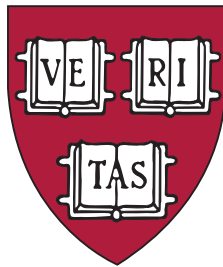


HARVARD UNIVERSITY



Information Technology

Integer Selections

Monday, August 25, 2014

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Project Integer¹ Selections

Version	Date	Description
0.1	4/21/2014	Initial version.
1.0	5/24/2014	Addition of business services to service element selection - it should have been there all along.
1.1	7/17/2014	Minor updates.
1.2	7/20/2014	Added a Grouping facility as part of the filter.
1.3	8/08/2014	Added environmental level.
1.4	8/25/2014	Corrected information about 'service layers' (e.g., layer 1 is the physical layer). Added revised diagram.

Introduction and General Description

Intended Audience

This document is intended for engineers familiar with the technologies Integer is managing and also have a basic acquaintance with software engineering principles used in its implementation. It is not a user-guide or general requirements document. It is intended to describe general concepts of operation for people that will eventually use Integer and/or be involved in developing it or plug-in modules.

Use of Italics and Reference Documentation

Throughout this document, CamelCase terms are written in *italic* as an indicator that they reference classes found in the Integer system design in UML. Understanding UML or the Java Integer uses to implement it is not necessary to a full understanding of this document. The information is provided for those that wish to explore further. Appendix A is a listing of reference documents that contain additional details about Integer and may be helpful in understanding this document.

General Background

Integer will ultimately contain a wide array of information. It will span many different types of physical and logical systems as well as their software, configuration, and state information. A single selection facility in Integer provides users with a way to tell the system what they wish to see/operate on that works across all of Integer's functions. For example:

¹ The project, Integer, is an attempt to create a unified whole from the separate protocols, data elements and software systems we use to operate our increasingly complex computing environments. See: <http://www.thefreedictionary.com/integer>. Also see: <http://en.wiktionary.org/wiki/integer#Latin>

- Selecting which systems to display on a graphic interface based on it's *Category* or *Location*. Selection will also evolve to include state and usage information.
- Providing a report of systems whose discovery status is missing or new.
- Showing on a graphic display devices that forward routing traffic or support VPNs including the ability to see the VPNs carried in each interface and the links between interconnected systems.
- Selecting systems for a report with systems with any elements that are over 60% utilized and have a growth rate that is 10% or more than their previous history.

What these examples share in common is that their creation included identification of:

- What systems (*ServiceElements*) and sub-systems are of interest:
 - Selecting the types of service elements (*ServiceElementTypes*) to include in the selection.
 - Determining if the view was hierarchical, for example is the case of a system that is missing from the discovery process, the top level chassis/main identifier may be all that is needed. It may not be necessary to include all the sub elements like the line cards.
 - Indicating whether the selection should include information about the interconnections between systems or not (e.g., VPN, general layer 3 routing, OSPF and/or BGP routes, etc.)
- How the information is to be used/viewed:
 - As a textual or graphic report
 - On our graphic user interface
 - Displayed in the alarm/event/log window
- Special attributes associated with or separately calculated such as utilization or rate of growth of utilization and whether they should simply be used as selection criteria or the data displayed, e.g., > 50% utilization.

Terms and Concepts

This section describes a few key terms and concepts of operation relevant to how users specify the *ServiceElements* they want to see, the characteristics of them that are of interest such as fault, discovery, performance, utilization or other data, and the form/format of the presentation. The three selectors are combined to create a selection in the Integer environment. Together, these items form a *Selection*. The major elements of a selection are:

- A Filter
- A View
- A Layer

What's a Filter?

A filter is the way users tell the system the range of *ServiceElements* they want to select for some purpose. This could be for display in our user interface, output to a file, or to be included in a report.

There are a number of different ways selections can be made, they can also be combined². *ServiceElements* are specified using:

- Technologies
- Category
- Providers
- Criticality
- Location
- Environment
- Service Element Type
- Organization
- Business Service

Note that within each of the selection areas, users may select more than one element. For example, a user might wish to select, routers, firewalls and DNS servers in main data centers (locations). The way the system works, *ServiceElements* would be included if they supported any of the listed technologies AND they were in any of the listed data centers³.

In the mock-up, the user has indicated that they would like to create a new selection. They would add the name and descriptions for future reference and select any number of the technologies they wish to include.

When you select a technology, you are telling Integer what types of systems you want included, since every type of system has a *ServiceElementType*.

Some *ServiceElements* support can contain/support

The mock-up shows a web interface for creating a selection. It features a top navigation bar with 'Manage Selections' and 'Create Selection' tabs. Below this is a secondary navigation bar with 'Select Systems', 'Select Layer', 'Information', and 'View' tabs. The 'Select Systems' tab is currently selected. The main content area includes a 'Selection Name' text input field, a 'Description' text input field, a 'Category' dropdown menu, a 'Grouping' dropdown menu with a 'Subnet' button, and a list of technologies: 'All types', 'Load Balancers', 'Routers', 'Servers', 'FMS', and 'DNS'. At the bottom of the form is a large blue 'Create' button.

