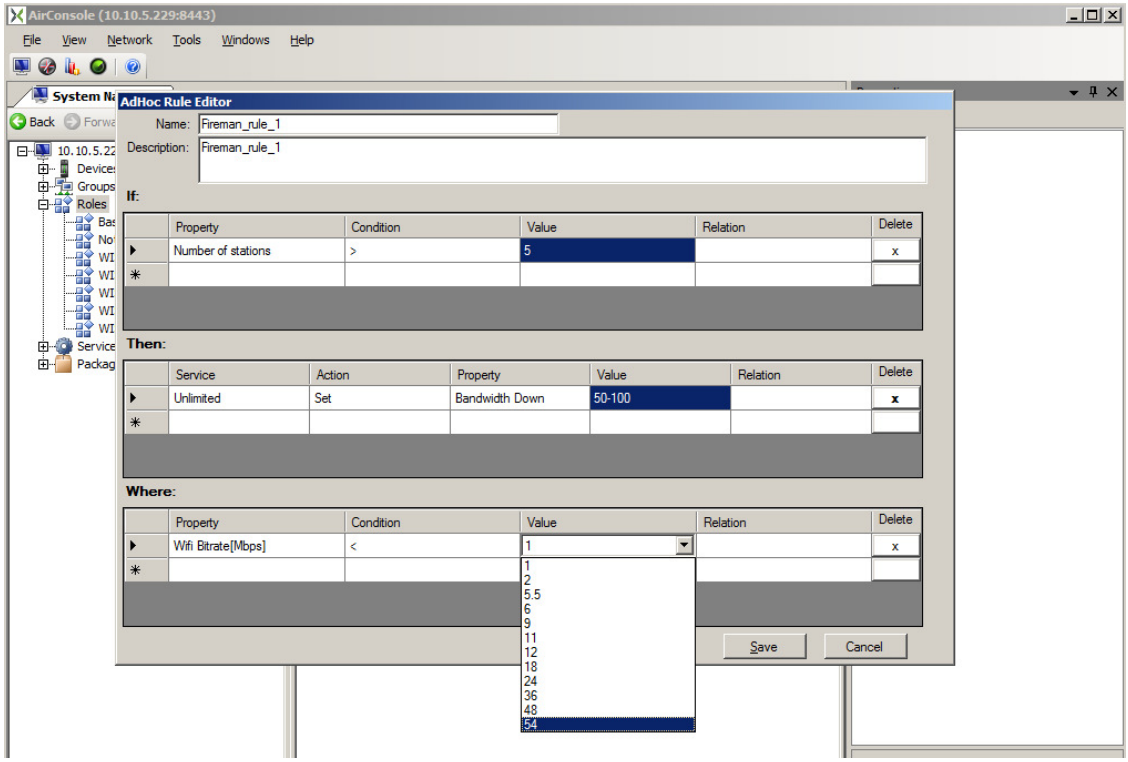
Working with AdHoc Rules

Implementing AdHoc Rules is an optional way to conditionally modify SLAs. AdHoc Rules are discussed in the section starting on page 131. In summary, AdHoc Rules allow an administrator to set-up certain "trigger conditions" that cause AirSync to manipulate QoS settings on the fly based on network events such as topology changes and signal changes. To add an AdHoc Rule to a role, use the **AdHoc Rules** wizard step and click **Add** action button, as shown in Screen Capture 140.



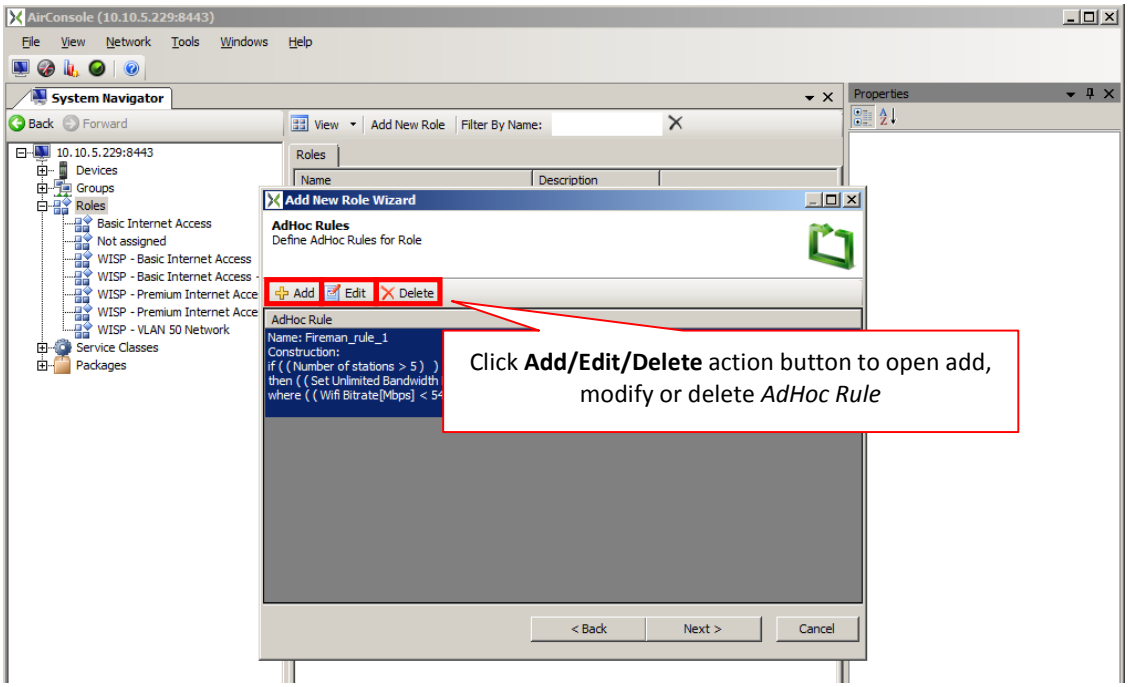
Screen Capture 140. Adding an AdHoc Rule

AirSync will then present its AdHoc Rule editor, which allows administrators to generate rules governing QOS behavior based on certain trigger events. The rule editor is shown in Screen Capture 141. It facilitates the creation of sophisticated, condition-based QoS rules without requiring administrators to memorize any special language. Instead, administrators point, click and select (or furnish) values to GUI objects that encapsulate the syntax details from the administrator.



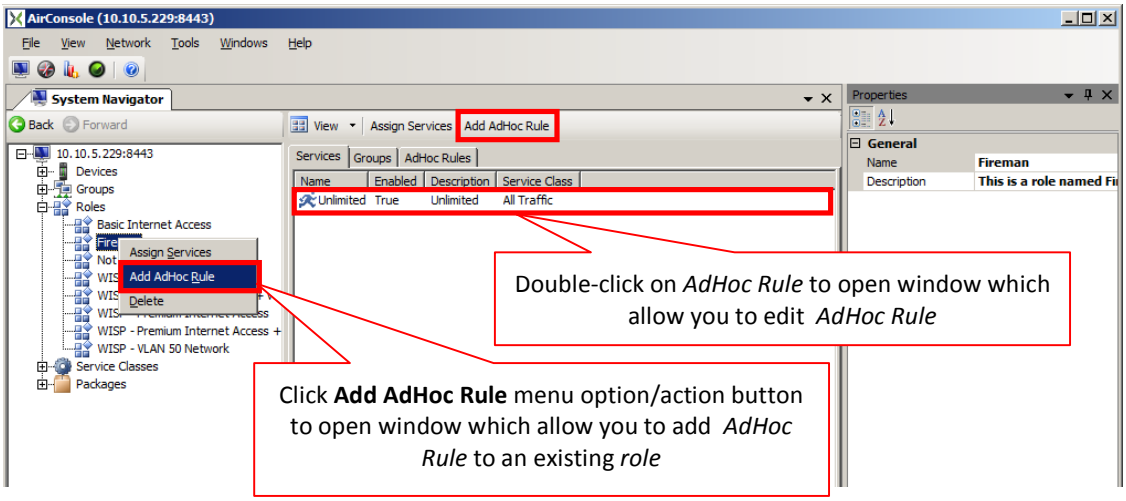
Screen Capture 141. AirSync's AdHoc Rule editor

Screen Capture 142 shows the **AdHoc Rules** wizard step for the new role after adding an AdHoc Rule to it. Multiple AdHoc Rules can be created for a role, if desired. Adding, editing and deleting them are straightforward operations.



Screen Capture 142. "Define AdHoc Rule for Role" wizard step

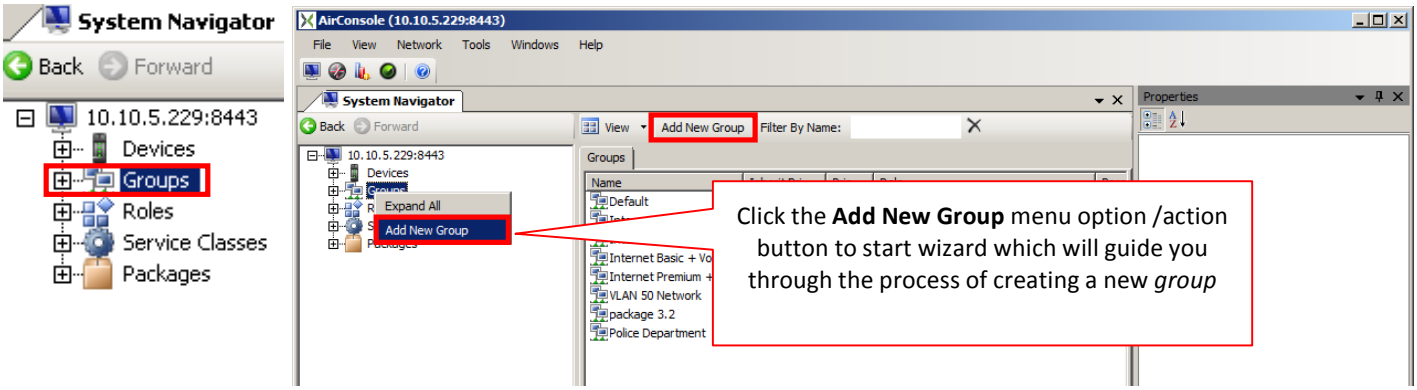
The same effect you may obtain using **AdHoc Rule Editor** window started for an existing role or double-clicking on it.



Screen Capture 143. Adding an AdHoc Rule to an existing Role

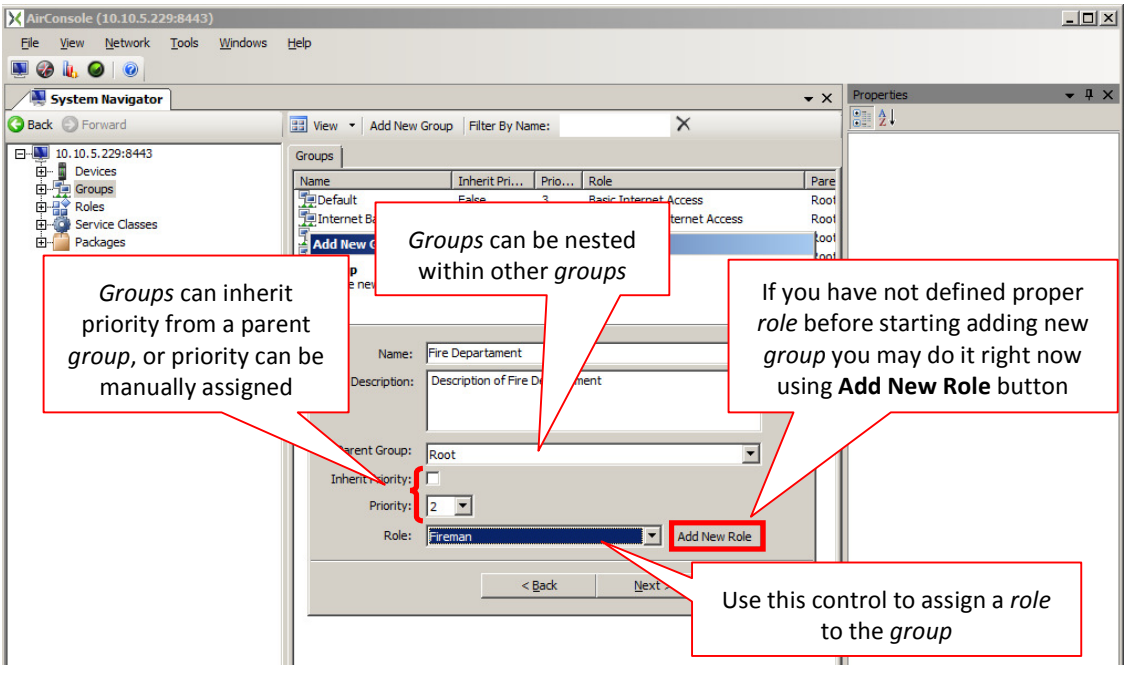
Working with Groups

To add, edit or delete a group select the **Groups** item from the **System Navigator** tree as shown Screen Capture 144.



Screen Capture 144. Running the Add New Group Wizard

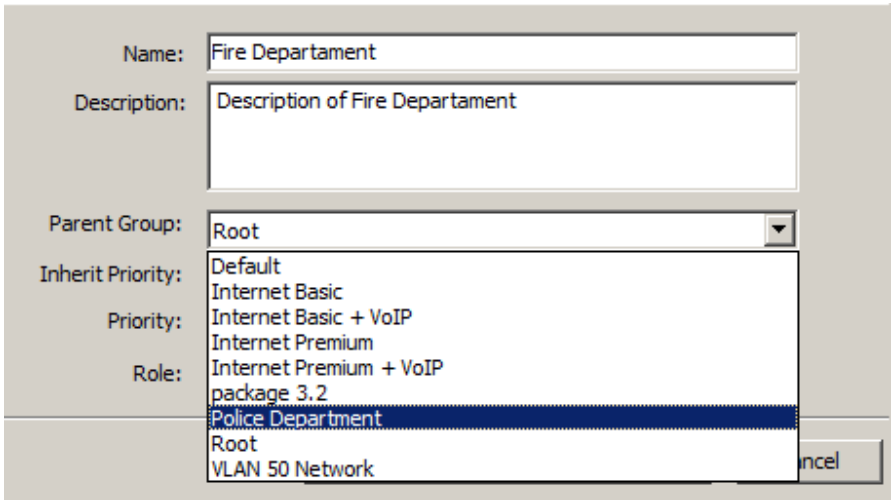
Clicking the **Add New Group** context menu option/action button runs the **Add New Group Wizard** as shown in Screen Capture 145. An example of adding a new group follows.



Screen Capture 145. Adding a new group

Groups can be nested within other groups

Groups can be arranged in a hierarchical fashion, if desired. To do so, select a value for the "parent Group" attribute from its associated drop-down list box as shown in Screen Capture 145 and with more detail in Screen Capture 146. To remove the hierarchical relationship, select the **Root** value from the list. The **Root** value is a special value representing the top level of the group hierarchy and cannot be deleted from the list. Groups can inherit a value for the **Priority** attribute from the parent group, but cannot inherit a role from the parent group.



Screen Capture 146. Groups can be nested within groups

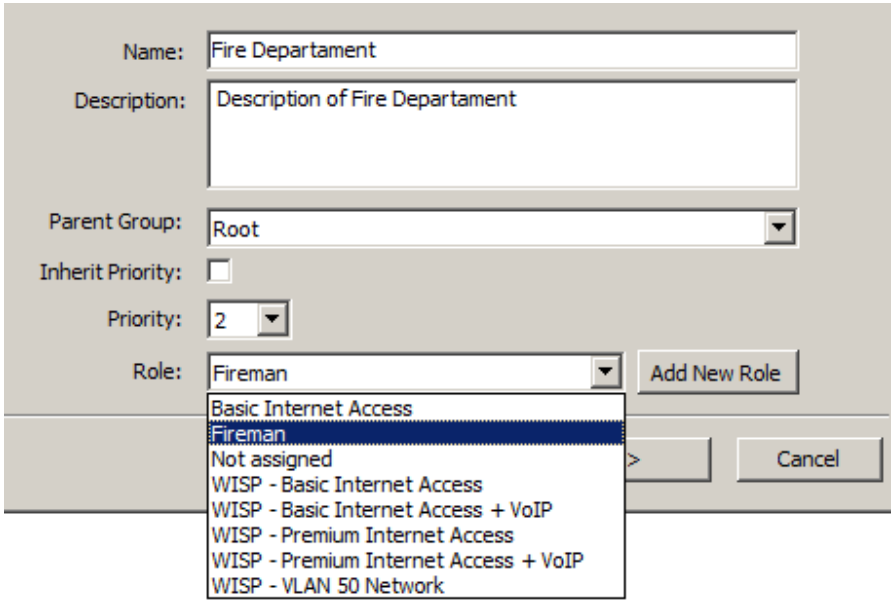
Assigning a Priority to a Group

You can choose to have a group inherit a priority value from its parent group by selecting the **Inherit Priority** attribute check box. Alternatively, you can leave this box unchecked and directly assign a priority value. See Screen Capture 145 and also Screen Capture 147.

Assigning a Role to a Group

To assign a role to a group, select the desired value from the drop down list box for the **Role** attribute as shown in Screen Capture 145 and with more detail in Screen Capture 147. Alternatively, you can drag and drop a role value onto a defined group object in the **Groups tree** or **list** area, if open. The section titled "Drag 'n' Drop" Operations with the System Navigator Window" on page 33 shows examples of "drag 'n' drop" operations.

To clear the role, select the **Not assigned** value. This is a special value and cannot be deleted. Unlike the **Priority** attribute value which can be inherited from a parent group, the **Role** attribute value must be explicitly assigned to a group. The default value is **Not assigned**.



Screen Capture 147. Assigning priority and role attribute values to a group

Working with Devices and Device Interfaces

The section titled Registering Devices in the AirSync System starting on page 64 discusses the basic details for adding devices and device interfaces. From a QoS perspective, the key point is to set the **Max Bandwidth kBps**, **Priority**, and **Group** attribute values appropriately for the device interface. Set these attribute values on the **Device Interface Details** tab as shown in Screen Capture 148.

Assigning the Group/Role Device Interface Attribute Value

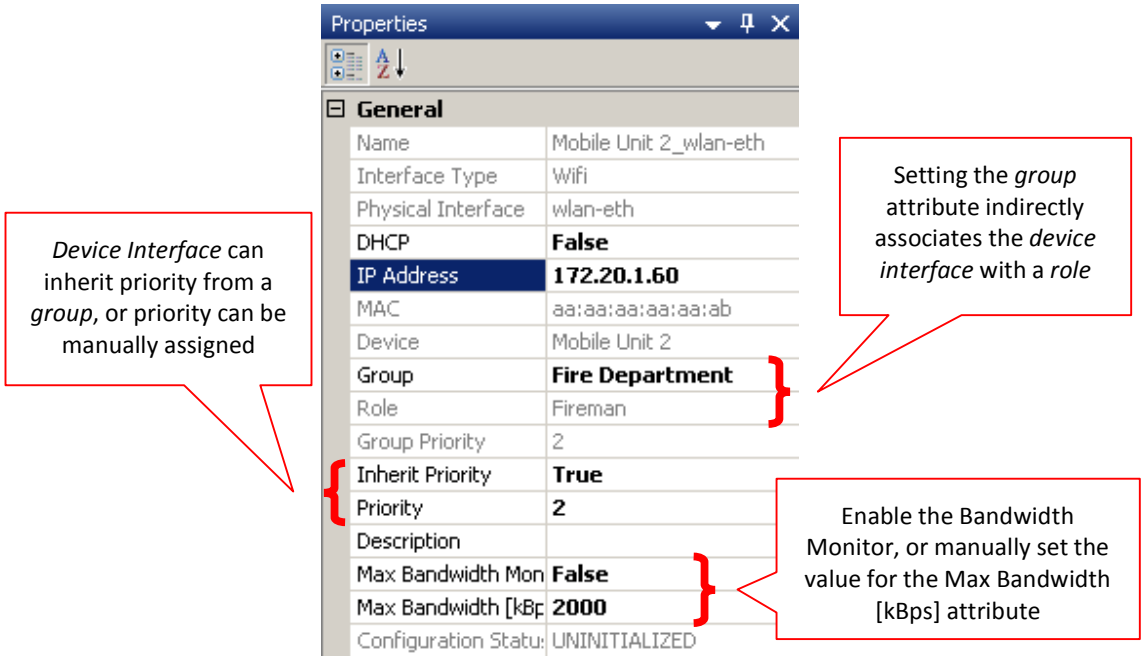
Remember from the discussion beginning on page 115 that assigning a value to the **Group** attribute of a device interface indirectly associates a role with it, too. On the **Add Device Interface Wizard** or **Properties** window, the **Role** attribute is a read-only display indicator of the role, if any, that has been assigned to the Group item selected. To modify the role value associated with the group in question, navigate instead to the **Groups** tree, select the group in question and modify the **Role** attribute value from the **Group Properties** window.

