

# Implementing a Manager of Managers for Effective Fault Management of Public Safety Radio Networks

## The case for a Manager of Managers

Telecommunications systems today are complex and heterogeneous. Network operators have to deal with devices and systems from a myriad of technologies and vendors, all brought together to provide their end customers with services vital to their business.

Public safety radio networks are a good example of this complexity. While the end user sees only hand-held or mounted transceivers, behind the scenes lays a plethora of systems and devices, including:

- ➔ Digital trunked radio systems.
- ➔ Microwave, fibre, SDH, PDH and leased line backhaul networks.
- ➔ IP-based network cores, including interfaces to PSTN telephony and other data systems.
- ➔ Various IT systems providing support functions, including dispatch, GIS, data storage and retrieval.

Keeping these networks operational requires effective management of the infrastructure, including rapid response to fault conditions as they occur. Fault management is challenging in these environments, as operators are faced with a torrent of events from multiple sources that they must analyse and respond to in real time. Due to the interconnected nature of the networks, a single fault condition can often result in large volumes of events being generated from each affected component, leaving the operator trying to sort the wheat from the chaff to determine a root cause.

A Manager of Managers (MoM) or Operations Bridge system can have a dramatic impact on fault management in these environments. The MoM consolidates events from across the network into a single holistic view of the entire environment. It then applies rules to the incoming event streams to filter, correlate and de-duplicate the events, resulting in a more coherent and manageable set of fault messages. The MoM also provides a graphical representation of the network, enabling operators to visualise the impact of faults and respond accordingly.

The deployment of a MoM results in better visibility across the entire network, faster root cause identification and better prioritisation of remediation activities. The bottom line is less downtime for the end user, which is vital in public safety communications.

## What functionality should a MoM provide?

### Event Consolidation & Normalisation

Network elements and their individual managers generate events in a variety of formats using multiple protocols. One of the key challenges facing network operators is bringing these disparate event types together, translating them into a common format for processing. The MoM system needs to be able to handle many different event types such as:

- ➔ SNMP traps.
- ➔ Log file messages.
- ➔ Windows Event Log messages.
- ➔ TL1 messages.

In addition to providing interfaces to receive the events, the MoM needs to be able to translate them to a common format. This process of normalisation should result in events that contain a basic set of attributes:

- Timestamp.
- Event source.
- Event description.
- Severity.

It is arguable that the final attribute listed above – severity – is not required, as the MoM will make a determination of the severity itself as it processes the event. While this argument has merit it is still prudent to include the network element's own severity even if it is overridden later – it serves as a starting point if nothing else.

The outcome of this function is a normalised set of events, sharing a common format and protocol, ready for processing by the MoM.

## Event Processing

It is here that the true value of a Manager of Managers is realised – taking a large set of events from disparate sources and distilling them into a set of actionable fault messages. The MoM needs to be able to handle very high event volumes, which in many cases exceed hundreds of events per second. It must be able to reliably intercept these messages and process them into meaningful fault messages that operators can act upon.

There are a key set of functions that a MoM should provide to implement this processing, captured in the table below:

Function	Description	Benefits
Filtering	Identifying and discarding events deemed to be irrelevant.	Drastic reduction in noise events in the browser, allowing the operator to see the true service affecting faults.
De-duplication	Identifying similar and/or duplicate events using key attributes and providing a single event with a duplicate count.	Fewer events in the browser, while still allowing the operator to see the frequency of event occurrence.
State based correlation	Identifying set and clear event pairs that indicate the start and end of a fault condition, and enabling the automatic processing of these events.	The event browser only shows current faults, as cleared faults are automatically removed from the browser.
Topology based correlation	Identifying events from multiple sources that provide symptoms of a fault, and tying these events together to form a single root cause event.	Allows operators to see past events from multiple network elements to the actual root cause of a fault.
Escalation	Applying events to a set of rules that determine if the events should be sent to an external system such as a trouble-ticketing system or notification system.	Provides automated triage of events, reducing operator effort in escalating faults to service technicians and third parties.

## Fault Visualisation & Impact Assessment

A visual representation of the network, with the current faults overlayed, helps operators to understand the impact of faults on the overall system. The Manager of Managers should provide this visualisation, building up a network topology encompassing the multiple elements that make up the network.

The MoM should also provide tools to assess the impact of faults on the service provided by the network. This impact assessment could utilise the topology to assist in determining impact, in addition to other business rules.

The table below provides a summary of the visualisation features desirable in a Manager of Managers.