² The focus of this document is on our first release however the full range of capabilities described here are not going to be implemented in our first release. We will implement as many as time permits.

³ **NOTE WELL:** The screen mockups in this document are intended only to illustrate function. The actual user interface will be different.

multiple technologies. If this were the case, as would be the true with a router, the top level would be selected (routers) and all the 'children' such as BGP and OSPF in this case would be included. Users can turn on/off the children as desired. If sub-technologies are removed, then *serviceElements* associated with the specific sub-technologies that have been excluded will not be included in the selection.

If users do not make further selections for Provider, Criticality, Location, etc., then the system assumes that the user wants all *ServiceElements* in the selection from all possible, Provider, Levels of Criticality and Locations.

Grouping

Grouping is an important element of filter selection. It is a concept that most will be familiar with and works like sorting in a report or in columns in a spread sheet. In management software systems that present network information, this has usually been done only one way. That is by subnet. Usually the top level view in these systems is the highest level of the organization. For example the main gateways to the known subnets. When users 'click' on these they are taken to the next layer of connected systems until they reach a subnet which is the 'terminal network' - one that only points to the subnet the user clicked on to get to this. Since even in this case, the network may have redundant connections, there could be links to other networks.

Integer will come with a number of groupings possible with more flexibility added over time if needed. The initial groupings will be:

1. Subnet - this will function as described above, a set of subnets sorted by connectivity.
2. Location/Subnet - this will group the *ServiceElements* by their associated *Location* information then, by network. For example by building, city state, etc. The second order sort will be within location by subnet using the same logic as subnet.
3. Location/Type/Subnet - allows users to see systems by type within location then their connectivity.
4. Business Service and location- allows users to see systems based on the business service they support and the various locations in which service elements reside.
5. Business service, location and service element type and subnet.

When this step is completed and Create is selected, they are given the opportunity to indicate if they are also interested in *InterDeviceLinks*. These are the links that connect systems and are divided into layers. They range from the physical up through the network layer (and higher in future releases). Note that the physical layer must be drawn by the user. If you select the physical layer all layer above will be included. If you select layer 2, then that layer and above will be included. A partial tree is shown below. If no links are selected, *ServiceElements* will not have any *InterDeviceLinks* shown, nor will state information about these links be included in

the selection. What the user really sees is a *Path* or Paths between systems. Each path contains at least one *InterDeviceLink* (generally there will be two).

The screenshot shows a software interface for creating a selection. At the top, there are two tabs: 'Manage Selections' and 'Create Selection'. The 'Create Selection' tab is active and contains a sub-tabbed interface with 'Select Systems', 'Select Layer' (the active sub-tab), 'Information', and 'View'. Below the sub-tabs, there is a section for 'Existing Service Layer List' with a dropdown menu currently set to 'All Service Layers' and a 'Create New List' button. The main area is titled 'Select Service Layer' and contains a tree view. The tree view has a root node 'All Levels' which is expanded to show three sub-nodes: 'Physical', 'Level 1', and 'Layer 2.5'. Under 'Layer 2.5', there are three sub-nodes: 'CDP', 'LLDP', and 'LLDP-MED', each with a checkbox next to it.

What's an Information Layer?

Information layers are integral parts of a selection. It indicates what pieces of information for the selected ServiceElements are desired. This information could be directly obtained such as discovery status, or later performance information such as utilization.

The illustration below represents a way of capturing the information a user would

The screenshot shows a web application interface for creating a selection. At the top, there are tabs for 'Manage Selections' and 'Create Selection'. Below these are sub-tabs: 'Select Systems', 'Select Layer', 'Information' (which is active), and 'View'. On the left, under 'Existing Information Selections:', there is a dropdown menu (1) currently showing 'Performance'. Below this is a blue button labeled 'Create New Information Selection' (2). To the right of the dropdown is a table (3) with columns: 'Capability', 'Calculation/Value', and 'Filter/Display'. The table contains four rows of data. Annotations 4 through 8 point to specific elements in the table: 4 points to 'Administrative Status', 5 to 'Down', 6 to 'is Not', 7 to 'Filter', and 8 to 'Exclude'. Below the table are two buttons, '+' (9) and '-' (10).

Capability	Calculation/Value	Filter/Display
Administrative Status	Down	is Not Filter Exclude
Calculated	Calc - Utilization	Calc. Display
Interface Speed	1 Gbps.	is greater than Display and Filter Include
CPU Utilization	Calc - CPU Utilization	Display and Filter Inc/Exc

need to provide the system when creating a new selection. If this entire section were left blank, the selection would still be valid, but only basic *ServiceElement* information would be displayed such as name. The numbers in the illustration below identify key aspects of user required information or actions:

1. A key aspect of the Integer system is that much of the intelligence is user configured as opposed to coded in by the Integer development teams. As such, the system may come with a variety of pre-configured information from the *ServiceElementManagementObjects* associated with a *ServiceElementType* to a number of selections of information to be included with *ServiceElements* included in a *Selection*. In this case, "Performance" has either been supplied with the system or defined by a user after the system has been deployed. This lets the user save time, avoid duplication, and variations in calculations but reusing these definitions in more than once selection. If a user with appropriate access privileges edits a *Layer* or any other element of a *Selection*, they will be able to either save the changes (which will impact all the *Selections* that use it, or save it as a new one. The pull-down indicated by (1) is a list of all current *Layers* in the system to which this user has access.
2. "Create New Information Selection" would be used in those cases where the user does not want to select from the list in (1). Initially the area with the table to the right of this button is empty. When this button is pressed, an empty table is created.