Assigning the "Priority" Device Interface Attribute Value

Device Interfaces can inherit the priority attribute from an assigned group, or priority can be manually assigned. The **Group Priority** attribute is a read-only indicator of the value assigned to the priority attribute of the group that this device interface is a member. To modify this value, navigate instead to the **Groups** tree, select the group in question and modify the priority attribute value from the **Group Properties** window.

Assigning the "Max Bandwidth" Device Interface Attribute Value

With respect to setting the **Max Bandwidth kBps** attribute value, you can either select the **Bandwidth Monitor Enabled** attribute value checkbox to have AirSync automatically estimate the link bandwidth for you, or clear this check box and statically set the value for the **Max Bandwidth kBps** attribute. The section titled "The AirSync Bandwidth Allocation Process" beginning on page 123 discusses the semantics of these items.



Screen Capture 148. Setting the Group, Priority, and Max Bandwidth attributes for a device interface

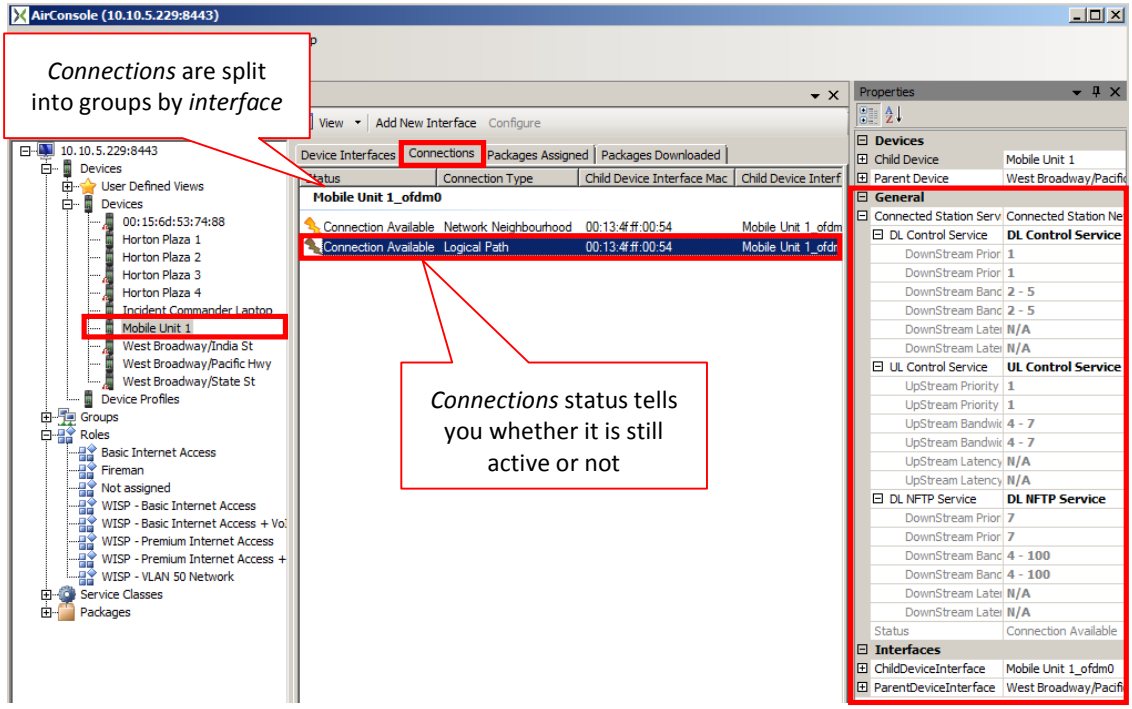
Monitoring the Results

There are three basic methods for verifying the results of an AirSync QoS implementation:

- Inspect the **Network State** item on the **Device Interface** list view, **Connections** sub pane for the device(s) in question.
- Show statistics such as number of bytes transmitted and received for the device interface(s) in question.
- Establish a remote access session with the device(s) in question and then use device platform specific tools to verify that the QoS rules have propagated all the way down to the device(s). A discussion of platform specific device tools is outside the scope of this document.

Inspecting the "Network State" for a device interface

To inspect the network state for a device interface, navigate to the Connections screen for the device(s) in question. Screen Capture 149 shows the navigation path from the main **Device** tree.



Screen Capture 149. Navigating to the Connections sub pane for a device interface

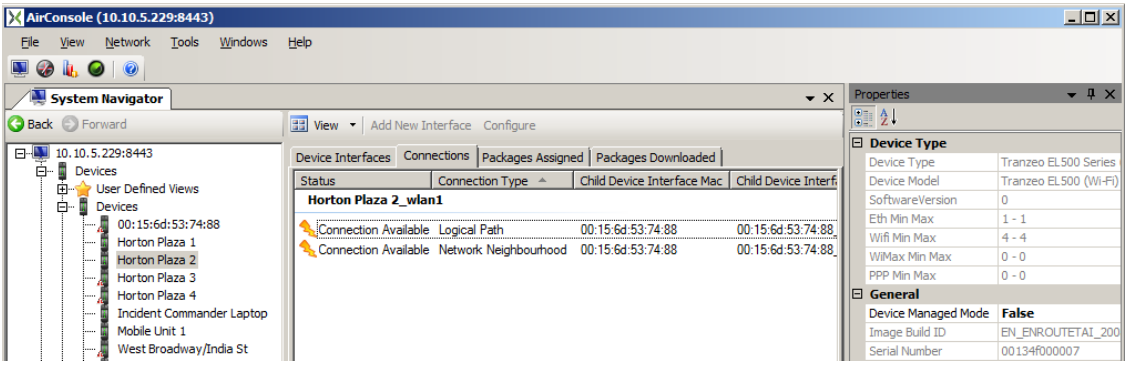
In case both connected devices (parent and child) have AirSync agent installed and running on connections sub tab device will be displayed as “Parent Device” depending on selection.

As you can see on Screen Capture 149 for selected device connection sub pane contains all connections split into groups by interface on witch connection is established with their status, type and other information which are helpful to identify parent and child device.

Connection Types

Screen Capture 150 shows different example of connections sub tab. As you can see the same connection is presented as two rows which differs only **Connection Type**. Logical Path presents second layer OSI network model connection. Network Neighbourhood presents radio sight (candidate for Logical Path connection).

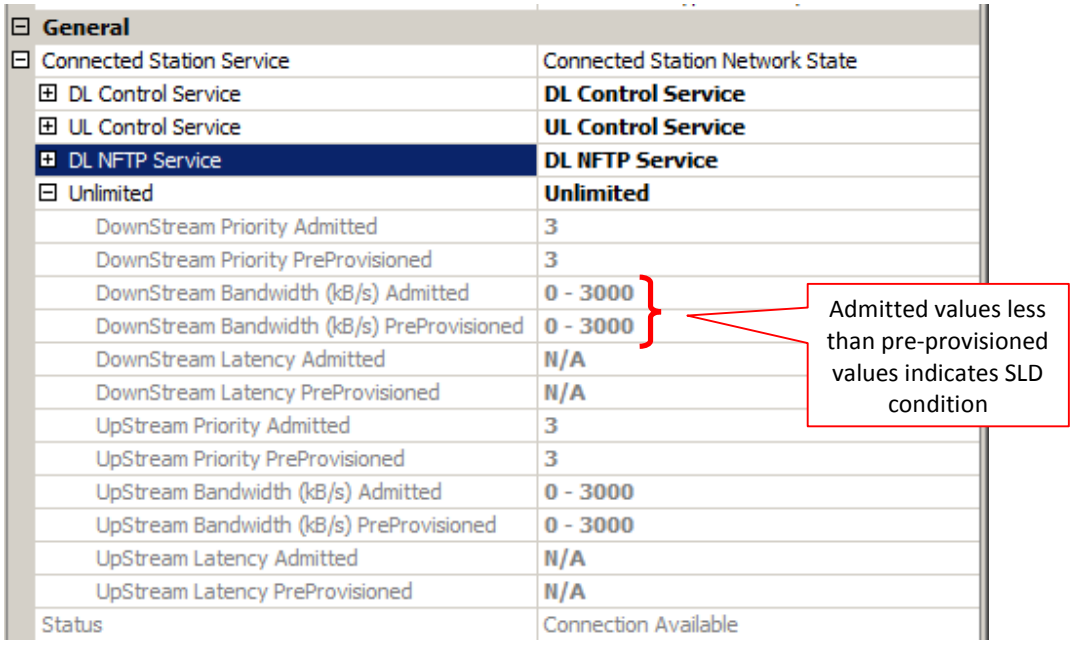
You cannot see statistics on Network Neighbourhood connection.



Screen Capture 150. Another example of connections

Use context menu on connection to show statistics or to simply add connected device. Device added in this way will have name containing its mac address.

Screen Capture 151 shows a close-up view of the **Network State** information for a particular device interface. This display shows the queueing structures (QoS Instructions) that AirSync has generated and sent to agents for implementation on the managed device. When this display shows Admited values less than the Pre-Provisioned values, the system is in an SLD condition.



Screen Capture 151. Close-up of "Network State" for a device interface

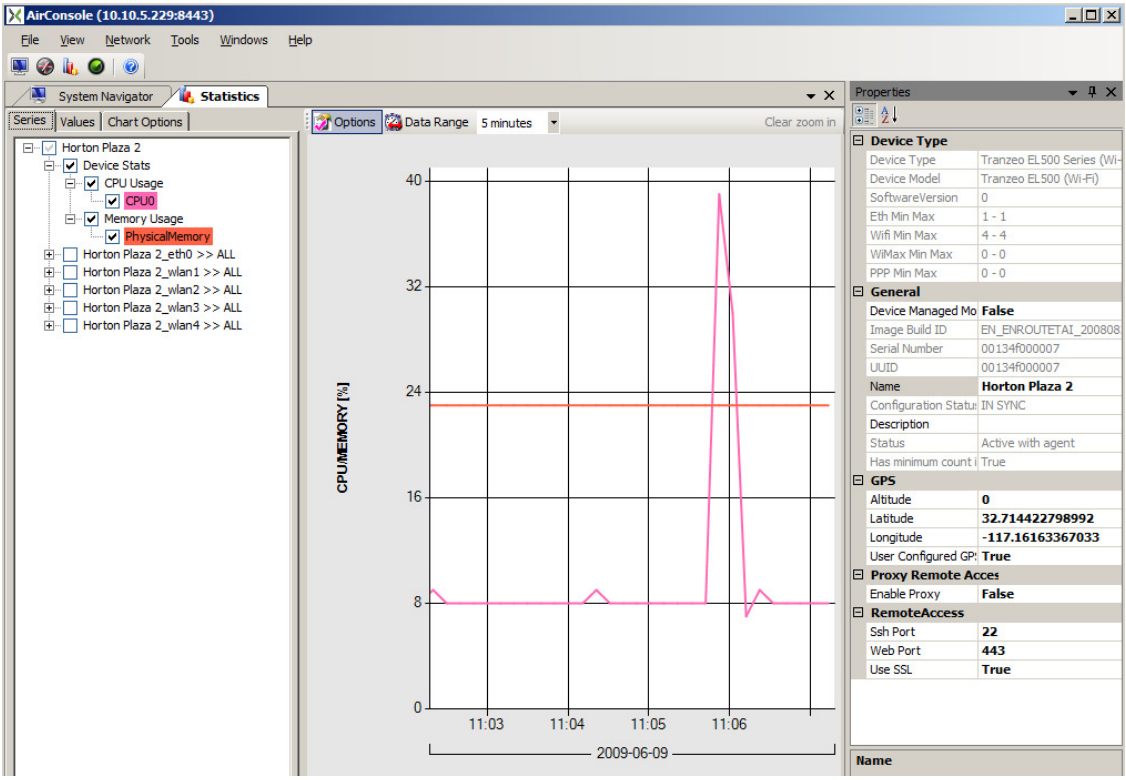
Charting Statistics

Watching statistics is a good way to monitor network. Now you have ability to see statistics for devices, interfaces and connections. What is more statistics for interfaces and connections are split into layers to increase their usability.

To run statistics window just use context menu option on selected device, interface or connection in any window in AirConsole. You may as well open empty statistics window using **Network** menu option or proper icon on tool ribbon.

Device statistics

To see statistics for device you have to use context menu **Show statistics** on it or drop device in question to a statistics window and select **Device Stats** node on the tree as it is shown on Screen Capture 152.



Screen Capture 152. Opening Device statistics

CPU Usage

As you can see on Screen Capture 152, **CPU Usage** chart shows percentage use of selected CPU.

Memory

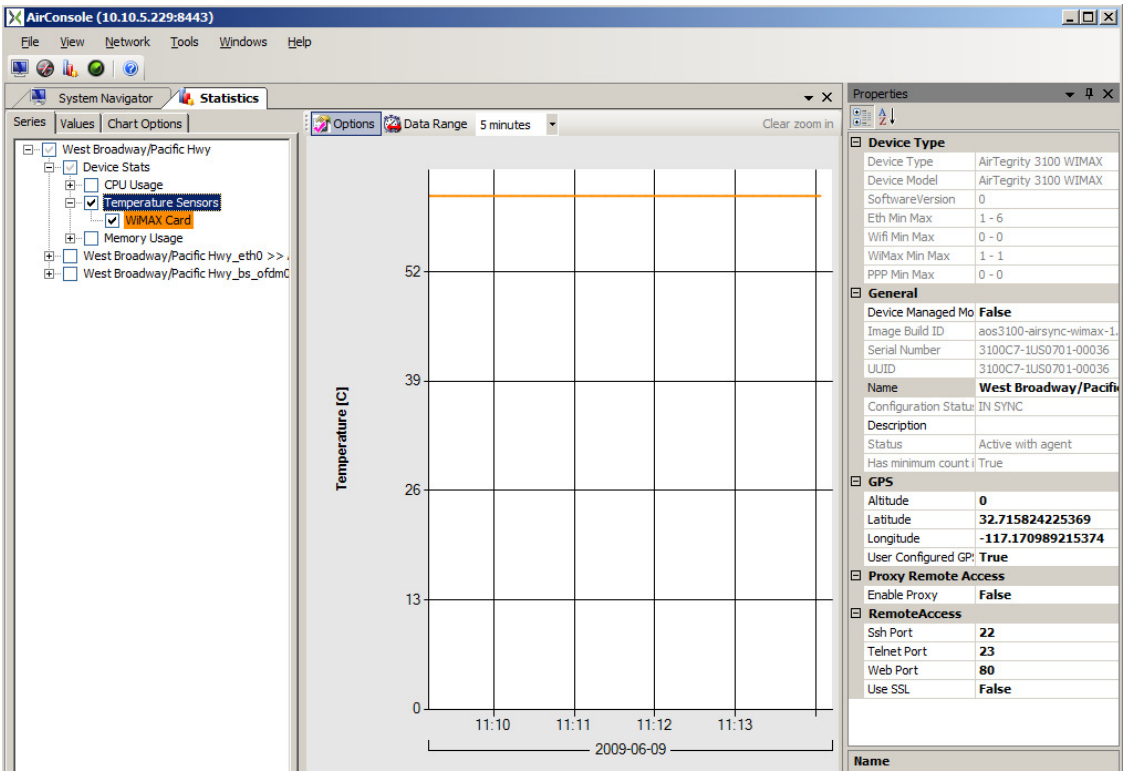
Similarly like previously mentioned **CPU Usage**, **Memory** chart shows percentage use of memory.

Uptime

This information is not available as a chart but you can find it watching device on Topology Manager or Map.

Temperature

As you can see on Screen Capture 153 there is ability to monitor WiMAX Card Temperature.



Screen Capture 153. Temperature statistics for selected device

Depending on device type AirSync agent reports temperature of Mainboard, CPU or WiMAX Card.

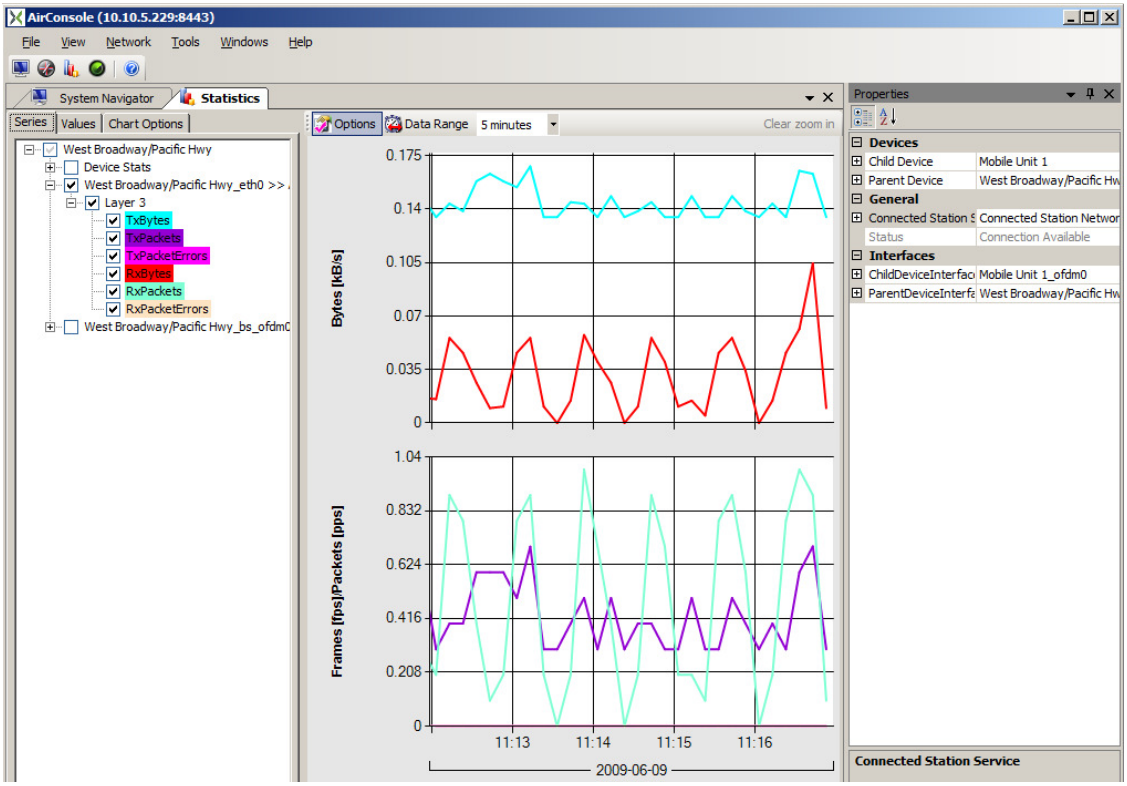
Interface statistics

Interface statistics are split into layers. Depending on interface type you can see only Layer 3 or both Layer 2 and Layer 3 statistics.

Layer 3

This Layer contains statistics for transmitted and received bytes, packets and packet errors.

Screen Capture 154 shows a chart of statistical information for a device interface. By viewing the aggregate I/O rates in and out of the interface (upper graph), you can get an idea of how well the QoS instructions sent to the device implement the organizational usage policy. Large dips or increases may indicate a change in topology that results in the application of a new set of QoS instructions on the device interface. These changes may indicate a new role or the application of AdHoc Rules due to dynamically occurring network conditions or events.