Feature	Description	Benefits
Network topology representation	A hierarchical representation of the network, starting from a top level global view down to individual sites, equipment and components.	Provides visual cues to the operator as to the location of faults along with their impact on the overall network.
Drill-down	The ability to navigate down through the layers of the topology to the layer at which the fault is occurring.	Give the operator tools to enable rapid investigation and analysis of fault impact.
Service impact representation	Mapping the physical network elements to the logical services they provide at a business level.	Enables the operator to prioritise their activities in the event of multiple faults, focusing attention in the faults with greatest service impact.
Geographic representation	The representation of sites and equipment on a geographic map.	Allows the operator to visualise the location of a fault, assisting in rapid dispatch of service personnel.
Fault prioritisation	Use of a set of rules to determine the priority of a fault. Can use topology and/or service mapping information.	Provides automated triage of events, saving operator time and workload in determining priorities.
Scheduled downtime management	The ability to configure specific scheduled outage time periods for elements or groups of elements, during which fault messages are not actioned or escalated.	Reduces the overhead involved in managing and remediating non-service affecting faults.

## Flexible and Customisable User Interface

As the focal point for fault management, the Manager of Manager's user interface must provide a comprehensive set of functionality to enable operators to effectively and efficiently manage network faults.

There are a number of use cases that need to be addressed by the MoM interface:

**NOC Operators** need to be able to view network faults and use the MoM to triage and action the faults.

**Service Delivery Managers** need to view the current service status and fault impacts on those services.

**Customers** want to gain visibility into the network status and service availability.

To be effective the MoM user interface should address each of these use cases, providing customisable functionality to address each of these user groups.

The table below summarises the interface requirements.

Function	Description	Benefits
Web-based interface	The user interface should be browser-based if possible.	Zero interface client management overhead.
Flexible security access model	Role-based access to the interface, limiting access to specific functions and data.	Allows for different user types within the organisation.
Single-sign on	The ability for the MoM to authenticate users using existing authentication methods (eg AD, LDAP).	Reduces the overhead involved in maintaining multiple authentication databases and managing credentials for the user.
Multi-tenant capable	The capability to segment data into different customers, with separation between customers built into the security model.	Enables the MoM to service multiple customers whilst maintaining security.
Customisable views	The ability for the user to define custom views to suit their responsibilities and working methods.	Provides operators with focused information based on how they work most efficiently.
Portal integration	Functionality to embed the MoM views into existing web portals.	Enables organisations to extend their existing web portals to include MoM data.
Drill-down to elements	Users can drill down from an event or element in the MoM to the element manager or element's own interface.	Assists operators in retrieving additional diagnostic information faster, speeding root cause analysis.
Linkable to external systems	Capability to launch external system interfaces context-sensitive to a specific event or element.	Enables the use of systems such as knowledge bases to supplement fault information and assist in diagnosing faults.
Customer viewable	Filtered read-only views of MoM data that can be presented to customers.	Provides visibility to customers of current network and service status.

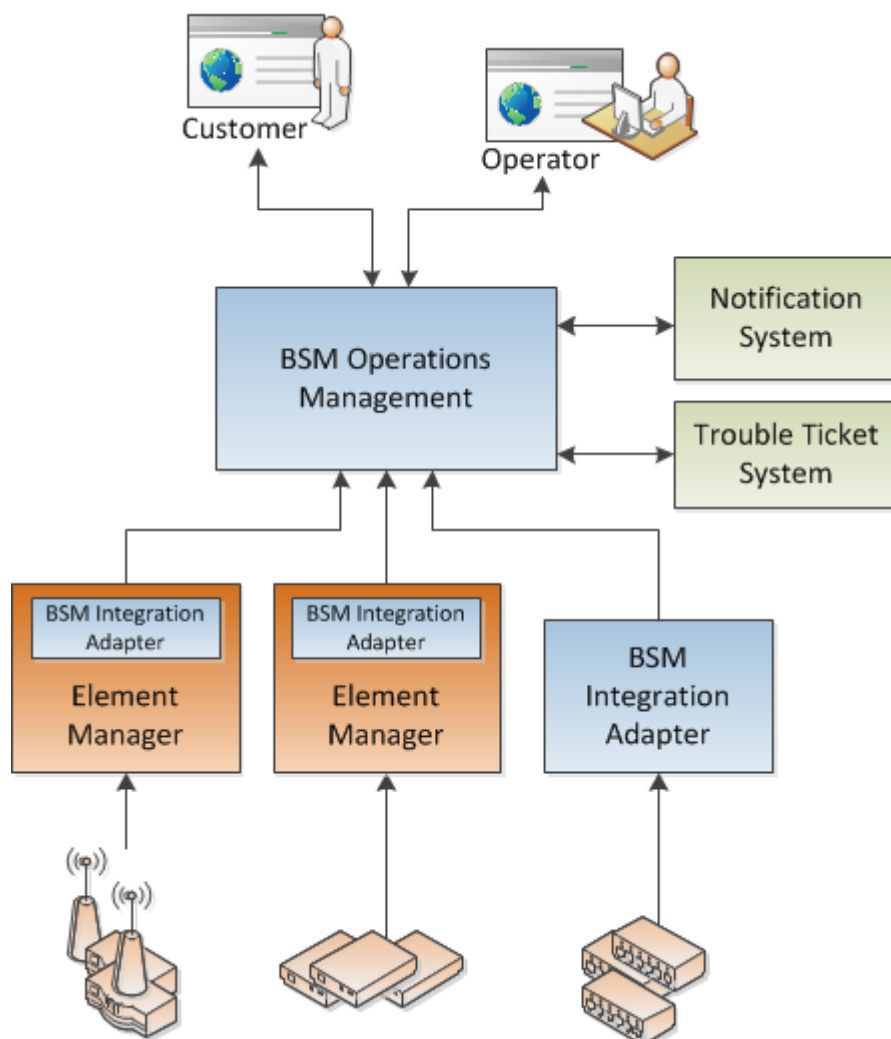
# A Manager of Managers based around HP's Business Service Management Platform