3. This identifies the entire table after the user has made edits. In this case, the user has defined four rows of information to be included in the *Selection*. They are: administrative status, a calculated value, interface speed and CPU Utilization (see details in the next items).
4. Items in this left most column of the table can be any one of the following:
 1. A system capability - in this example it is administrative status. It is possible that some *ServiceElementTypes* will not have some of the capabilities listed. This is permitted, but where possible, we will let the user know.
 2. A calculation - in the illustration “Calculated” and CPU Utilization both are calculated values.
5. The calculation/value column indicates whether the value is calculated or a value that would be evaluated from the *ServiceElement*. In the example above, “Down” is a possible value for the *Capability* Administrative Status.
6. This field is the operation to be performed. In this example the user has specified that they want to limit the *Selection* to *ServiceElements* that are known to NOT be in a Down state. Whether they are Included or Excluded is shown in (8).
7. Filter is used to control:
 1. Whether the resulting evaluation of 6 and 8 is used to filter the elements in the Selection without showing any information. In the above example it would say, exclude all *ServiceElements* included in the selection by Select Systems tab that are in an Administrative Status of Down. It would not display this information, it would simply exclude these *ServiceElements*.
 2. In the second row of the table utilization is calculated (this will be a simple editor that will pop up to allow the user to express this). The Filter Value is “Display”. This means that no filtering is taking place, simply that all *ServiceElements* are to have their utilization (as calculated) included. So now basic information about the *ServiceElement* plus this calculated utilization information is included. This might be useful when looking at a range of *ServiceElementTypes*.
 3. Display and Filter is a combination of 1 and 2. That means not only filter on the *capability*/calculated value, but also display the value for all *ServiceElements* in the *Selection*.
8. See description in #6.
9. The “+” is the way the user tells the system to add another attribute or calculation to this set of information. While Integer does not enforce rules about what information elements are part of a set, some groupings might make sense. For example a set that describe various interface operational metrics such as in and out packets, errors, etc. Integer does enforce basic rules in calculation for example you can not add an integer value to a text string.
10. The “-“ tells the system to remove the selected row (which would be highlighted). As a general rule, this and other ‘destructive’ actions will

cause a confirmation dialog — we will have to fine tune this so the system helps prevent unrecoverable errors without being too click intensive.

Note that not all *ServiceElements* will have the same capability set, that is what makes them different. For this reason, not all service elements in the resulting selection will have information for all the *Capabilities* included in the selection.

What's a View?

A view is the form in which the user would like to present the information whether in a graphic display, tree or grid, flat form or hierarchical. There are also special views built into the system such as the alarm/event window. There will be default information in the alarm/event window, but users can add additional 'columns' if desired.

The diagram above shows information required to create a new *View* or reuse an existing *View* in the *Selection*:

1. Existing Views are saved in the system and assuming access privileges are correct, users will have the choice of selecting one of these *Views* for use in their *Selection*.
2. If they wish to create a new one, a dialog will ask for the name and description of the new view and then they can select the rest of the information from the above screen.
3. The *Display Hierarchy* option lets users control the amount of information in the view. For example, one might be interested in top level devices such as servers, but not want all the elements they contain. In this case, they would select 'no' in the *Display Hierarchy* option. Note that the system will provide a default form for display/organization. For example, if the user has selected a view of topology hierarchy, the default will be to display the

- ‘top level’ of the hierarchy (for example in a network that had a core with regional distribution networks etc., the core would be the default). In some cases, there may be differences in the ‘terminal’ level (e.g., when there are no networks to connect to). In this case there will be a visual indication - such as no other networks to connect to)
4. Users may select as many view/output types as they wish. In some cases, previous selections will make some formats less useful than others. Where possible, Integer will provide a warning.

The Selection Manager/Service

Integer has a *SelectionService* that may have several *SelectionManager* for scale and other reasons. Each is responsible for providing services to users. These services include:

- Selection Creation
- Selection Modification
- Selection Deletion
- Providing services to software elements of the system that use selections including:
 - Reporting System
 - Alarm/Event System
 - Graphic display via the Web interface.

Appendix A - Reference Documents

1. Integrated Management System - Project Integer
2. Integer First Release Functions and Objectives
3. Integer Distribution Model
4. Integer Access Control Model
5. Alternate Login
6. General User Interface Objectives and Requirements
7. Integer Discovery