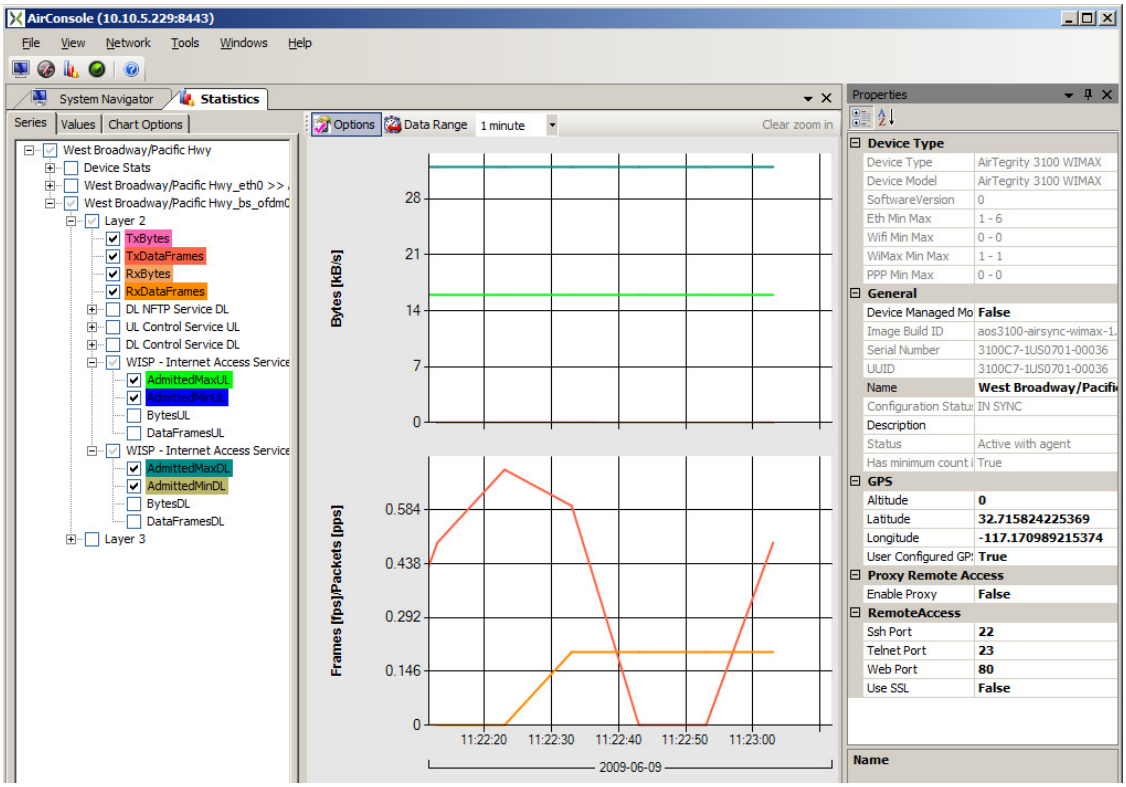


Screen Capture 154. Layer 3 statistics for selected interface

Lower graph displays how packets are transmitted. It contains not only information about in how many frames packet was sent but as well whether some packets were lost and should be sent again.

Layer 2

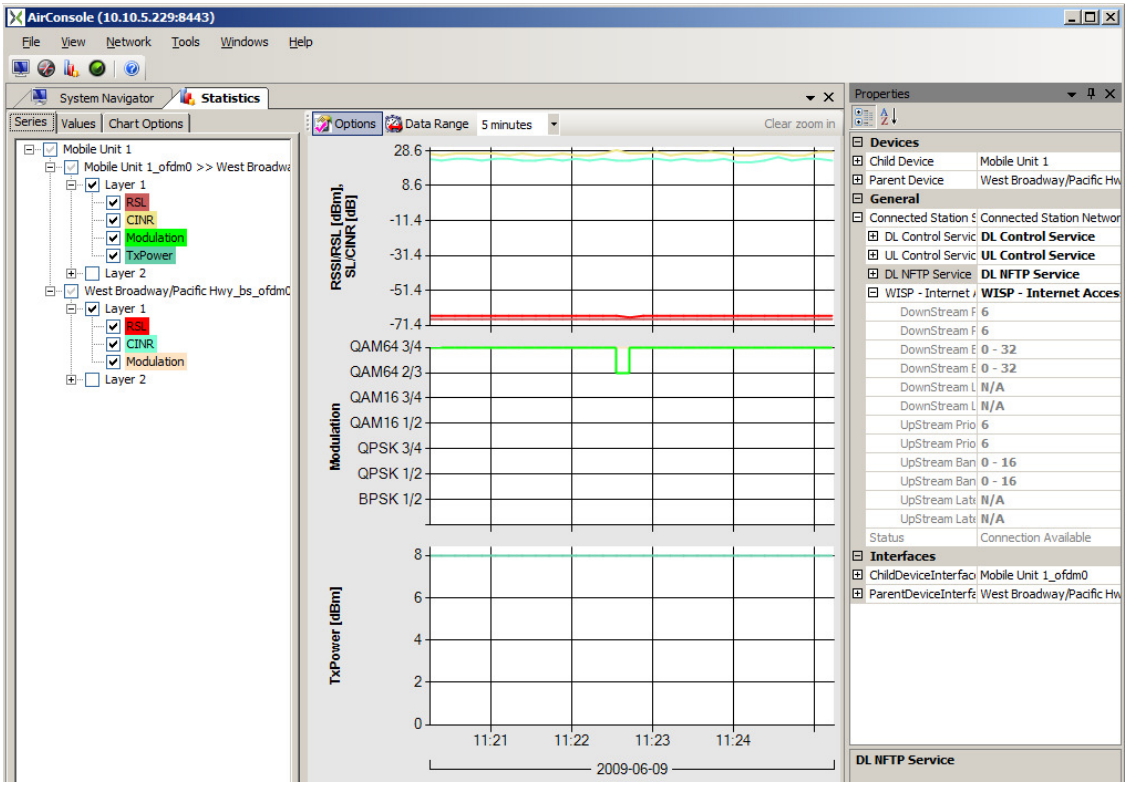
In this layer you have ability to select and monitor much more statistics. There are not only transmitted or received bytes and frames but Control services and applied service flows as well. As you can see on Screen Capture 155 except monitoring frames (lower graph) you may as well watch statistical information for admitted minimum/maximum bandwidth for selected service flow in compare to transmitted data.



Screen Capture 155. Layer 2 statistics for selected interface

Connections statistics

Not only interface statistics are split to layers. Connections statistics are split into layers as well. Layer 2 contains same information as Layer 2 on interface statistics but Layer 1 is different. This layer tells about signal quality. You may watch here RSL, CINR, Modulation and TxPower. Note that the rate value is not an indication of actual link throughput capacity, so much as an indication of the current modulation scheme (QAM, QPSK, BPSK, etc.) used on the link. The modulation scheme determines the theoretical maximum bandwidth available on the link. Further, the framing efficiency of different modulation schemes varies inversely with the amount of forward error correction (FEC) used by the modulation scheme.



Screen Capture 156. Layer 1 statistics for selected connection

Remote Access

For radio device platforms that allow telnet (or similar) access to system administrators, it can be helpful to start a remote-access session to verify that the device properly received and implemented the QoS instructions from the AirSync server. The commands to verify the implementation status vary by vendor platform and are beyond the scope of this document. However, AirSync does provide the ability to establish remote access connections to devices.

Using AirSync's Package Management System

AirSync has a package management system that allows system administrators to systematically define and distribute items to managed nodes.

Theoretical Building Blocks

A package is a container containing content that is addressed for delivery to a specific set of devices and instructions for how to process the content after it is received by the targeted device(s). The package can contain more than one item if desired. Currently, the package distribution system is primarily designed to deliver firmware upgrades and configuration files to managed radios, but it could easily be expanded to other uses. Proximetry has a related product, GateSync, which is a more sophisticated package management system.

The basic steps for package management are:

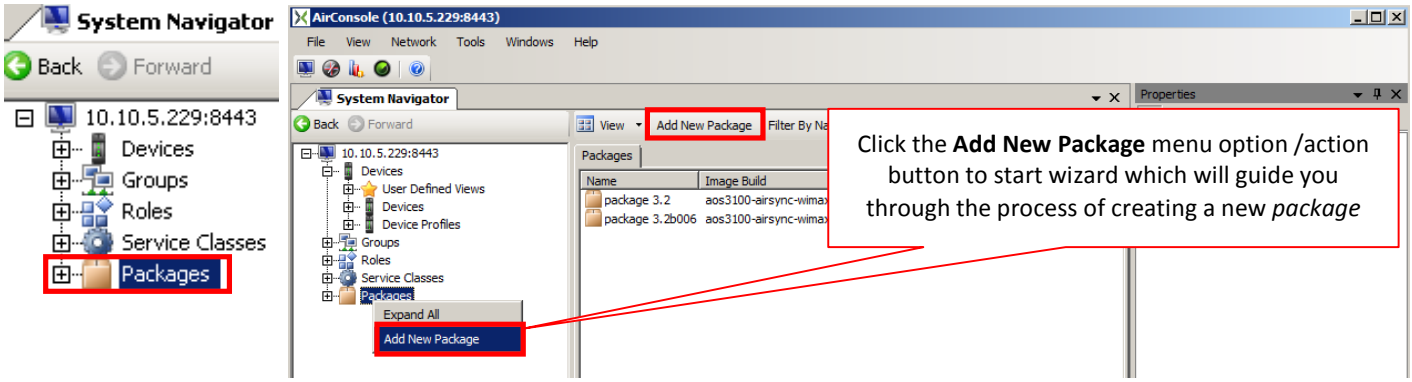
1. Define a new package and assign it to the appropriate group(s).
2. Upload one or more package items for storage on the AirSync server.
3. Assign appropriate device interfaces to a group used for package management.

Because configuration files are device-specific, you should have only one device interface assigned to any group used for distributing configuration files. For configuration files, create one group for each device.

4. Change the status of the package from **Staged** to **Ready for Release**.

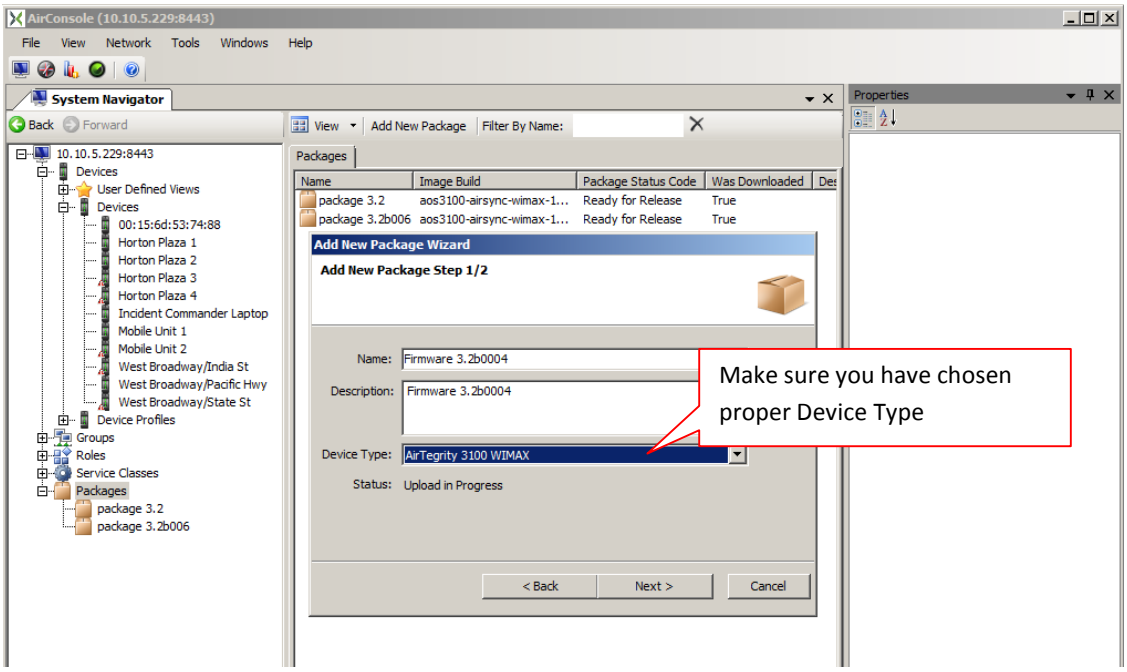
Working with Packages

To add, edit or delete a package select the **Packages** item from the **System Navigator** tree as shown in Screen Capture 157.



Screen Capture 157. Running the Add New Package Wizard

Clicking the **Add New Package** context menu/action button runs the **Add New Package Wizard** as shown in Screen Capture 158.



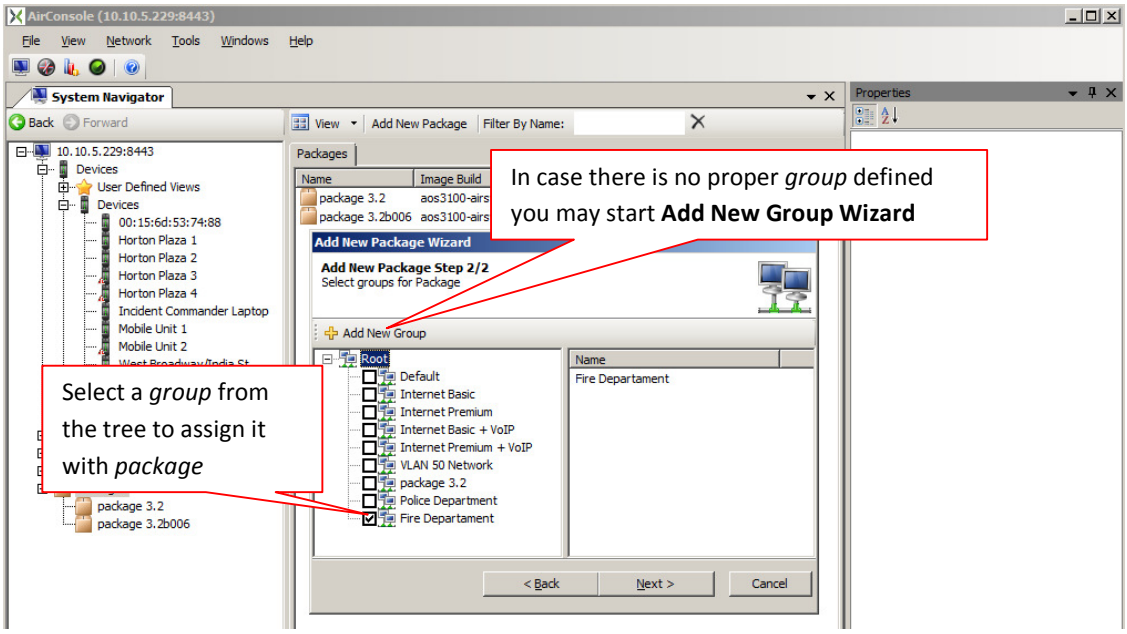
Screen Capture 158. Adding a new package

Package is Device Type specific

The most important thing during defining package is selecting proper device type as shown in Screen Capture 158. This attribute decides whether device(s) in question will be upgraded or not.

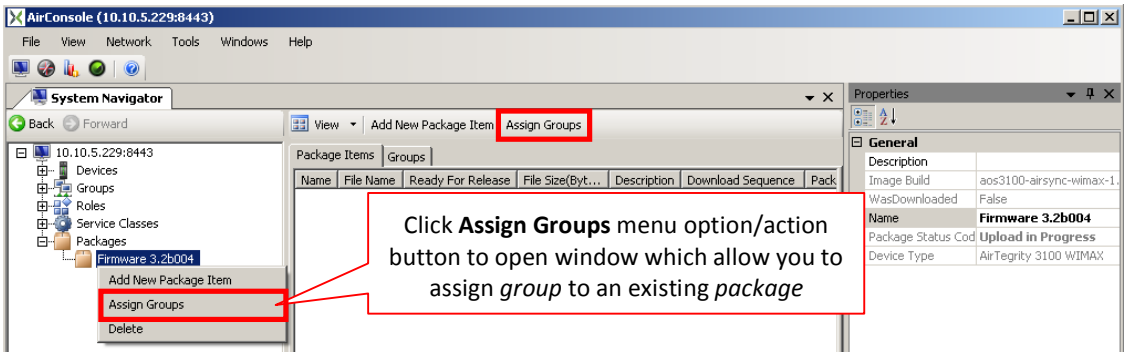
Assigning Package with Group(s)

To make sure that package will be associated with proper device(s) you have to assign a package with the same group as device's interface is. Just select proper group on the tree to assign group with a package as shown in Screen Capture 159.



Screen Capture 159. Assigning package with a group

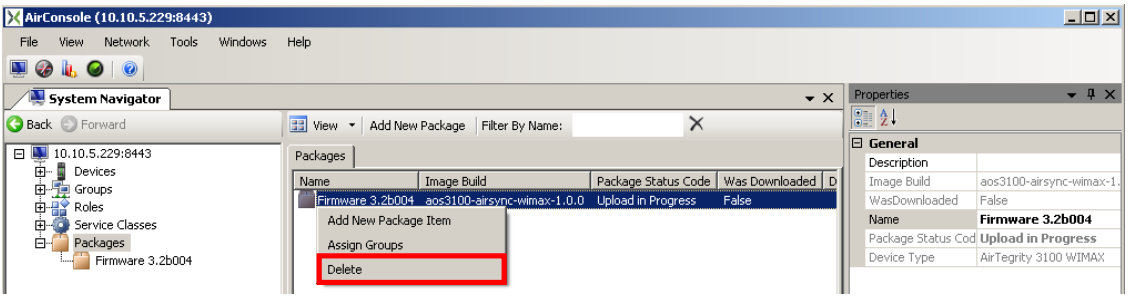
The same effect you may obtain using **Assign Groups to a Package** window started for an existing group.



Screen Capture 160. Assigning group with an existing package

Deleting Packages

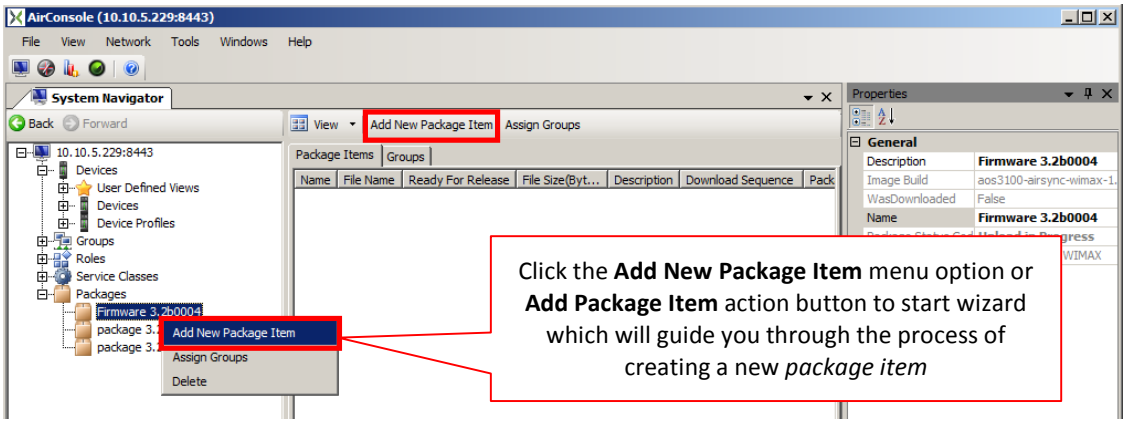
Before you can delete a package, you must remove all targeted groups from it (select the package, then the targeted group item then click the **Remove** action button from the **Groups** sub pane).