The HP Business service Management portfolio is a set of integrated solutions that provide monitoring of applications, systems, networks and business transactions. One of the solutions within this portfolio is the Service and Operations Bridge. This solution provides consolidated service and event management using the Operations Management (OMi) product, combining infrastructure events from HP and third party products with service monitoring from other BSM components such as Business Process Monitor and Service Level Management.

The Manager of Managers solution described here leverages the HP BSM platform, combined with specialised content developed for monitoring radio network components, to provide a holistic fault management platform.

The diagram below provides a high level overview of the solution architecture. BSM Integration Adapters are deployed to intercept and process events from network elements, either directly or via element managers. The events are then forwarded to the BSM Operations Management platform, where they are processed and presented to users via the myBSM portal.

The myBSM portal provides a highly customisable web-based user interface that allows users to browse fault messages, view the network topology and service model, and create links to other systems context sensitive to the message or element they are currently viewing.



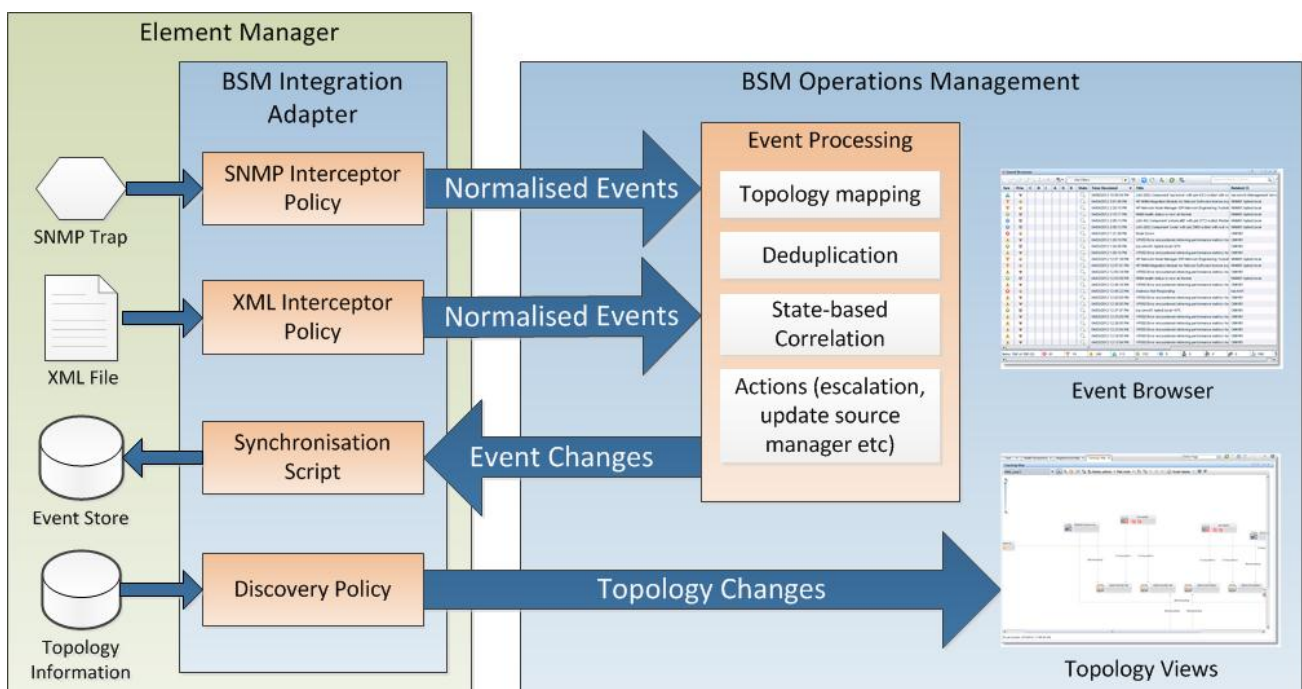
## Consolidating events using BSM Operations Management

The BSM Operations Management (OMi) platform provides a comprehensive toolset for integrating events from disparate systems. The BSM Integration Adapter is used to both to intercept and normalise events and to discover topology information from elements and element managers.