Screen Capture 161. Deleting package

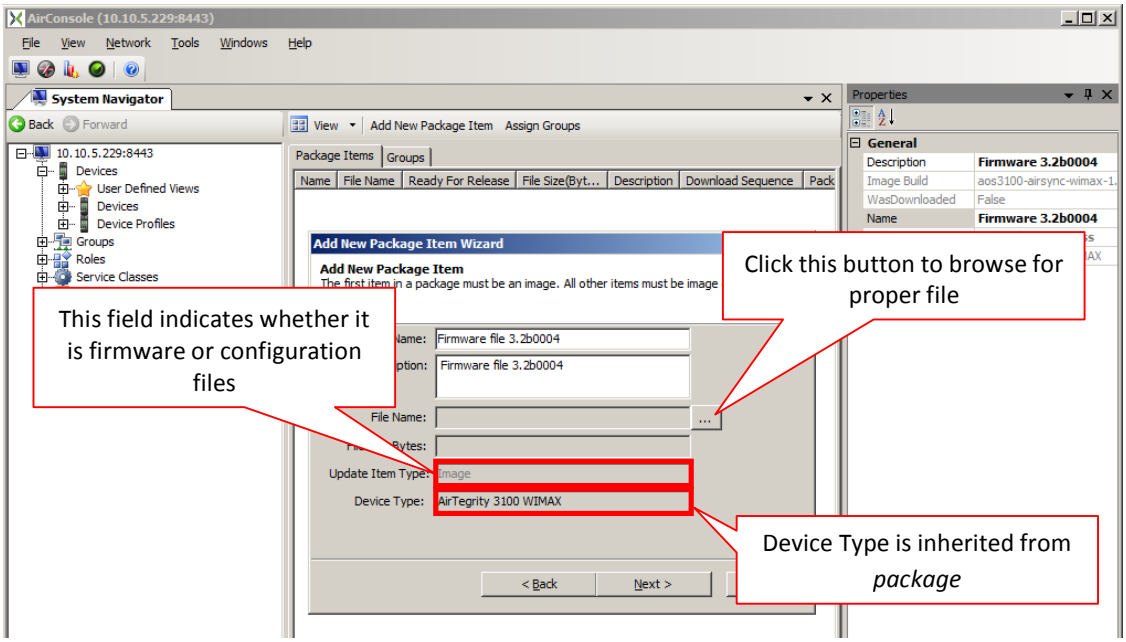
Working with Package Items

After defining the basic package you should add one or more items to the package. To work with **Package Items** you must navigate to the **Package Items** list. The quickest way to do this, however is to double-click proper **Package** as shown in Screen Capture 162. The other way to work with **Package Items** is to start wizard write after saving **Package**.



Screen Capture 162. Starting Add New Package Item Wizard

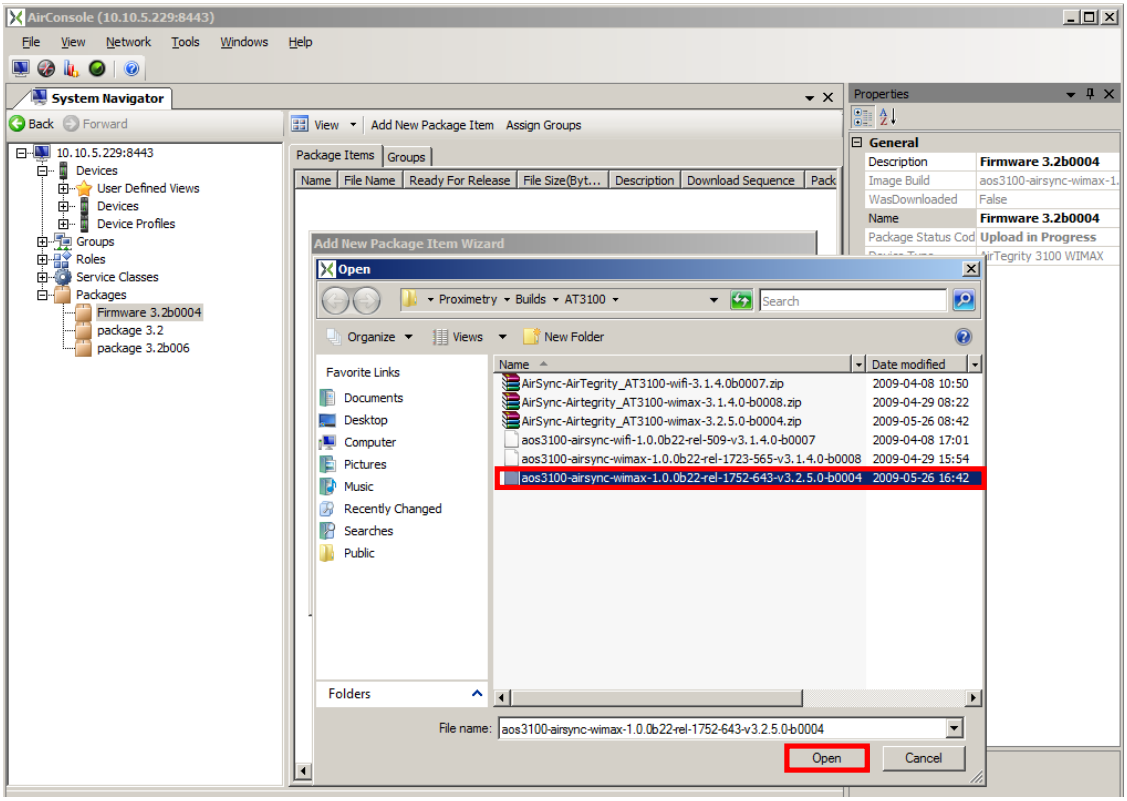
Clicking the **Add New Package Item** context menu or **Add Package Item** action button runs the **Add New Package Item Wizard** as shown in Screen Capture 163.



Screen Capture 163. Add New Package Item Wizard

Browsing for image file

The most important thing to do while adding package item is to select proper image file. Click the … action button and windows explorer browser window opens allowing you to find and select the source file for your package item as shown in Screen Capture 164.



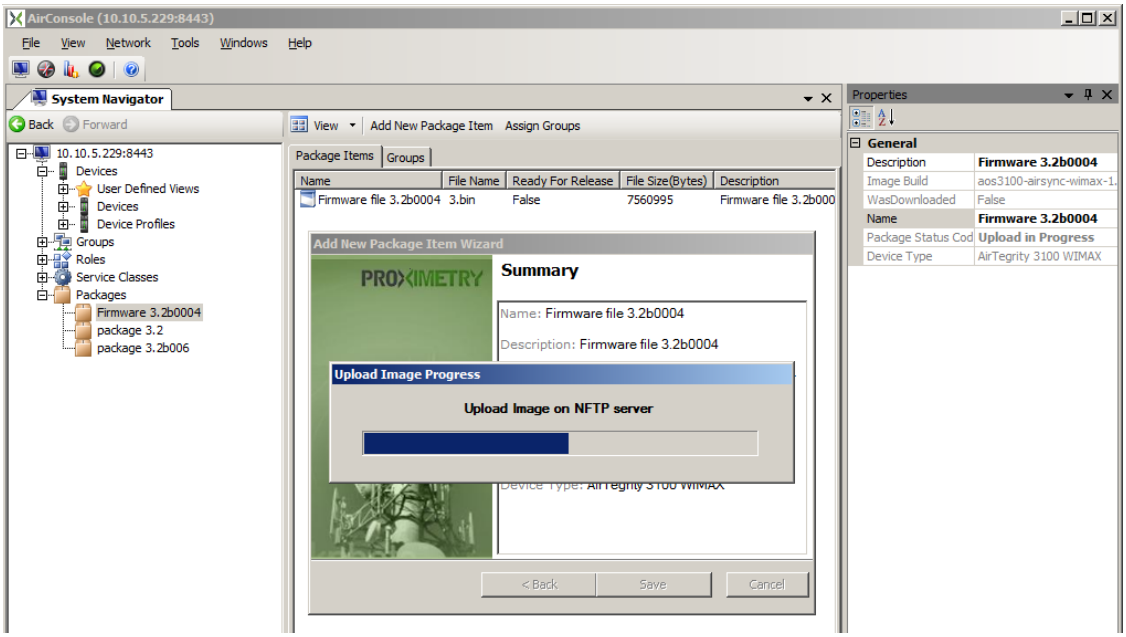
Screen Capture 164. Finding and selecting the source file for a package item in windows

Update Item Type

The value for the **Update Item Type** attribute is set automatically for the system as shown in Screen Capture 164. **Image** is set for firmware updates and **Image Delta** for configuration file updates. **Update Item Type** generates an appropriate set of instructions that tells the device how to process the package item after it has been received.

Update Item Type for the first package item has to be set to **Image.**

Click the **Next** and **Save** action button and the file will be uploaded to the AirSync Server. You can watch the progress indicator as shown in Screen Capture 165.



Screen Capture 165. Watching the Progress Indicator as the file is uploaded to the AirSync Server

Where and How are the files stored?

The files are upload to the /home/airsync/services/nftp/files subdirectory of the AirSync installation directory as shown in Screen Capture 166. Note the **File Name** and **File Size Bytes** attributes shown in Screen Capture 167 and also in Screen Capture 166 differs. The file size reported in the AirSync UI in is 7560995 which is smaller than the value 8979366 initially reported in Screen Capture 166.

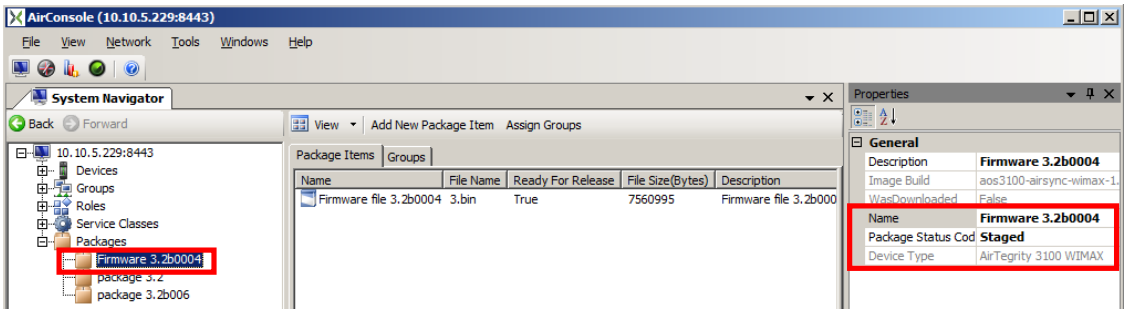
This is because NFTP encapsulates the original source file within an additional header. The smaller size value, 7560995, represents the original file size on the source computer before encapsulating the contents within an NFTP header. A subsequent inspection of the stored file, "4.bin" shows that the NFTP header has the original source file size encoded within it.

```
SD-AirSync:~# ls -l /home/airsync/services/nftp/files
total 30980
-rw-r--r-- 1 airsync airsync 7563401 2009-06-03 10:43 1.bin
-rw-r--r-- 1 root    root    7558720 2009-06-09 15:10 2.bin
-rw-r--r-- 1 root    root    7561174 2009-06-09 23:49 3.bin
-rw-r--r-- 1 root    root    8979366 2009-06-10 08:40 4.bin
SD-AirSync:~#

SD-AirSync:/home/airsync/services/nftp/files# more 4.bin
 <FileContent><Build_id>aos3100-airsync-wifi-1.0.0</Build_id><File
name="aos3100-airsync-wifi-1.0.0b22-rel-580-v3.2.5.0-b0003" size="8979194
"/></FileContent>
```

Screen Capture 166. Inspecting the package files stored on the server

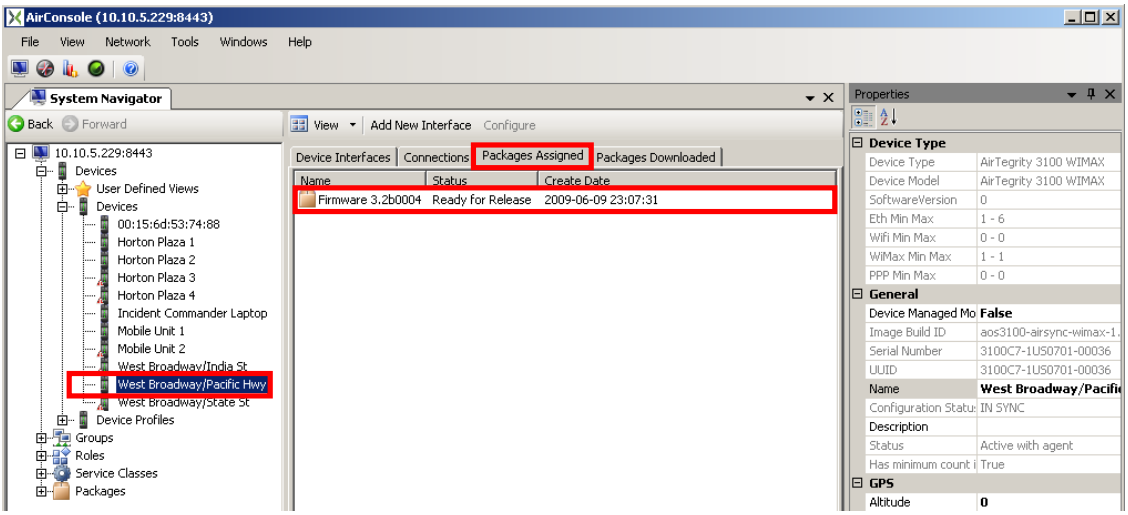
Before the package can be downloaded to any devices, its status must be changed to ready for release as shown in Screen Capture 167.



Screen Capture 167. Changing the status from "Staged" to "Ready for Release"

Packages and Device(s)

In order for the package to be processed by a device, one of the device's interfaces must be a member of one of the groups that has been assigned the package. Assuming this has been done, you can monitor the package management status by navigating to the **Devices** item list as shown in Screen Capture 168.

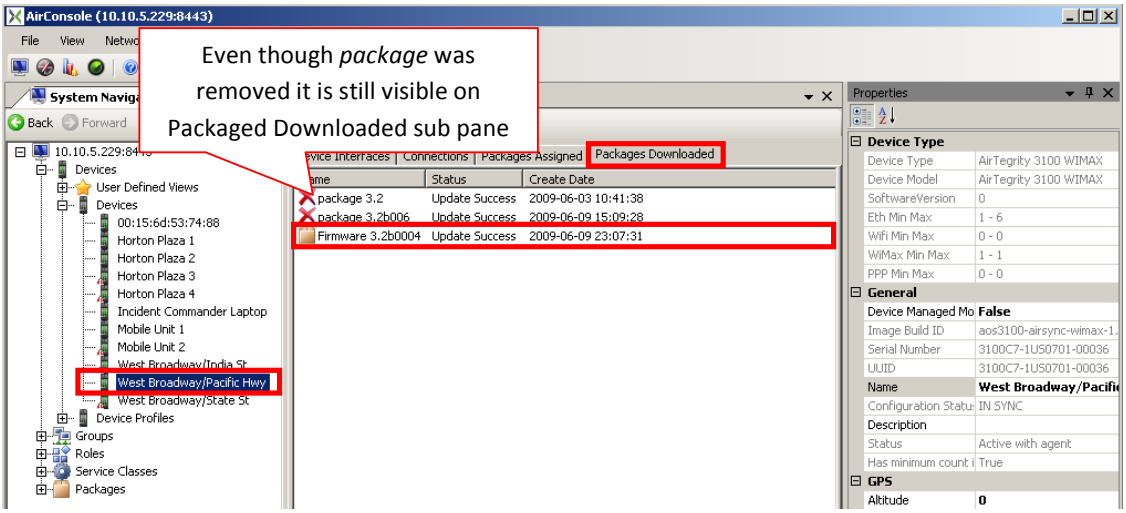


Screen Capture 168. Package assigned with a device

The **Packages Assigned** sub pane as shown in Screen Capture 168 will show all the packages currently assigned to a given device. In order to show up as assigned, the package must be assigned to an appropriate group or set of groups and the device must have one of its interfaces as a member of one of the groups for which the package has been targeted.

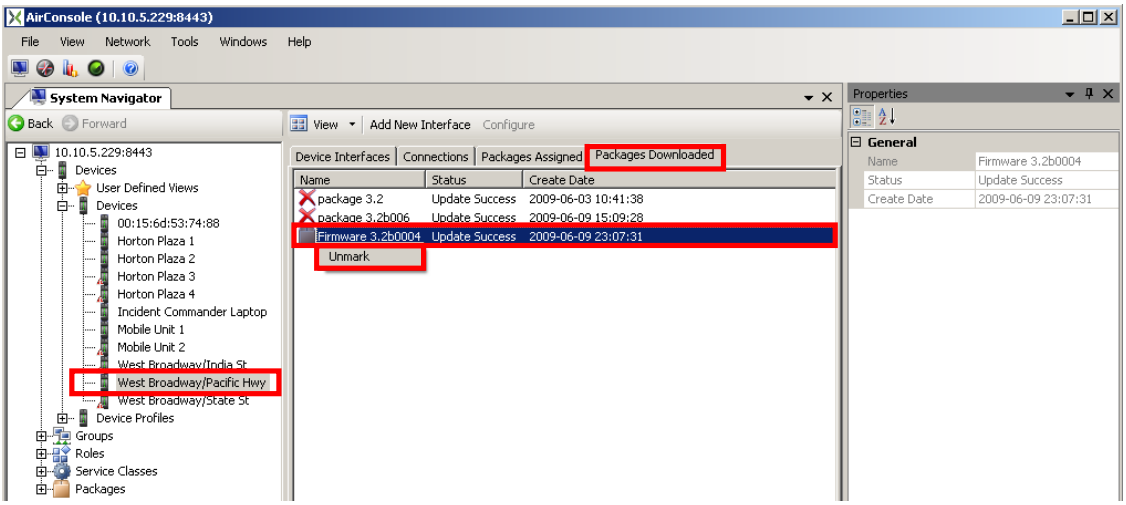
To clear the package from the device, either remove the device's interface(s) from the targeted group(s) for the package, or remove the package assignment from the group.

Navigate to the **Packages Downloaded** sub pane as shown in Screen Capture 169. You will see a list of the packages that have been downloaded and processed by the device in question. Items will show up in this list, even if they are not currently assigned to the device.



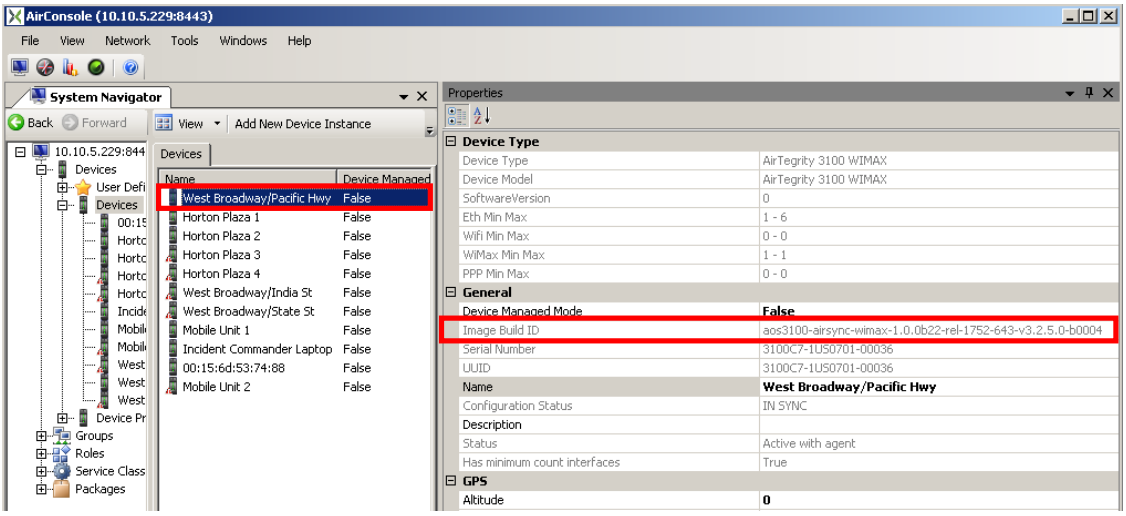
Screen Capture 169. Checking download status on the "Packages Downloaded" Device sub pane

If you want to re-process a package that is assigned to a device and has previously been processed, select the package in question from the **Packages Downloaded** item list for the device in question and click the **Unmark** action button as shown in Screen Capture 170. The selected package will disappear from the list. If it is still assigned to the device, it will be re-processed. This provides a convenient mechanism for rolling firmware back to previous versions but only in case that you have at least two packages downloaded and you unmark package with older version number. Unmark package will be re-processed again as it was said before and thanks to it device will have older firmware version installed again



Screen Capture 170. Using the "Unmark" action button to reapply the package update

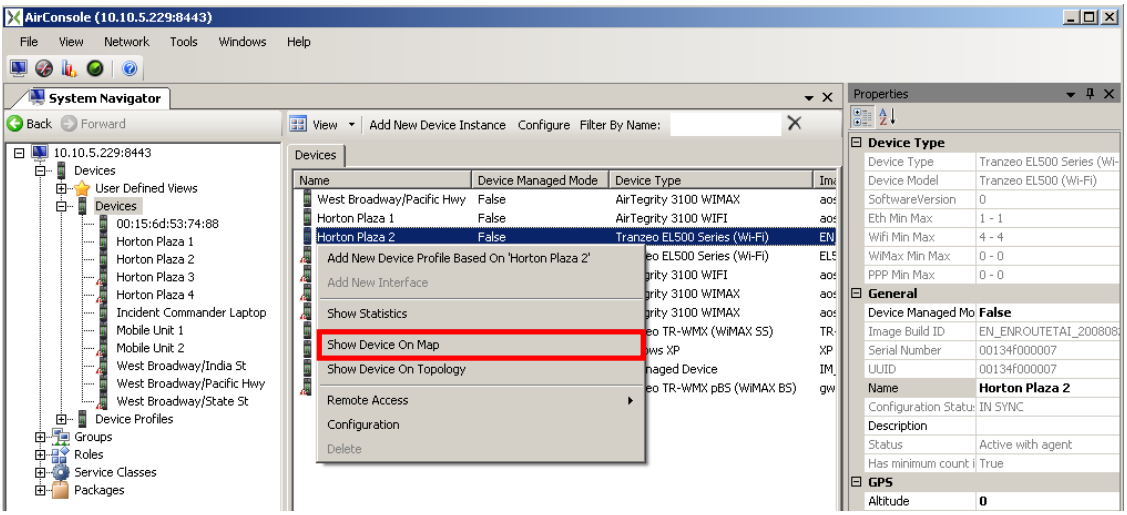
After a firmware or a configuration update package is received and unpacked successfully by the device, it will reboot to finish the process. Notice that AirSync will automatically adjust the value of the device's **Image Build ID** attribute as shown in Screen Capture 171. If you recall from a previous session, the **Image Build ID** is a read-only attribute, but AirSync's package management functionality keep this value appropriately updated.



Screen Capture 171. The Image Build ID attribute value for the device changes after update

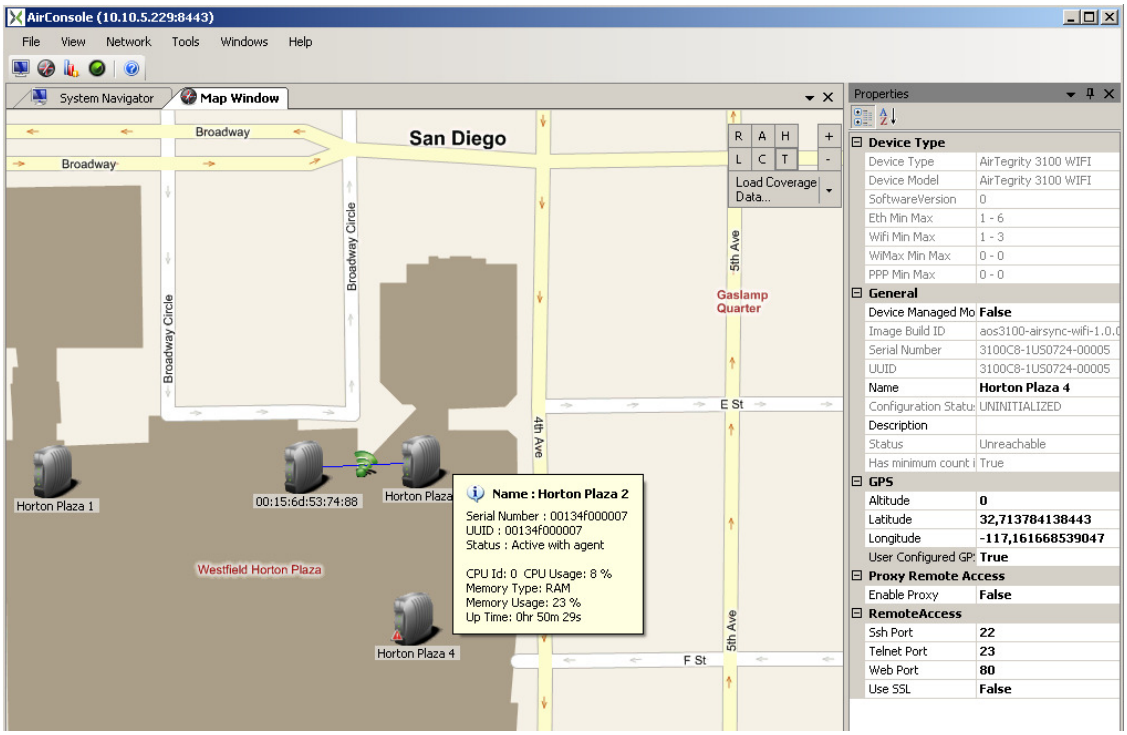
Using AirSync to Monitor the Network

AirSync provides a variety of network monitoring and mapping functions. Perhaps the simplest way to invoke them is to right click on a device and select a monitoring function from the context-sensitive menu. Screen Capture 172 shows a context-sensitive menu for displaying a device on a map.



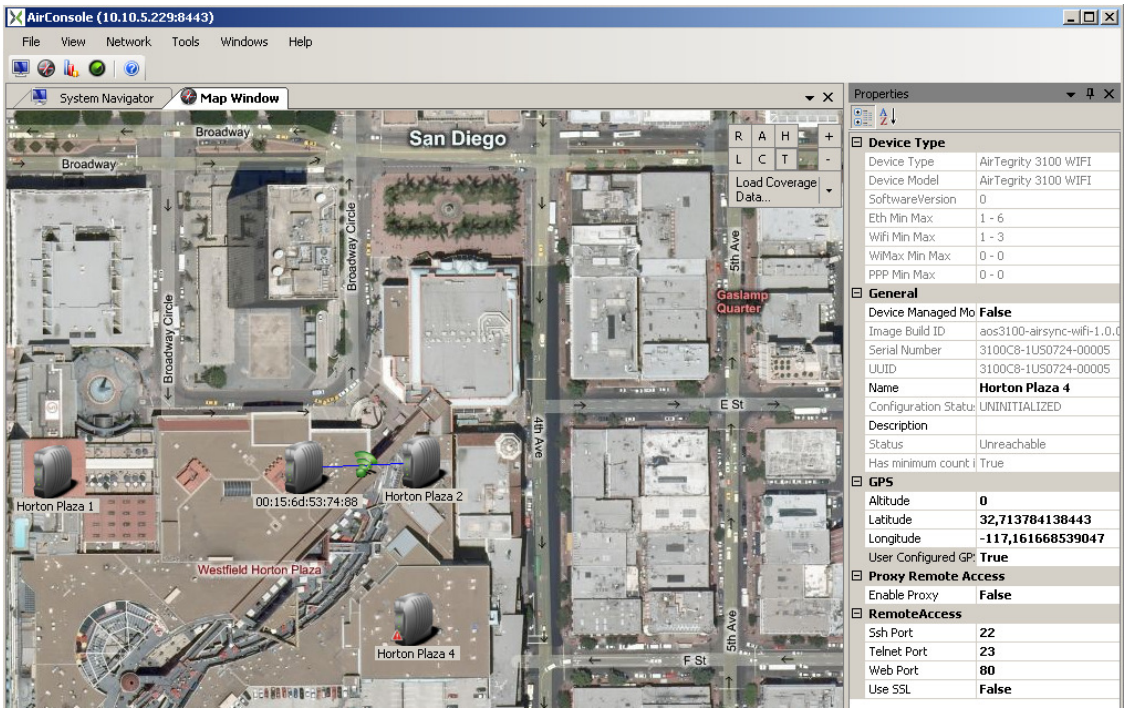
Screen Capture 172. Using a context sensitive menu to open the Map Window

Screen Capture 173 shows the **Map Window** open in streets mode. Notice the controls in the upper right hand part of the window. You can change the map mode to display an aerial or satellite view (click the A) or a Hybrid view showing both Street names and the satellite view. You can zoom in and zoom out with the "+" and "-" buttons. You can also hide or display labels, tooltips and connections by toggling the "L", "T" and the "C".



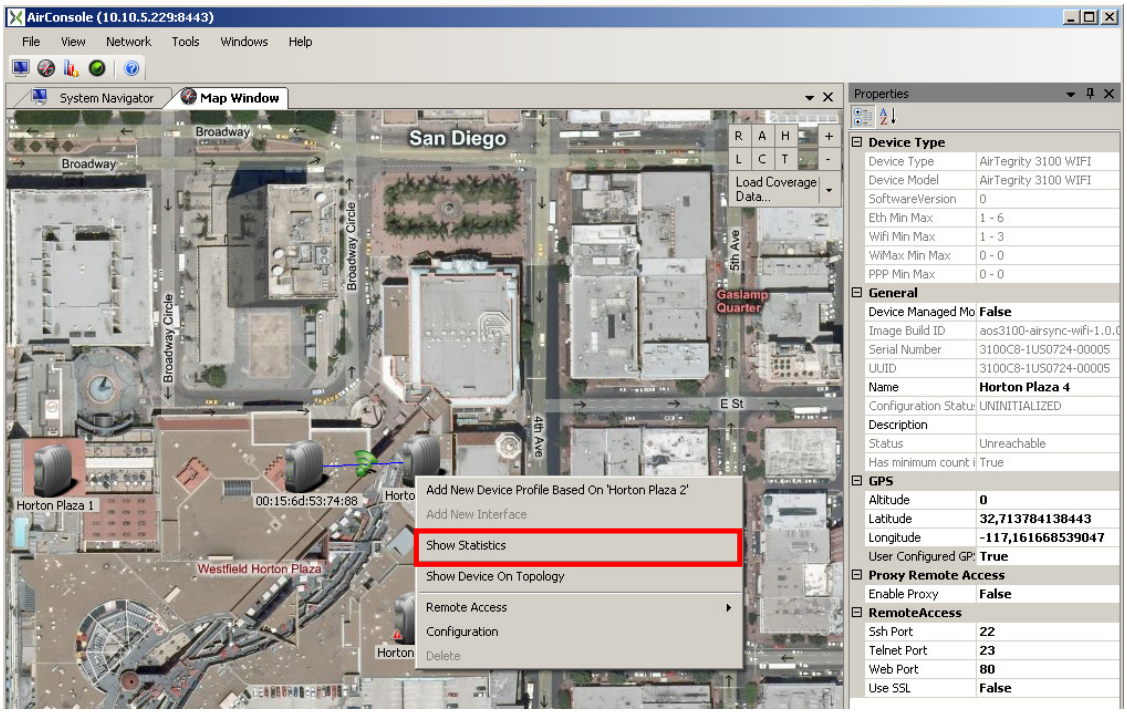
Screen Capture 173. The Map window in Streets mode

Screen Capture 174 shows the map window after it has been switched into hybrid mode.



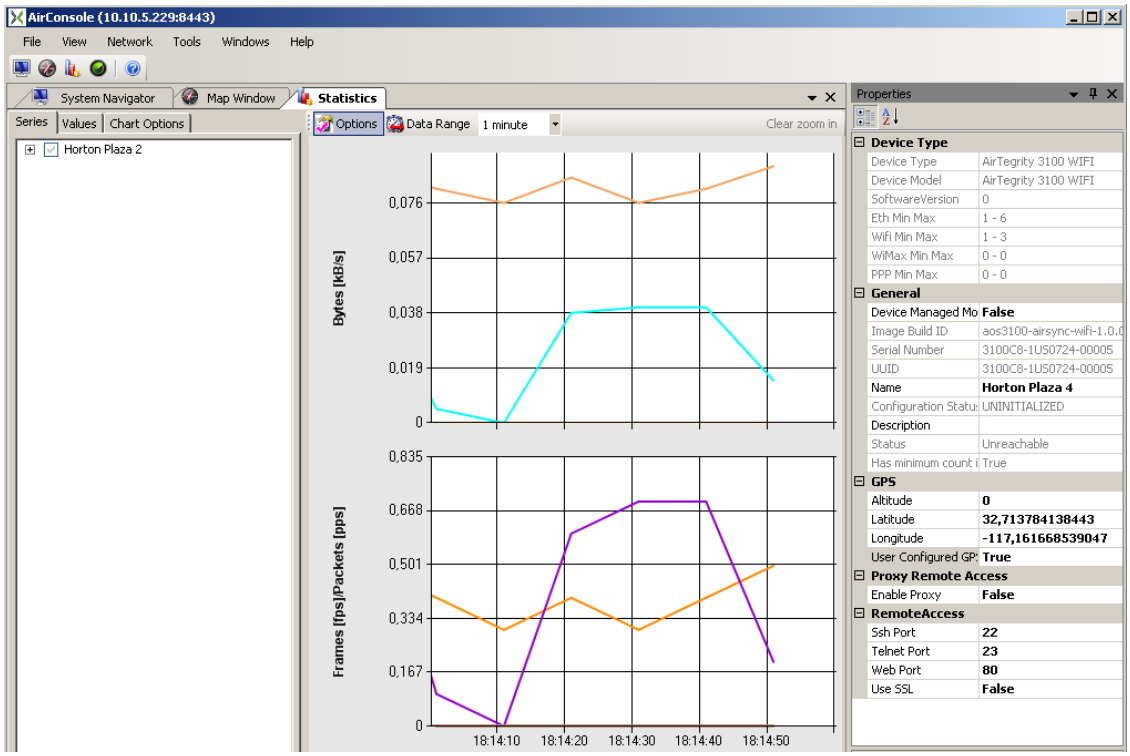
Screen Capture 174. Switching the Map window into Hybrid mode

Notice that you can right click on links, connections and nodes to bring up context sensitive menus from the **Map** window as shown in Screen Capture 175.



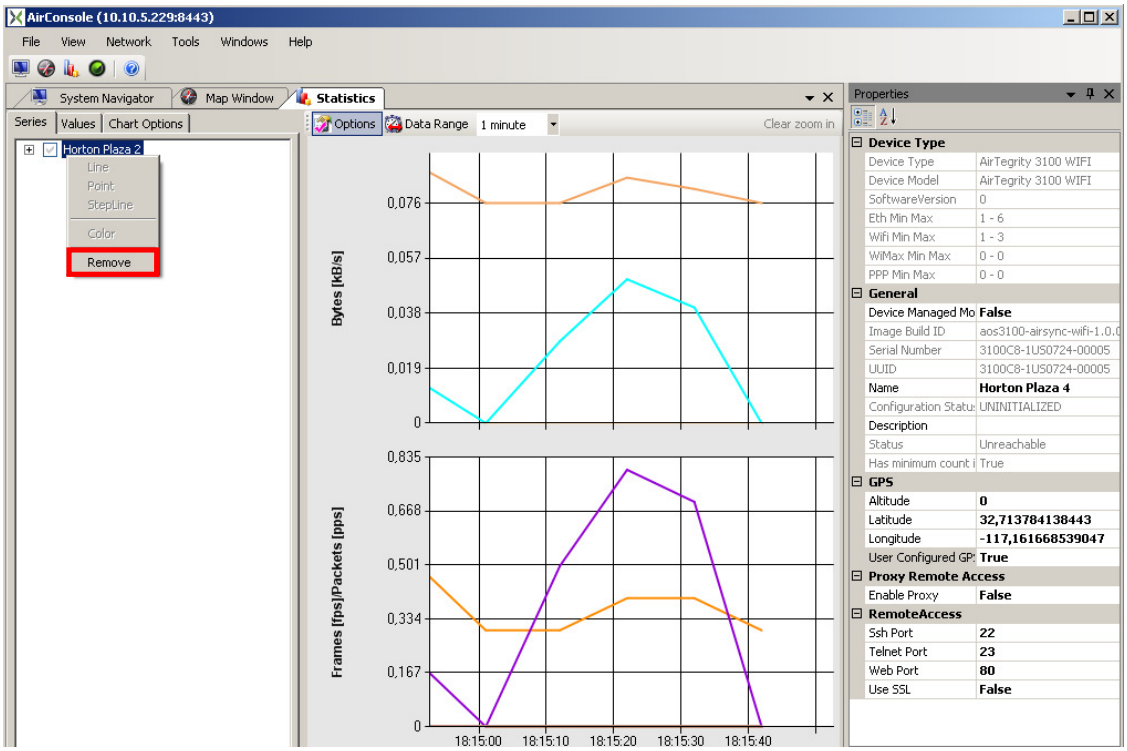
Screen Capture 175. Using a context menu to open the Statistics menu for an item

Show statistics context menu option shows the statistics window. You can also drag and drop devices or device interfaces into this window to chart them.



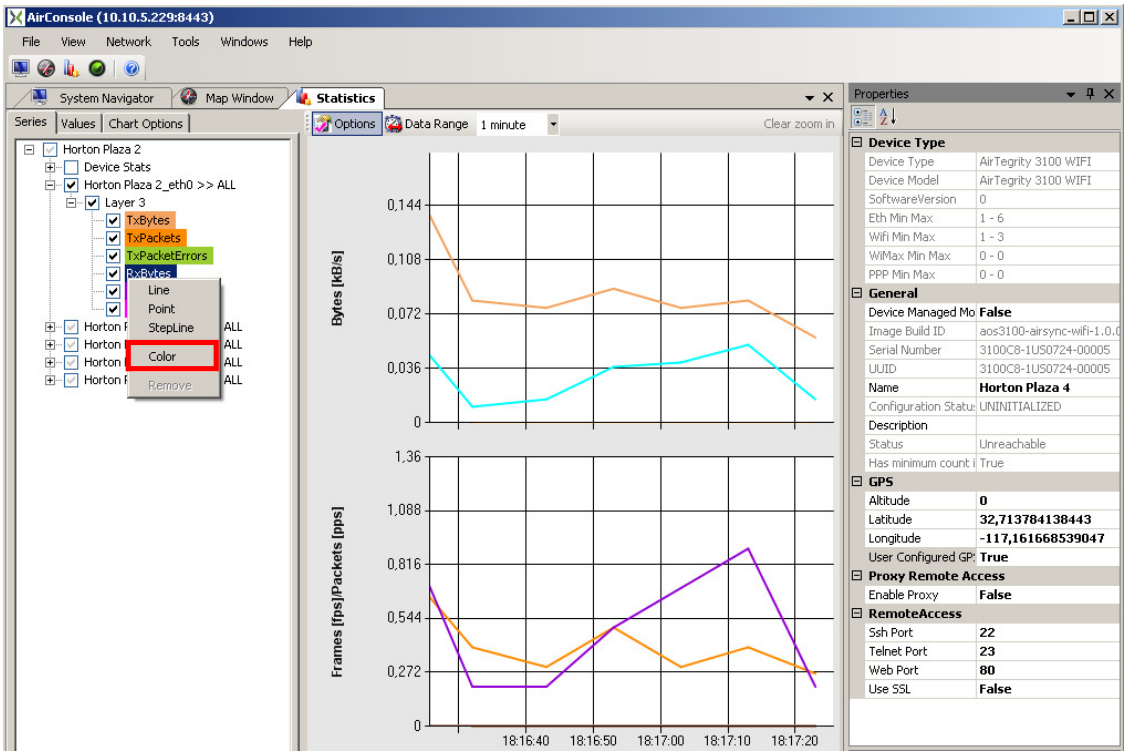
Screen Capture 176. The statistics window

To remove an item, right click it and choose **Remove** from the context sensitive menu as shown in Screen Capture 177.