The diagram below illustrates how OMi is used for event consolidation. The Integration Adapter is deployed on the element manager, and then configured to process event and topology information from that source.

For SNMP trap based events the Adapter uses policies to determine which traps to capture, and how they should be normalised into a common format for the MoM. For other event types, a conversion to XML format is required, after which the Adapter again uses policies to determine event selection and normalisation.

The normalised events are then sent through to the OMi platform for processing. The Adapter is also able to query the element manager for topology information, which it sends through to the OMi platform.



When OMi receives the events it applied a set of processing rules to map them to the topology, perform deduplication and state-based fault correlation, and execute any actions required. These actions may include:

- ➔ Automatic escalation of the fault to an external trouble-ticketing or notification system.
- ➔ Perform additional diagnostic commands to better define the fault condition.
- ➔ Enrich the fault message with data from external sources.
- ➔ Update the source element manager with event changes.

Users view the fault messages and topology impact using the myBSM portal. They can create custom views of these messages based on broad criteria including source, severity, message content, and time received. They can annotate the event, provide additional description and solution details, and execute actions associated with the event such as escalation.

## Content Packs for Radio Network Elements

The policies and rules used by the Integration Adapter and within the OMi platform itself to process events and topology information can be packaged up into Content Packs around a specific element type. These Content Packs can then be deployed to an OMi system to provide instant-on capability in monitoring and managing these network elements.

Kalibre has amassed extensive experience over the past decade in developing content for Manager of Manager environments, having integrated fault monitoring for radio networks, microwave networks, multiplexer systems, IP networks and IT systems. We are currently in the process of developing BSM Content Packs for a number of public safety communications network related elements, including:

- ➔ Motorola Astro trunked radio networks.
- ➔ Nokia microwave and multiplexer networks.
- ➔ Aviat microwave networks.
- ➔ Siemens microwave networks.

The vision is to provide these Content Packs as licensable products that can be rapidly deployed to HP BSM systems. These products would include best practice guidance for deployment and tuning to minimise the implementation time and effort required to achieve a working system.

## Extending Fault Management to Service Management

One of the advantages of leveraging the HP BSM platform for a Manager of Managers is the additional functionality available via other BSM modules. One of the most useful modules in this scenario is Service Level Management (SLM). While the solution described in this paper so far has been focused on managing faults and assessing impact on the network topology, the addition of SLM extends this to include the management, monitoring and reporting against Service Level Agreements.

The Service Level Management module manages Service Level Agreements (SLAs) as well as Operational Level Agreements (OLAs) and Underpinning Agreements (UAs). The SLAs have associated Key Performance Indicators (KPI) objectives, which SLM measures using service models created from the objects in the BSM topology.

SLM then allows you to:

- ➔ Monitor the performance of your SLAs, both the current status and the forecast status for the period.
- ➔ Alert of SLA and service status changes.
- ➔ Report on SLA performance both internally and to your customers.
- ➔ Review outages and remediate them if they should not be SLA impacting.

The SLM module is a separately licensed component of the BSM portfolio, and requires additional implementation effort to map topology to services, and define the SLAs and KPI objectives. As no two Service Level Agreements are identical, it is envisaged that Service Level Management for public safety radio networks would not be a shrink-wrapped product per se. It would be packaged as an add-on solution offering to the MoM consisting of SLM licensing and professional services to define the required SLAs, KPI objectives and service models.

## Summary

Fault management of complex public safety radio networks can be enhanced through the deployment of an over-arching Manager of Managers system to consolidate events into a single pane of glass. Network operators can reduce fault resolution time and minimise network and service disruption.

The HP Business Service Management portfolio provides a very effective platform for building a MoM system, providing comprehensive functionality for integrating events from multiple disparate sources. It also provides extensibility with its service level management functionality, enabling network operators to move beyond network infrastructure management to true business service management.

Kalibre's extensive experience in creating Manager of Manager systems for network operators can be leveraged to develop packaged content for the BSM platform to provide instant-on capability for managing faults from the various network elements.

The vision described here is a Manager of Managers solution that shrink-wraps as much functionality as possible, reducing the need for custom-built solutions and reducing the total cost of ownership to the network owner or operator.