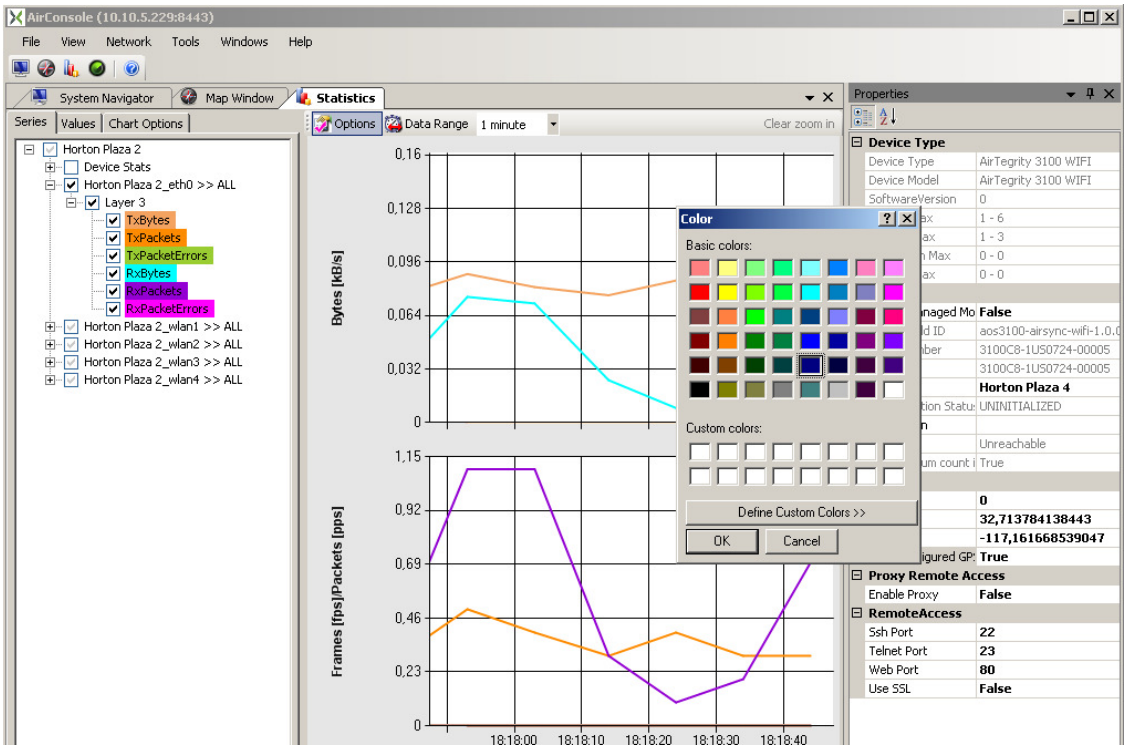
Screen Capture 177. Right click an item and choose "Remove" to delete it from the chart

If you expand an item in the **Series** pane, you can choose which options to chart including various items showing signal quality and throughput as shown in Screen Capture 178. You can also change the chart type and the color of the series plot.



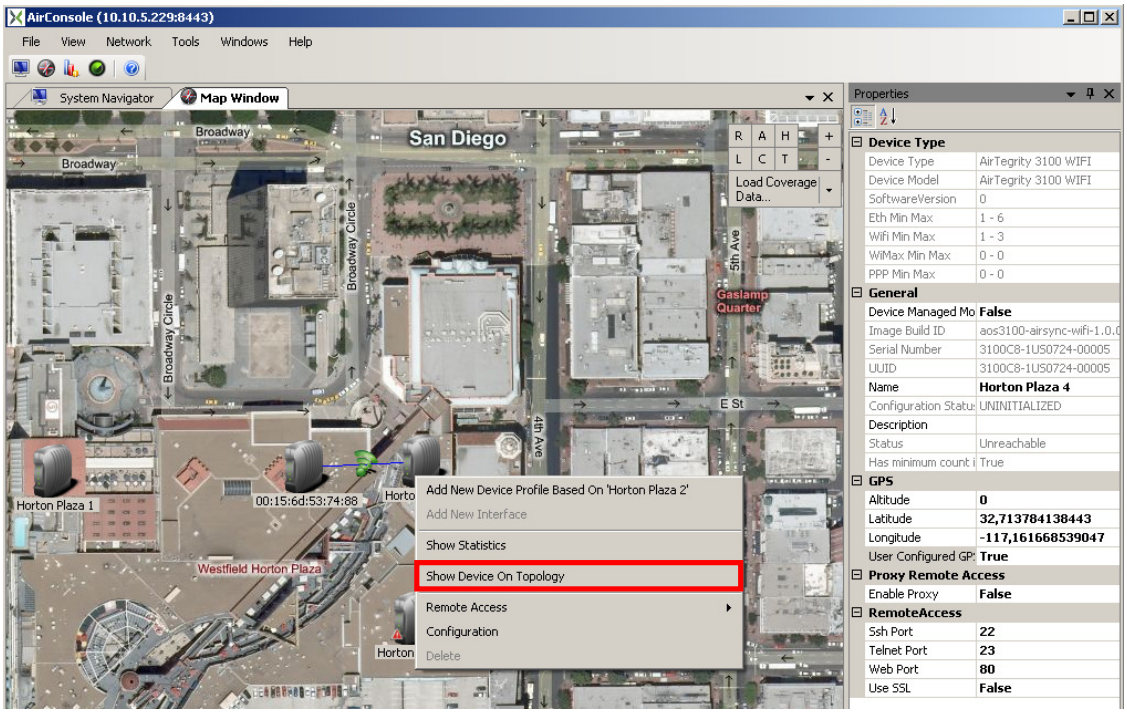
Screen Capture 178. Changing the color for a chart item from the context-sensitive menu

The **Color** context menu option shows the color selection tool window.



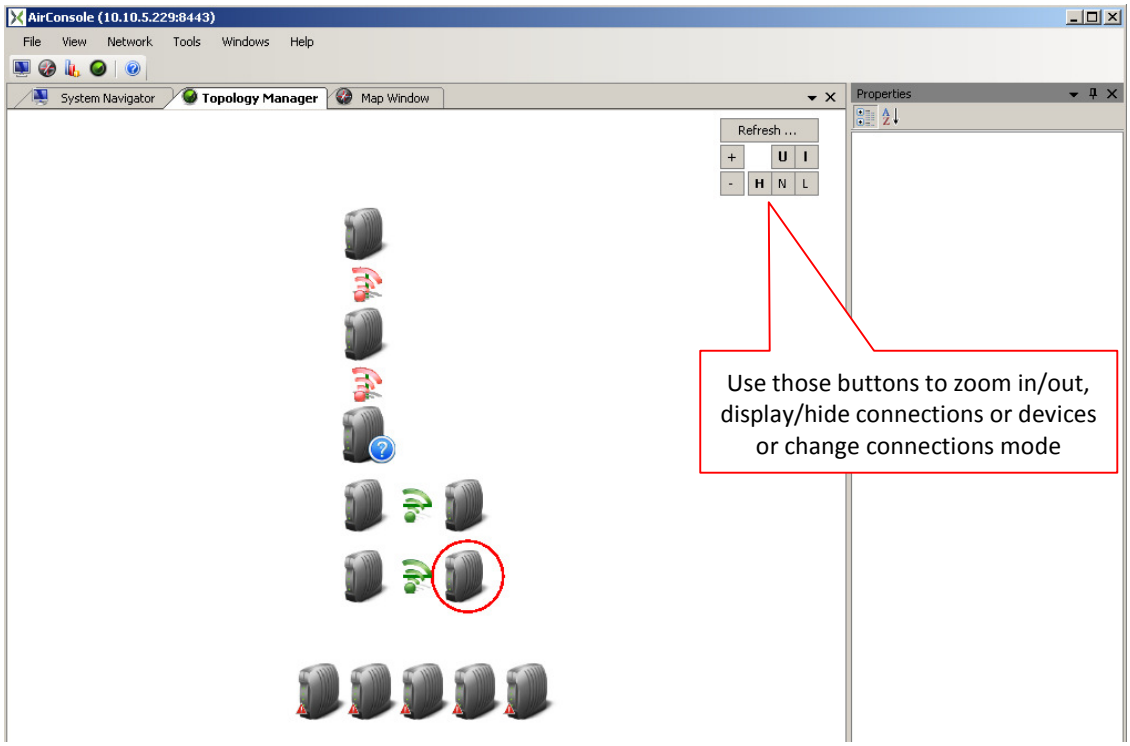
Screen Capture 179. The Color selection tool window

If you prefer to see a logical view of network topology, right click a device and choose the **Show Device on Topology** option from the context-sensitive menu as shown on Screen Capture 180.



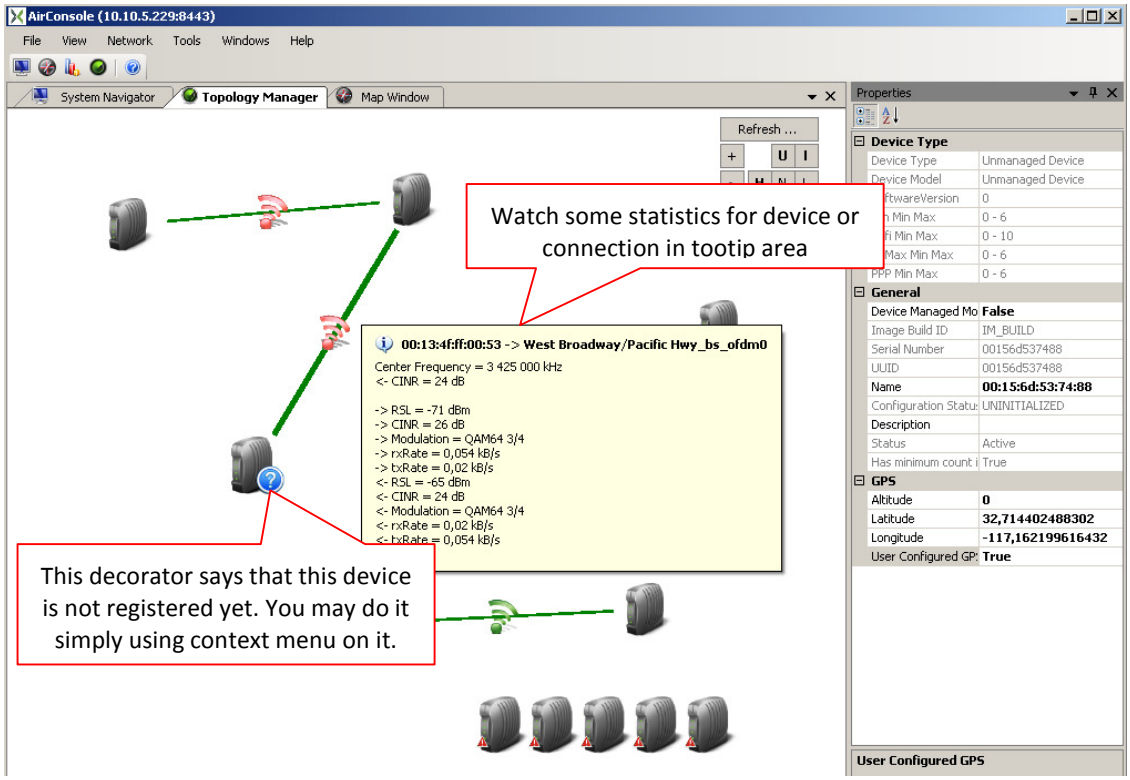
Screen Capture 180. Using a context menu to open the Statistics menu for an item

Screen Capture 181 shows the **Topology Manager** window with selected (red circle) device on which context menu option was used. At the beginning devices in this window are displayed in default mode but you may place them as you wish. You may change the **Topology Manager** mode to display logical path (click the N), network neighbor (click the L) or a hybrid connections view (click H). You can zoom in and zoom out with the "+" and "-" buttons. You can also hide or display inactive connections and unregistered devices by toggling the "U" and the "I".



Screen Capture 181. The "Topology Manager" window

Screen Capture 182 shows the **Topology Manager** window after relocation process. As you can see there is a possibility to observe some statistics for devices or connections as well in tool tip area. You may as well use context menu options started on device or connections to start another window or simply add unregistered device.



Screen Capture 182. The "Topology Manager" window after relocating devices

Appendix A. Item Descriptions for Tools – Options

Confirmations Tab

All values can be set to **True** or **False**

Confirm Closing Application

Determines whether or not the system will display a confirmation dialog box when the user attempts to close an application.

Confirm Delete AdHoc Rule

Determines whether or not the system will display a confirmation dialog box when the user attempts to delete an AdHoc Rule.

Confirm Delete Connection

Determines whether or not the system will display a confirmation dialog box when the user attempts to delete connection.

Confirm Delete Device

Determines whether or not the system will display a confirmation dialog box when the user attempts to delete a device from the AirSync system database.

Confirm Delete Device Interface

Determines whether or not the system will display a confirmation dialog box when the user attempts to delete an interface from a device in the AirSync database.

Confirm Delete Group

Determines whether or not the system will display a confirmation dialog box when the user attempts to delete a group from AirSync's database.

Confirm Delete Role

Determines whether or not the system will display a confirmation dialog box when the user attempts to delete a role from AirSync's database.

Confirm Delete Service

Determines whether or not the system will display a confirmation dialog box when the user attempts to delete a service from AirSync's database.

Confirm Delete Service Class

Determines whether or not the system will display a confirmation dialog box when the user attempts to delete a service class from AirSync's database.

Confirm Delete Service Class Pattern Value

Determines whether or not the system will display a confirmation dialog box when the user attempts to delete a Service Class Pattern Value from AirSync's database.

Confirm Delete Service Parameter

Determines whether or not the system will display a confirmation dialog box when the user attempts to delete a service parameter from AirSync's database.

Confirm Delete Update Package

Determines whether or not the system will display a confirmation dialog box when the user attempts to delete a package update from AirSync's database.

Confirm Group Move On Groups Tree

Determines whether or not the system will display a confirmation dialog box when the user attempts to move a group on the Groups Tree.

Confirm Remove Service From Role

Determines whether or not the system will display a confirmation dialog box when the user attempts to remove a service from a role in AirSync's database.

Remote Access Tab

These settings allow users to control the way AirSync establishes remote access connections to managed devices, for instance by right-clicking on a device and selecting "Remote Access" from the context-sensitive menu. All values are strings

Command Line Parameters (SSH)

Default value: [IP][P]

Meaning: Specify the command line parameters to use by the third-party program which is set in **SSH Executable Path** as proper tool for establishing SSH connections. This should normally be set to the default value [IP][P] which means IP Address and Port number, but for some tools there may be some other parameter set. For example to use third-party program named SecureCRT set **\[IP]** parameter in **Command Line Parameters (SSH)** field

Command Line Parameters (Telnet)

Default value: [IP][P]

Meaning: Specify the command line parameters to use by the third-party program which is set in **Telnet Executable Path** as proper tool for establishing SSH connections. This should normally be set to the default value [IP][P] which means IP Address and Port number, but for some tools there may be some other parameter set. For example to use third-party program named SecureCRT set **\[IP]** parameter in **Command Line Parameters (Telnet)** field

Default SSH Port

Default value: 22

Meaning: Specify the port number to use for establishing SSH connections. This should normally be set to the default value, 22, but should be changed if managed devices expect SSH connections on a different port

Default Telnet Port

Default value: 23

Meaning: Specify the port number to use for establishing telnet connections. This should normally be set to the default value, 23, but should be changed if managed devices expect telnet connections on a different port

Default Web Port

Default value: 80

Meaning: Specify the port number to use for establishing web (HTTP) connections. This should normally be set to the default value, 80, but should be changed if managed devices expect web (HTTP) connections on a different port

Default Web Port (SSL)

Default value: 443

Meaning: Specify the port number to use for establishing web (HTTPS) connections. This should normally be set to the default value, 8443, but should be changed if managed devices expect web (HTTPS) connections on a different port

SSH Executable Path

Default value:

Meaning: Specify the full path to the third-party executable program to be invoked for establishing remote access SSH connections to a managed device.

Telnet Executable Path

Default value: C:\Windows\System32\telnet.exe

Meaning: Specify the full path to the third-party executable program to be invoked for establishing remote access telnet connections to a managed device.

Web Executable Path

Default value: C:\Program Files\Internet Explorer\iexplore.exe

Meaning: Specify the full path to the third-party executable program to be invoked for establishing remote access telnet connections to a managed device.

Refresh Times Tab

These value determine the responsiveness of the user interface to a variety of events that can cause display information to change. Value is in seconds. Setting the value lower increases responsiveness at the expense of greater polling/CPU overhead.

Element Manager Refresh Time

Default value: 10

Meaning: How often configuration settings are refreshed from the server.

Chart Window Tab

Series Timeout

Default value: 5

Meaning: The AirSync system receives samples from AirSync Agent installed on a device. Each sample is send in some time. If sample does not come, AirSync waits for it as long as it is set in this parameter. If time is out AirSync plots a brake in statistics chart

Appendix B. Item Descriptions for Tools – System Configuration

Remember that any System Configuration Parameter Change requires AirSync Server restart to be completed.

General Configuration Tab

APPLY CONTROL SERVICES

This parameter decides whether apply control services onto WiMAX devices or not.

DOWNLOAD SERVER

Indicates, in <IP Address>:<TCP Port> format, the address of the server from which package updates may be accessed and downloaded.

SOFTWARE UPDATE FAIL TIMEOUT [s]

Time (in seconds) that is designated as the maximum allowed time span for a requested software update to complete.

UPLOAD SERVER

The UPLOAD SERVER configuration item specifies connectivity parameters for transferring files to the AirSync server. Indicates, in <IP Address>:<TCP Port> format. For instance, AirSync's Package Distribution functionality uses this facility for staging packages on the AirSync Server for subsequent redistribution to managed client devices. The Package Distribution feature is discussed in more detail elsewhere in this document.

Specifically, this configuration item should be set to an IP address followed by a ":" and a TCP port number:

<IP Address>:<TCP Port>

The IP address and port number specifies an endpoint where an NFTP server process is configured to listen for requests. The product installation process sets the initial value for the UPLOAD SERVER configuration item based on the IP address furnished to the installation script and a standard default port value.

This parameter will not require modification for most installations, but it may be appropriate to modify it, for example to distribute or offload server components to multiple machines, or if the default port (6667) is not available on the host machine.

Resource Manager Configuration Tab

BANDWIDTH CHANGE THRESHOLD

This parameter governs AirSync's bandwidth allocation algorithms.

You should generally never need to adjust this parameter value and doing so could lead to unexpected results.

DATAGRAM TIMEOUT [ms]

This parameter defines timeout for UDP packet waiting in the queue, after this timeout queue is being flushed.

SLD LIMITING INTERVAL [ms]

This parameter defines interval between invocations of Rules Enforcement algorithm.

For WiFi Rules Enforcement algorithm includes SLD algorithm, thus its processing time might be increased.

SLD PRIORITY MAX BANDWIDTH TABLE

This parameter governs AirSync's bandwidth allocation algorithm during periods of contention. AirSync invokes its Service Level Degradation (SLD) algorithms to arbitrate bandwidth allocation between competing traffic flows when there is not enough bandwidth to satisfy all requests. This is discussed in greater detail elsewhere in the document.

You should generally never need to adjust this parameter value and doing so could lead to unexpected results.

Activation Server Configuration Tab

The Activation Server runs on the AirSync server. Its primary function is to automatically detect manageable devices and register them with the AirSync system. The activation server sends XML-based multicast messages informing client devices about the parameters they should use to register themselves with an AirSync server. The most important parameters to check and set are the **RM SERVER** parameters.

ACK TIMEOUT [s]

This parameter is configured via AirConsole. It is time when AirSync waits for acknowledge on CAPWAP layer.

DEVICE STATISTICS INCIDENCE

This parameter is configured via AirConsole. It is multiplication of Statistic Time Span parameter. It means that device statistics will be send with Statistics Time Span * Device Statistics Incidence time interval. On a device it can be configured in airsync.ini as device_statistics_incidence. Default value 1. Range 0-255. Value 0 means Off (statistics are not send).

ECHO TIME SPAN [s]

This parameter is configured via AirConsole. It is interval between AirSync agent HeartBeats send to AirSync server. On a device it can be configured in airsync.ini as echo_time_span.

INTERFACE STATISTICS INCIDENCE

This parameter is configured via AirConsole. It is multiplication of Statistic Time Span parameter. It means that interface statistics will be send with Statistics Time Span * Interface Statistics Incidence time interval. On a device it can be configured in airsync.ini as interface_statistics_incidence. Default value 1. Range 0-255. Value 0 means Off (statistics are not send).

MONITORING TIME SPAN [ms]

This parameter is configured via Air*Console*. It is interval between asking network devices about their status. It allows AirSync server to find out network events like associations or disassociations. On a device it can be configured in airsync.ini as Monitoring Time Span.

RETRY COUNT

Number of retries of sending message when ACK Timeout occurs, after limit is reached, RMAgent is being reset. On a device it can be configured in airsync.ini as retry_count.

RM SERVER

IP Address of AirSync server process that communicates with AirSync software agents on managed client devices.

RM SERVER PORT

Port number of AirSync server process that communicates with AirSync software agents on managed client devices.

STATION STATISTICS INCIDENCE

This parameter is configured via AirConsole. It is multiplication of Statistic Time Span parameter. It means that station statistics will be send with Statistics Time Span * Station Statistics Incidence time interval. On a device it can be configured in airsync.ini as station_statistics_incidence. Default value 1. Range 0-255. Value 0 means Off (statistics are not send).

STATISTIC TIME SPAN [s]

This parameter is configured via AirConsole. It is interval between sending statistics. Statistics are also used as a device heartbeat. On device it can br configured in airsync.ini as basic_statistics_time_span.

This parameter is used by Http Managed devices as well even though they do not have AirSync Agent installed.

UPDATE TIME SPAN [s]

This parameter value should be configured via AirConsole. It is interval between checking for updates (in case when server is available). On a device it can be configured in airsync.ini as Update Time Span.

Http Manager Configuration Tab

DEVICE DETECTION INTERVAL [s]

This parameter defines time interval (in seconds) between tests of device activity. After changing this parameter AirSync Server must be restarted. Default value 60.

PARAMETERS REFRESH INTERVAL [s]

This parameter defines time interval (in seconds) between device parameters update. After changing this parameter AirSync Server must be restarted. Default value 300.

Appendix C. AirSync Preinstallation Requirements

This document describes AirSync preinstallation requirements related to network configuration for AirSync ability to operate. Figure 29 shows diagram of general AirSync usage.

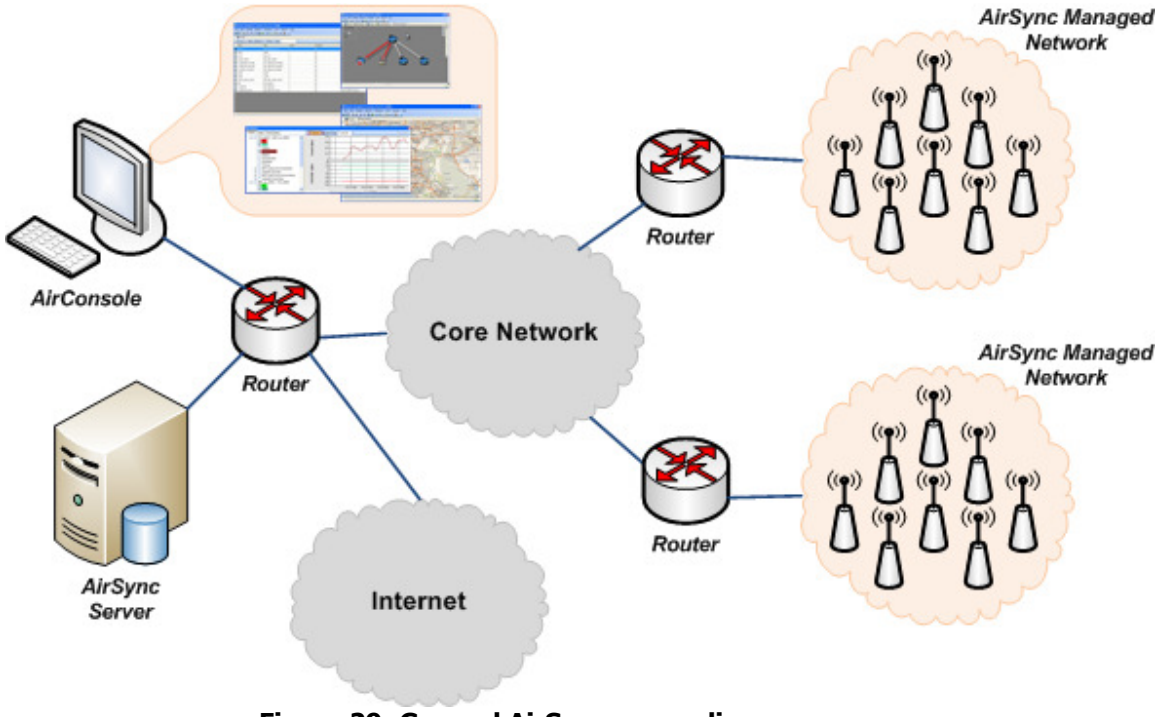


Figure 29: General AirSync usage diagram

Requirements Related to communication between AirSync Server and Managed Networks

All routers/firewalls operating between AirSync Server and AirSync Managed Networks must be configured to pass through following network traffic:

- multicast communication between AirSync enabled network devices and AirSync Server,

- udp communication on 5000 port
- udp communication on 6666 port
- tcp communication on 6668 port

tcp communication on 80 port for devices managed via AirSync HTTP Manager (or other port which is used by device's web configuration tool)

Requirements Related to communication between AirConsole and AirSync Server

All routers/firewalls operating between AirSync Server and AirConsole must be configured to pass trough following network traffic:

- tcp communication on 8443 port
- tcp communication on 6667 port

All routers/firewalls operating between AirConsole and Internet must be configured to pass trough following network traffic:

- tcp communication on 80 port

Requirements Related to Network Time Synchronization

AirSync managed devices and AirSync Server machine must have synchronized time in UTC (e.g. via NTP service).

Appendix D. Example AirSync configuration for Wireless ISP scenario

Following chapter describes simple AirSync configuration for Wireless ISP scenario. The scenario assumes that network operator provides for his customers three services: VoIP, Internet Access with various service levels and VLAN dedicated connection. Figure 1 shows general network diagram for this scenario.

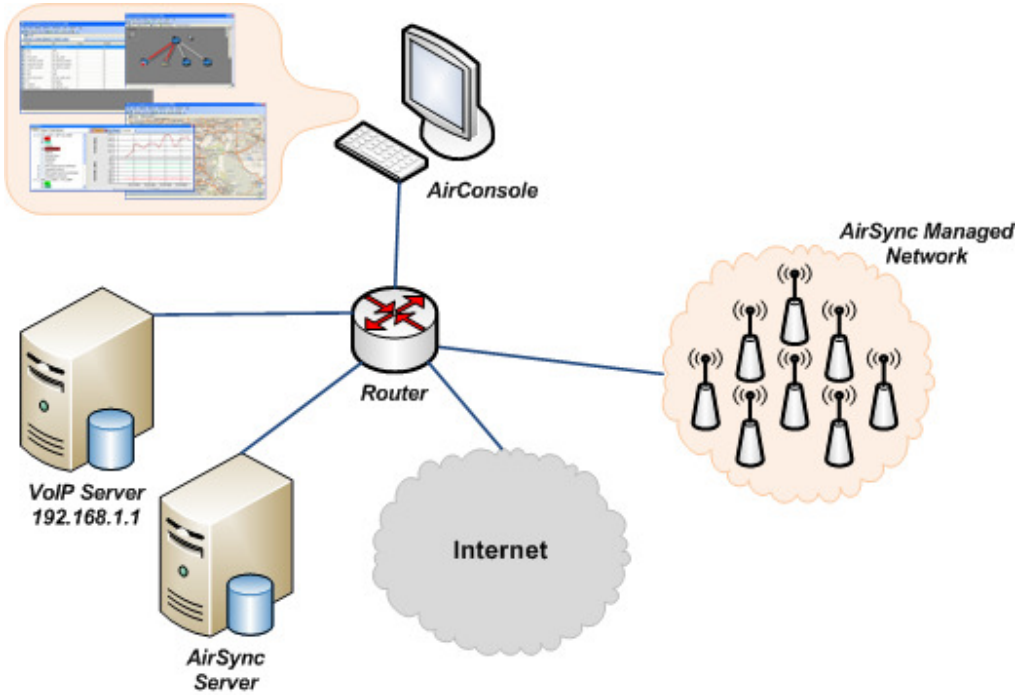


Figure 30. General network diagram for Wireless ISP scenario

Wireless ISP service description

1. VoIP

Voice over IP service runs on server with IP address 192.168.1.1 which uses UDP 5060 port for signaling protocol and UDP ports 10001 – 20000 for RTP streams.

Service parameters: downstream and upstream bandwidth 320 – 400 kBps, latency up to 40 ms, priority 1.

2. Internet Access

Internet Access service provides connectivity to all IP addresses over ICMP and TCP protocols and to all IP addresses over UDP protocol on all ports except 5060 & 10001-20000.

Internet Access service has two levels:

- Basic – upstream bandwidth up to 128 kBps, downstream bandwidth up to 256 kBps, priority 6,
- Premium – upstream bandwidth up to 512 kBps, downstream bandwidth up to 1024 kBps, priority 6.

3. VLAN dedicated connection

VLAN dedicated connection service provides VLAN based connectivity. In this example VLAN ID 50 is used. Service parameters: downstream and upstream 2048 kBps, priority 2.

AirSync Service Classes configuration

Following tables shows AirSync Service Classes configuration (see 'Working with Service Classes' chapter for details about creating Service Classes).

Name	WISP – VoIP Service Class
Min Up Bw	20
Min Down Bw	20
Patterns	Pattern type: transproto:dscp:ip/net:port_start-port_end Pattern value: udp:any:192.168.1.1/255.255.255.255:10001-20000 Pattern type: transproto:dscp:ip/net:port_start-port_end Pattern value: udp:any:192.168.1.1/255.255.255.255:5060-5060

Table 12. WISP – VoIP Service Class configuration

Name	WISP – Internet Access Service Class
Min Up Bw	0
Min Down Bw	0
Patterns	Pattern type: transproto:dscp:ip/net:port_start-port_end Pattern value: icmp:any:0.0.0.0/0.0.0.0:0-65535 Pattern type: transproto:dscp:ip/net:port_start-port_end Pattern value: udp:any:0.0.0.0/0.0.0.0:0-5059 Pattern type: transproto:dscp:ip/net:port_start-port_end Pattern value: udp:any:0.0.0.0/0.0.0.0:5061-10000 Pattern type: transproto:dscp:ip/net:port_start-port_end Pattern value: udp:any:0.0.0.0/0.0.0.0:20001-65535 Pattern type: transproto:dscp:ip/net:port_start-port_end Pattern value: tcp:any:0.0.0.0/0.0.0.0:0-65535

Table 13. WISP – Internet Access Service Class configuration

Name	WISP – VLAN_50 Service Class
Min Up Bw	0
Min Down Bw	0
Patterns	Pattern type: vlan Pattern value: 50

Table 14. WISP – VLAN_50 Service Class configuration

AirSync Services configuration

Following tables shows AirSync Services configuration (see 'Working with Services' chapter for details about creating Services).

Name	WISP – VoIP Service
Description	Voice over IP Network Traffic
Service Class	WISP – VoIP Service Class
Parameters	Bandwidth DownStream: 40-50 Bandwidth UpStream: 40-50 Priority: 1 Latency: 40

Table 15. WISP – VoIP Service configuration

Name	WISP – Internet Access Service - 128/256 kBps
Description	Internet Traffic
Service Class	WISP - Internet Access Service Class
Parameters	Bandwidth DownStream: 0-32 Bandwidth UpStream: 0-16 Priority: 6

Table 16. WISP – Internet Access Service - 128/256 kBps configuration

Name	WISP – Internet Access Service - 512/1024 kBps
Description	Internet Traffic
Service Class	WISP - Internet Access Service Class
Parameters	Bandwidth DownStream: 0-32 Bandwidth UpStream: 0-16 Priority: 6

Table 17. WISP – Internet Access Service - 512/1024 kBps configuration

Name	WISP - VLAN_50 Service
Description	VLAN 50 Network Traffic
Service Class	WISP – VLAN_50 Service Class
Parameters	Bandwidth DownStream: 256-256 Bandwidth UpStream: 256-256 Priority: 2

Table 18. WISP - VLAN_50 Service configuration

AirSync Roles configuration

Following tables shows AirSync Roles configuration (see 'Working with Roles' chapter for details about creating Roles).

Name	WISP – Basic Internet Access
Services	WISP – Internet Access Service - 128/256 kBps

Table 19. WISP – Basic Internet Access Role configuration

Name	WISP – Premium Internet Access
Services	WISP – Internet Access Service - 512/1024 kBps

Table 20. WISP – Premium Internet Access Role configuration

Name	WISP – Basic Internet Access + VoIP
Services	WISP – Internet Access Service – 512/1024 kBps WISP – VoIP Service

Table 21. WISP – Basic Internet Access + VoIP Role configuration

Name	WISP – Premium Internet Access + VoIP
Services	WISP – Internet Access Service – 512/1024 kBps WISP – VoIP Service

Table 22. WISP – Premium Internet Access + VoIP Role configuration

Name	WISP – VLAN_50 Network
Services	WISP - VLAN_50 Service

Table 23. WISP – VLAN_50 Network Role configuration

AirSync Groups configuration

Following tables shows AirSync Groups configuration (see 'Working with Groups' chapter for details about creating Groups).

Name	Internet Basic
Role	WISP – Basic Internet Access

Table 24. WISP – Internet Basic Group configuration

Name	Internet Premium
Role	WISP – Premium Internet Access

Table 25. WISP – Internet Premium Group configuration

Name	Internet Basic + VoIP
Role	WISP – Basic Internet Access + VoIP

Table 26. WISP – Internet Basic + VoIP Group configuration

Name	Internet Premium + VoIP
Role	WISP – Premium Internet Access + VoIP

Table 27. WISP – Internet Premium + VoIP Group configuration

Name	VLAN 50 Network
Role	WISP – VLAN_50 Network

Table 28. WISP – VLAN 50 Network configuration

Appendix E. AirSync tuning

AirSync system after installation is configured to some default parameters. As networks can vary in size (including infrastructure characteristic like number of managed devices vs unmanaged clients), services definitions and especially activity characteristics (frequency and type of events generated which have to be serviced by Server) all parameters which can be used to tune the system regardless if available from AirConsole or require changing startup scripts or modifying configuration files are described.

Parameters

Parameters used by AirSync Agent:

Parameter	Agent Process	Description	Default Value
Update Time Span [s]	DMUpdate	Interval between checking for updates. Configured via AirConsole or in airsync.ini as update_time_span.	600
Statistic Time Span [s]	RMAgent	Basis interval between sending statistics. Configured via AirConsole or in airsync.ini as basic_statistics_time_span.	10
Device Statistics Incidence	RMAgent	The multiplier for final device statistics interval. Configured via AirConsole or in airsync.ini as device_statistics_incidence	1
Interface Statistics Incidence	RMAgent	The multiplier for final interface statistics interval. Configured via AirConsole or in airsync.ini as interface_statistics_incidence.	1
Station Statistics Incidence	RMAgent	The multiplier for final station statistics interval. Configured via AirConsole or in airsync.ini as station_statistics_incidence.	1
ACK Timeout [s]	RMAgent	Timeout for receiving acknowledge	10

		message from server, after this timeout RMAgent retries sending message, configured in AirConsole or in airsync.ini as ack_timeout.	
Retry Count	RMAgent	Number of retries of sending message when ACK Timeout occurs, after limit is reached, RMAgent is being reset. Configured via AirConsole or in airsync.ini as retry_count.	5
Echo Time Span [s]	RMAgent	Interval between AirSync agent HeartBeats send to AirSync server. Configured via AirConsole or in airsync.ini as echo_time_span.	30
Monitoring Time Span [ms]	RMAgent	Interval for polling driver for system events. Configured via AirConsole or in airsync.ini as monitoring_time_span.	5000

Parameters used by AirSync Server:

Parameter	Description	Value
Polling Interval [ms]	Interval for polling RM State Tables. Configured by passing command line argument *–i*	10000
ACK Timeout [ms]	Timeout for receiving acknowledge message from agent, after this timeout message is being resent. Configured by passing command line argument *–t*	5000
Dead Timeout [ms]	Timeout for receiving acknowledge message from agent, after this timeout agent is being asked to reset itself. Configured by passing command line argument *–td.* This parameter should be configured taking into account values of other parameters: - Agent Retry Count (ARC) - Agent ACK Timeout (AAT) - Server Datagram Timeout (SDT) and follow the equation:	70000

	1000 * (ARC * AAT) + SDT	
Device Status Timeout [ms]	Timeout for monitoring if device is alive (if sends heartbeats. Configured by passing command line argument *–dst* This parameter should be configured taking into account values of other parameters: - Echo Time Span (ETS) - Agent Retry Count (ARC) - Agent ACK Timeout (AAT) - Server Datagram Timeout (SDT) and follow the equation: 1000 * (ETS + ARC * AAT) + SDT	100000
Datagram Timeout [ms]	Timeout for UDP packet waiting in the queue, after this timeout queue is being flushed. Configured via AirConsole.	20000

Business:

Parameter	Description	Value
SLD Limiting Interval [ms]	Interval between invocations of Rules Enforcement algorithm. Configured via AirConsole.	15000[1]
Bandwidth Change Threshold (kB)	Threshold value for difference between last estimated bandwidth and new estimated bandwidth, if exceed SLD is being invoked. Configured via AirConsole. Used only for WiFi interfaces.	100

[1] For WiFi Rules Enforcement algorithm includes SLD algorithm, thus its processing time might be increased

Parameters Dependency

Server – Device communication

Communication protocol between server and device is based on UDP. In order to increase its reliability acknowledges mechanism is used. In order to assure proper communication between devices in the network and AirSync server, parameters of this mechanism has to be tuned to existing network conditions. In communication between Server and Device, only Statistics message is not acknowledged. From the AirSync Agent perspective parameters used are ACK Timeout and Retry Count, while from RMServer ACK Timeout and Dead Timeout.

Parameters ACK Timeout (on both sides of the communication) has to be tuned to existing network conditions. Of course value of this parameter on RMServer side has to be tuned to the worst node (AirSync enabled device), while on the Agent side it can be treated individually. ACK Timeout parameter takes into account time of sending and receiving UDP packet, therefore its value cannot be less than ping time. This value should be tuned in case there are succeeding restarts of AirSync Agent. If the value is too small, it can result in unneeded retries of sent packets, on the other hand if the value is too large Agent will send retry after longer time which leads to slower self-healing in case packet was lost. The other thing to consider during tuning Agent ACK Timeout is that its change should influence other parameters (Dead Timeout and Device Status Timeout) and making it to high will delay recognition that device is offline. Due to event's queue flush algorithm on a Server a good practice is to have Agent ACK Timeout in the range of ½-1 of Datagram Timeout parameter.

Parameters Retry Count (AirSync Agent) and Dead Timeout (RMServer) are used to stop the communication that is not reliable. From the Agent perspective, after ACK Timeout is being reached, last message is being resent. If number of resends exceeds Retry Count, communication is being stopped, i.e. AirSync Agent goes into fault mode of operation. If the value of this parameter is too small, Agent will most of the time be in fault mode, if it's too large network traffic generated by AirSync may increase. On the server side parameter Dead Timeout is analogous to Retry Count, however it works differently. If value of this parameter is exceeded, server starts to treat Agent as working in fault mode and asks it to reset itself. It is very important that value of Dead Timeout is greater than value of ACK Timeout parameter, otherwise acknowledges mechanism on server side will be disabled, e.g. if ACK Timeout = 5s and Dead Timeout = 15s not acknowledged message will be resent after 5s, but after three retries, device is asked to reset itself. In case of setting Dead Timeout smaller than ACK Timeout, after exceeding value of the first, device is already treated as dead and none message is being resent. The value of this parameter should be calculated according to equation defined in table above.

In case of very dynamic network, or network startup when very large number of network events is sent from managed devices to server, it may happen that server will not be able to process events with sufficient time and it'll be blocked after a while. In order to prevent from such a situation, server posses a mechanism for flushing events queue in case of processing time being too large. This mechanism together with reliability advantages of communication protocol (acknowledges and retries) allows to handle the situation presented. The parameter that controls when the queue will be flushed is called Datagram Timeout. The parameter value says that if first packet that is supposed to be processed stays in the queue longer than Datagram Timeout, the queue should be flushed. The proper value of this parameter

depends on network size, events frequency (clients activity – how often can associate, disassociate or bitrate/modulation change happens) and hardware on which Server is installed due to all the events have to be processed by AirSync Server. Guidelines for tuning this parameter are proposed in section "Configuration guidelines".

QoS rules propagation

Process of providing QoS rules to the devices is triggered by any of the following:

1. Association/Disassociation of client/subscriber device.
2. Satisfaction (or revocation) of AdHoc Rule IF statement.
3. Bandwidth change calculated by Bandwidth Estimator (for WiFi only).
4. Provisioning plan modification by system operator (not tunable).

First and second types of events have their source in changes in network environment, therefore there tuning is performed on Agent side by the parameter Monitoring Time Span parameter. Setting this interval to small value increases faster system reaction on any of above, however increases both network traffic (multiple messages in short time slot) and server load. For example if Monitoring Time Span is set to 1s and any of association-disassociation-modulation change - SNR change happens each second, than each second a message from a device is being sent to server, however if in the same case Monitoring Time Span is set to 5s, then only network state from fifth second is being sent. In case of oscillating networks it might be useful to set this interval to larger value in order to stabilize system reaction (do not react on small changes). Other important thing to remember is that results of monitoring are periodically sent as statistics, therefore Monitoring Time Span should be less than Statistic Time Span multiplied by the minimal of Device / Interface / Station Statistics Incidence.

Third type of event is controlled by two parameters, namely Statistic Time Span (described earlier) and Bandwidth Change Threshold. First one was already described above. Second parameter allows tuning system reaction for small changes. As Bandwidth Estimator algorithm is very sensitive to both environment (radio) and topology changes, in case of varying network system may end up with permanent device reconfiguration, and finally in network instability. In case of small value of this parameter, above situation may occur. However, in case of too large value, system may not react on bandwidth changes of the radio links. Bandwidth Estimation is available only for WiFi devices, thus this type of event is WiFi specific.

Rules propagation mechanism is driven by events described above, but can be also tuned in the second stage of it. Two parameters used for this tuning are SLD Limiting Interval and Polling Interval. First parameter defines how often service parameters (and resulting QoS rules) are scheduled for distribution to the network. [In case of WiFi, before the distribution occurs an adjusting of the parameters to existing network conditions is being performed. In case when QoS rules are not changed, they are not propagated to the devices, even when any of above events occurs.] Therefore this is the next place in rules propagation process that may slow down system reaction, or decrease system oscillations (and in result increase network stability) and in opposite. Second parameter, Polling Interval, is used by RMServer to poll database for any changes in QoS rules. This is the last point where slowing down of the rules propagation process can be performed. In case when this parameters is too large,

system response for any network event increases. The estimated time of delivering/changing rules in case of client events appears in good network conditions and Server not being overloaded consists of: Monitoring Time Span, SLD Limiting Interval and Polling Interval and is supposed to be half of the sum of the listed parameters in average.

Device update

Update process is very crucial both from system, network and device perspective. From system side, when poll for updates from network nodes are very often, it may increase the load on the server. Similarly network also will be overloaded because of additional transfer generated by updating application. And at the end, most software updates result in device reboot, so these are crucial for network access. In order to parameterize Device update process, one can use Update Time Span parameter. This parameter defines how often device polls server for update. Taking into account how crucial the process is value of the parameter should rather be defined in hours. Other fact to be said for it is that in real life network device updates do not happen very often, therefore system reaction on the update can be delayed. It is claimed as a good practice to try to tune value of this parameter for all network devices in such a way, that they do not poll for update in the same time. This can both decrease server and network load.

Configuration guidelines

Based on a variety of networks some experimental configuration parameters appropriate for those networks are presented in next section. Proposed to tune are only some parameters which have crucial meaning for supporting bigger networks. In every case proposed are safe values which means that on specified hardware configuration AirSync Server will appropriately support those networks. Basing on those information proper values for other network sizes can be interpolated.

Having different network characteristic like e.g. less clients' events or less services defined it is still possible to tune up configuration. While making parameters more aggressive (typically shorter values) it may happen that system starts to lose statistics or flush events queue which effectively leads to Agents restarts. When this behavior is observed it simply means that system cannot support network with this configuration and parameters should be loosen.

Especially interesting from practical point of view is decreasing Statistic Time Span which is possible when less services then presented 5 are defined. Although it has to be tune up in final network the suggestion is not to decrease it above the factor the service number was decreased since presented in appropriate table. E.g. when services are decreased from 5 to 3 which is 40% less the Statistic Time Span should not be lower more than 40% of presented in appropriate for your network table value (e.g. network 100x10 has Statistic Time Span proposed to be not less than 45s so having only 3 services instead of 5 it might be configured to 27s).

Example Configurations

Below are some example configurations for 4 kinds of networks with different activity

characteristics. The settings are especially valid to hardware platform like: Intel Core2Duo 2,4GHz CPU, 2GB RAM, 250GB HDD, 100Gb Ethernet with Debian GNU/Linux.

Network 1:

- 10 WiMAX BS with 10 clients for every BS
- 5 bidirectional service flows defined and assigned to every client device
- Maximum planned clients' activity (like associations or modulation changing) is not more often generated than every 2 minutes by an individual client device.

Parameter	Value
Statistic Time Span (s)	*5*
Device / Interface / Station Statistics Incidence	*1 (default)*
SLD Limiting Interval (ms)	*3000*
Datagram Timeout (ms)	*5000*
ACK Timeout (s)	*5*
Monitoring Time Span (ms)	*5000 (default)*

Network 2:

- 30 WiMAX BS with 10 clients for every BS
- 5 bidirectional service flows defined and assigned to every client device

  Maximum planned clients' activity (like associations or modulation changing) is not more often generated than every 5 minutes by an individual client device.

Parameter	Value
Statistic Time Span (s)	*10 (default)*

Device / Interface / Station Statistics Incidence	*1 (default)*
SLD Limiting Interval (ms)	*10000*
Datagram Timeout (ms)	*10000*
ACK Timeout (s)	*10 (default)*
Monitoring Time Span (ms)	*5000 (default)*

Network 3:

- 50 WiMAX BS with 10 clients for every BS
- 5 bidirectional service flows defined and assigned to every client device

  Maximum planned clients' activity (like associations or modulation changing) is not more often generated than every 9 minutes by an individual client device.

Parameter	**Value**
Statistic Time Span (s)	*15*
Device / Interface / Station Statistics Incidence	*1 (default)*
SLD Limiting Interval (ms)	*20000*
Datagram Timeout (ms)	*20000 (default)*
ACK Timeout (s)	*20*
Monitoring Time Span (ms)	*5000 (default)*

Network 4:

- 100 WiMAX BS with 10 clients for every BS
- 5 bidirectional service flows defined and assigned to every client device

  Maximum planned clients' activity (like associations or modulation changing) is not more often generated than every 17 minutes by an individual client device.

Parameter	Value
Statistic Time Span (s)	*45*
Device / Interface / Station Statistics Incidence	*1 (default)*
SLD Limiting Interval (ms)	*60000*
Datagram Timeout (ms)	*60000*
ACK Timeout (s)	*60*
Monitoring Time Span (ms)	*5000 (default)*

Appendix F. Setting AirSync Server Logging Options

Setting AirSync's JBoss server logging options

Locating the configuration file

The main configuration file for log4j can be found under:

/home/airsync/services/jboss/server/default/conf/jboss-log4j.xml

Logging behavior

By default JBoss logs the messages to:

/home/airsync/services/jboss/server/default/log/server.log with the log level set in **jboss-log4j.xml**.

By default, logging levels for all categories (i.e. source packages from which the log messages are incoming) are set to **ERROR**. This setting is supposed to fit the production environments, meaning that the log will contain only the messages with priorities of **ERROR** or higher. Log4j's logging levels hierarchy can be found at http://logging.apache.org/log4j/1.2/manual.html. For a quick reference, AirSync uses the following log levels:

DEBUG < WARN < INFO < ERROR

There are several categories in the configuration file that inherit their settings (logging levels, appenders) from the root category. They can be set to an individual log level, as well as an appender.

Log level for file can be easily changed by editing the **jboss-log4j.xml** file. Edit this line:

```
<param name="Threshold" value="ERROR"/>
```

in section `Preserve messages in a local file` for file. For example changing log level to a debug for a file:

```
<!-- ================================== -->
   <!-- Preserve messages in a local file -->
   <!-- ================================== -->
   <!-- A size based file rolling appender-->
   <appender name="FILE"
class="org.jboss.logging.appender.RollingFileAppender">
     <errorHandler class="org.jboss.logging.util.OnlyOnceErrorHandler"/>
     <param name="File" value="${jboss.server.home.dir}/log/server.log"/>
```

```
    <param name="Append" value="false"/>
    <param name="MaxFileSize" value="500MB"/>
    <param name="MaxBackupIndex" value="2"/>
   <param name="Threshold" value="DEBUG"/>
    <layout class="org.apache.log4j.PatternLayout">
      <param name="ConversionPattern" value="%d %-5p [%c] %m%n"/>
    </layout>
  </appender>
```

JBoss server.log is a cyclic buffer managed by log4j. The default settings are to keep 2 backups of **server.log** file, each sized 500MB max. That means you need at least triple more free space for those log files. It can be easily changed by editing **log4j.properties** file. Edit this two lines:

```
<param name="MaxFileSize" value="500MB"/>
<param name="MaxBackupIndex" value="2"/>
```

Remember that logging level has impact on log file size.

Setting AirSync's Activation logging options

Locating the configuration file

The main configuration file for log4j can be found under:

/home/airsync/services/activation/log4j.properties

Logging behavior

By default Activation logs the messages to:

/home/airsync/services/activation/ activation.log with the log level set in **log4j.properties**.

Log level for file appenders can be easily changed by editing the **log4j.properties** file. Edit the first two lines:

```
log4j.logger.com.proximetry=error, R
```

The available log levels are: **debug <warn <info <error** (these are log4j's priorities). This means that if you want to discard debug and warning messages, you should set the log level to **info** (at least).

Activation log is a cyclic buffer managed by log4j. The default settings are to keep 2 backups of **activation.log** file, each sized 100MB max. That means you need at least triple more free space for those log files. It can be easily changed by editing **log4j.properties** file. Edit this two lines:

```
log4j.appender.R.MaxFileSize=100MB
log4j.appender.R.MaxBackupIndex=2
```

Remember that logging level has impact on log file size.

Setting AirSync's RMServer logging options

Locating the configuration file

The main configuration file for log4j can be found under:

/home/airsync/services/remserver/log4j.properties

Logging behavior

By default RMServer logs the messages to:

/home/airsync/ services/remserver/rmserver.log with the log level set in **log4j.properties**.

Log level for file appenders can be easily changed by editing the **log4j.properties** file. Edit the first two lines:

```
log4j.logger.fileLogger=error, R
```

The available log levels are: **debug <warn <info <error** (these are log4j's priorities). This means that if you want to discard debug and warning messages, you should set the log level to **info** (at least).

RMServer log is a cyclic buffer managed by log4j. The default settings are to keep 2 backups of **rmserver.log** file, each sized 50MB max. That means you need at least triple more free space for those log files. It can be easily changed by editing **log4j.properties** file. Edit this two lines:

```
log4j.appender.R.MaxFileSize=50MB
log4j.appender.R.MaxBackupIndex=2
```

Remember that logging level has impact on log file size.

Setting AirSync's NFTP Servers logging options

Locating the configuration file

The main configuration file for log4j can be found under:

/home/airsync/services/nftp/log4j-down.properties

/home/airsync/services/nftp/log4j-up.properties

Logging behavior

By default NFTP servers logs the messages to:

/home/airsync/services/nftp/nftp-down.log and **nftp-up.log** with the log level set in **log4j.properties**.

Log level for file appenders can be easily changed by editing the **log4j-down.properties** and/or **log4j-up.properties** files. Edit this line:

```
log4j.rootLogger=error, stdout, R
```

The available log levels are: **debug <warn <info <error** (these are log4j's priorities). This means that if you want to discard debug and warning messages, you should set the log level to **info** (at least).

NFTP logs are cyclic buffers managed by log4j. The default settings are to keep 1 backup of **nftp-down.log** and **nftp-up.log** files, each sized 50MB max. That means you need at least twice more free space for those log files. It can be easily changed by editing **log4j.properties** file. Edit this two lines:

```
log4j.appender.R.MaxFileSize=50000KB
log4j.appender.R.MaxBackupIndex=1
```

Remember that logging level has impact on log file size.

Setting AirSync's HTTPManager logging options

Locating the configuration file

The main configuration file for log4j can be found under:

/home/airsync/services/httpmanager/log4j.properties

Logging behavior

By default HTTPManager logs the messages to:

/home/airsync_dir/services/httpmanager/ httpmanager.log with the log level set in **log4j.properties**.

Log level for file appender can be easily changed by editing the **log4j.properties** file. Edit this two lines:

```
log4j.logger.com.proximetry=error, R
```

The available log levels are: **debug <warn <info <error** (these are log4j's priorities). This means that if you want to discard debug and warning messages, you should set the log level to **info** (at least).

HTTPManager log is a cyclic buffer managed by log4j. The default settings are to keep 1 backup of **httpmanager.log** file, each sized 50MB max. That means you need at least twice more free space for those log files. It can be easily changed by editing **log4j.properties** file. Edit this two lines:

```
log4j.appender.R.MaxFileSize=50MB
log4j.appender.R.MaxBackupIndex=1
```

Remember that logging level has impact on log file size.

Glossary

Activation Server

A process that runs periodically. The activation server makes sure that nodes managed by AirSync know with which AirSync server to communicate. Among other things, the activation server helps during the device registration process. It makes it possible for devices to be automatically "discovered" by the AirSync server.

AdHoc Rules

AdHoc Rules are custom rules defined by a role that influence the role. AdHoc Rules can also influence traffic of other network devices according to the device priority, throughput defined by particular services for a given device, and available network resources.

Bandwidth downstream

A service parameter that defines the interval for the throughput to the end-user device for a service. This parameter is defined as the range of two integers representing lower and upper limits, in kB/s. For example [100-250] means Bandwidth DownStream should be in the range from 100kB/s to 250 kB/s. The range you select should be sufficient for the particular service type.

Bandwidth upstream

A service parameter that defines the interval for the throughput from the end-user device for a service. This parameter is defined as the range of two integers representing lower and upper limits, in kB/s. For example [100-250] means Bandwidth UpStream should be in the range from 100kB/s to 250 kB/s. The range you select should be sufficient for the particular service type.

Device or Device instance

A device is an item to be managed in AirSync. Devices are generally radios but other types of devices such as PCs can be registered and managed in AirSync. For radios, think of devices as a collection of interfaces. While traffic shaping and package distribution both work in conjunction with device interfaces, certain attributes apply to the entire device, such as the configuration file and the firmware.

Device Interface

Device interfaces are the focal point for traffic shaping, package distribution and statistics collection. To implement traffic shaping and/or package distribution, include the appropriate device interface in a group and then assign a role to the group (traffic shaping) or assign a package to the group (package distribution).

Device Profile

Device profile is a kind of representation of a device which suppose to be used for configuring device interfaces and setting proper QoS policy. This item should be used for provisioning device instances.

Group

A group links end-user device interfaces to a role. Groups have a priority that can either be explicitly defined for the group or inherited by a device. If inherited, the priority can influence the Service Level Degradation algorithm and affect network traffic-shaping parameters.

AirSync uses groups as containers for associating roles (for traffic shaping) and packages (for package distribution) with device interfaces.

NFTP

Network File Transfer Protocol. This is a special protocol for efficiently transferring files over wireless networks.

NIC

Network Interface Card, a PC card or expansion board inserted into a device to connect the device to a network.

Package

A package is used for delivering and installing files such as configuration files or new firmware versions on devices. Packages contain one or more items and some instructions telling the receiving device how to process the items received in the package.

Package Item

A package item is a specific file to be included in a package. Although many packages may have only one item, it is possible to define a package with multiple items for instance a firmware version and some corresponding patches.

Pattern

Patterns are an important component of *Service Classes.* Patterns are used to construct packet classifiers used for implementing traffic shaping. There are three types of patterns: Those based on MAC addresses, those based on traditional TCP/IP or UDP/IP socket connections, and those based on higher level application characteristics such as SIP

Provisioning

AirSync gives you the ability of preparing proper device configuration and setting QoS policy even though you have not installed them in the filed yet.

Priority

AirSync uses the term priority in two different ways. When there is not enough bandwidth available to satisfy all SLAs defined for an interface (i.e., the system is experiencing SLD), AirSync uses the priority associated with a device interface (which can be inherited from group membership or explicitly defined for the device interface) to arbitrate the bandwidth allocation compromises that must be made while the network is oversubscribed.

AirSync uses the priority associated with services to arbitrate the bandwidth allocation process when there is surplus bandwidth available, that is to say, after all the minimum SLAs for an interface have been satisfied. AirSync allocates additional "burst" bandwidth capacity (up to the maximum value in the bandwidth range specified for a service) for traffic flows based on the priority level associated with each service.

Rate

On RF links you may see a reference to rate with values such as 54 48 36 24 18 12 9 6 (depending on frequency). These numbers are really an indication of the modulation scheme being used which defines the maximum theoretical rate of traffic over the link. The rate parameter may be used in traffic shaping, for example as the basis for an ad-hoc shaping rule.

Resource Management

Resource Management lets you manage wireless network resources using AirSync. Management is performed using services, service parameters, groups, group priorities, roles, and AdHoc Rules, all of which are defined in AirSync. The Resource Manager administers Quality of Service and Throttling in wireless networks. Using AirSync Resource Management lets you attain the level of service described in Service Level Agreement.

Role

A role is used in traffic shaping. A single role can be assigned to a group which effectively associates it with all the device interfaces in the group. A role can have a set of provisioned services each representing an SLA for a given type of traffic for a given class of user.

RSSI

Received Signal Strength Indication. This is an indication of the signal quality of an RF link. For some chipsets this is really just the difference between the signal level and the noise level on the link.

Service

A service represents a provisioned SLA for a given type of traffic for a given type of traffic. Each service references a service class containing one or more patterns that match the traffic that will be provisioned according to the SLA defined by the service.

Service parameters define the upstream and downstream bandwidth and priority for a service in the system. Using AdHoc Rules and device priority, you can modify a device's service parameters, based on the results of the Service Level Degradation (SLD) algorithm (which adjusts the network based on a particular Service Level Agreement and current network load).

Service Class

Service Classes are related to services but don't carry the provisioning information that defines an SLA. Service classes reference patterns that define a set of packets that will be treated the same way from a traffic shaping perspective. It is the service, not the service class that defines the SLA. Each service references a single service class. A single service class can reference multiple patterns.

Signal Quality

Signal Quality affects the throughput available on a link and therefore affects the implementation of traffic shaping for a link.

SLA

Service Level Agreement. In AirSync you can define minimum throughput rates for services. If the system is able to deliver the minimum rate of traffic, it is meeting the SLA. At times, however, the system does not have enough bandwidth to meet the SLA.

SLD

During periods of network oversubscription when the system cannot meet the set of SLAs for an interface the system experiences Service Level Degradation, or SLD. AirSync implements an intelligent SLD algorithm that allows the system to degrade traffic in a systematic fashion based on a seven level priority scheme. The algorithm includes a tunable weighting coefficient for traffic at each priority level. The algorithm works in such a way that each priority level will get better service than worse priority levels (1 is the most preferred, 7 is the least preferred).

The algorithm ensures that the most bandwidth is allocated to the most important traffic, unlike strict priority queuing schemes, the AirSync SLD algorithm eliminates queue starvation for the lowest priority traffic. Even the lowest priority levels will get a little bit of bandwidth during times of congestion.

The Service Level Degradation algorithm considers:

- The current network load on wireless network devices.
- Service-level agreement parameters defined in the AirSync system.
- Ad-hoc rules used to adjust these parameters to current network conditions.
- Group/device priorities.
- Parameters defined in the AirSync configuration.

Based on these factors, the algorithm reduces the minimum defined bandwidth or denies access for particular users or user services until there are sufficient network resources for them to operate correctly while allowing mission-critical data to pass.

A high load on an access point may prevent the Service Level Degradation from achieving the provisioned minimum bandwidth. If this occurs, you can change the provisioned rules or add network devices to increase the available resources.

Universal Datagram Protocol (UDP)

A connectionless protocol that, like TCP, runs on top of IP networks. UDP offers a direct way to send and receive datagrams over an IP network.

VoIP

Voice over Internet Protocol, a category of hardware and software that enables the Internet as the transmission medium for telephone calls by sending voice data in packets using IP rather than by traditional circuit transmissions of the PSTN.

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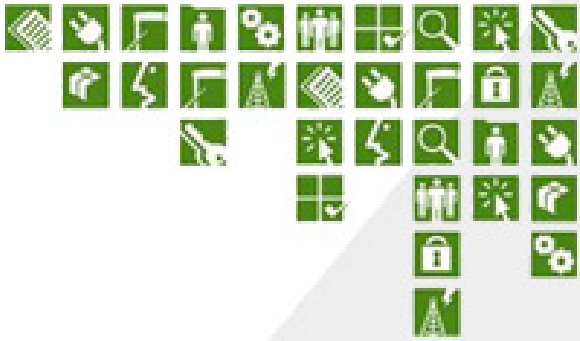

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