IBM Almaden/Austin/Hawthorne Research Center

Policy-Based Validation of SAN Configuration

Dakshi Agrawal, James Giles, Kang-won Lee, Kaladhar Voruganti, Khalid Filali-Adib

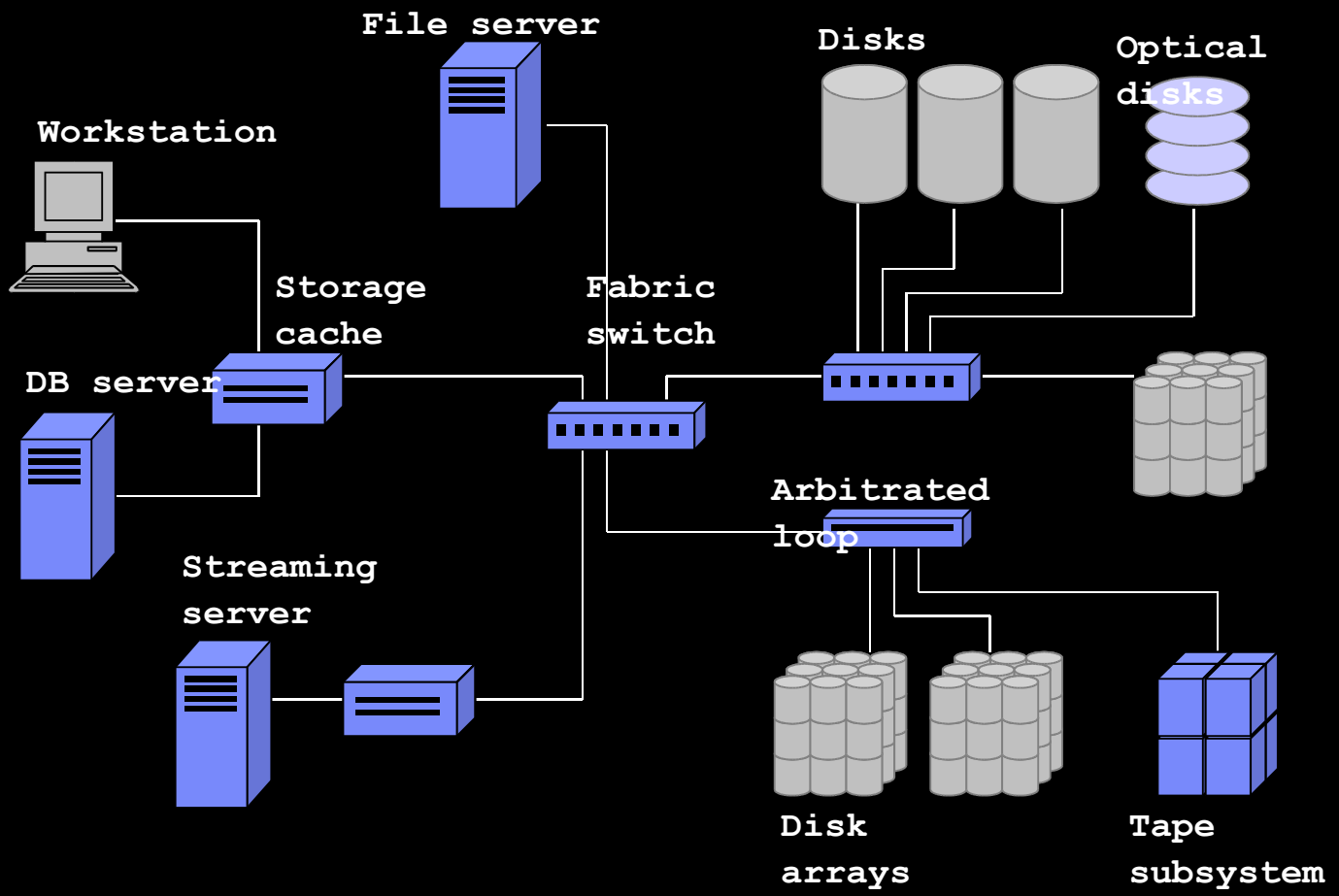
with help and encouragement from

Mandis Beigi, Seraphin Calo, Sandeep Gopisetty, Dilip Kandlur, David Olshefski, Dinesh Verma, and other colleagues from IBM IGS, Research and Tivoli.

Outline

- **Problem Statement and Proposed Solution**
  - Background on SAN, Policies
  - Configuration Validation Using Policies
- **SAN Configuration Validator**
  - Architecture
  - Data Model
  - Aspects of policy management
- **Conclusion and Future Work**

Overview: Storage Area Network (SAN)



Problem Statement

- **SAN management is a difficult task!**
- **Field representatives have designed "recipes" or best practices for SAN deployment**
  - goal is to minimize configuration problems
- **Provide an automated solution to audit a SAN configuration**
  - encourage more economical SAN designs
  - encourage consolidation of best practice

Examples of SAN Interoperability Problems

- **Switches are not interoperable with each other**
  - Switches from vendor X and Y cannot be cascaded
- **Different OS hosts cannot be put in the same zone**
  - Windows and Linux hosts cannot be in the same zone
- **Software compatibility**
  - Multi-pathing software from storage vendor X on host A will not let you see the storage from vendor Y

Solution: Policy-Based SAN Configuration Validation

- **Policy infrastructure can be used to manage interoperability constraints:**
  - updating, distributing, evaluating
- **Allows different actions to be taken**
  - actions depend on type of interoperability problems
- **Policy infrastructure can be used by other components of SAN management software.**
  - virtualization, backup, storage planning

Policy Model

- Scope
  - A context or domain within which the policy applies. Examples:

    "SAN Configuration Validation:IntraHBA"

    "Storage Access Control:FileAccess"

    "Storage Allocation:DiskQuota"
- Condition
  - Specifies when a policy is to be applied. Condition is specified as a Boolean expression. The "***if*** *clauses*" within a policy.
- Decision
  - A policy guidance. The "***then*** *clause"* within a policy.
- Priority
  - A statement of priority, expressed as an integer.

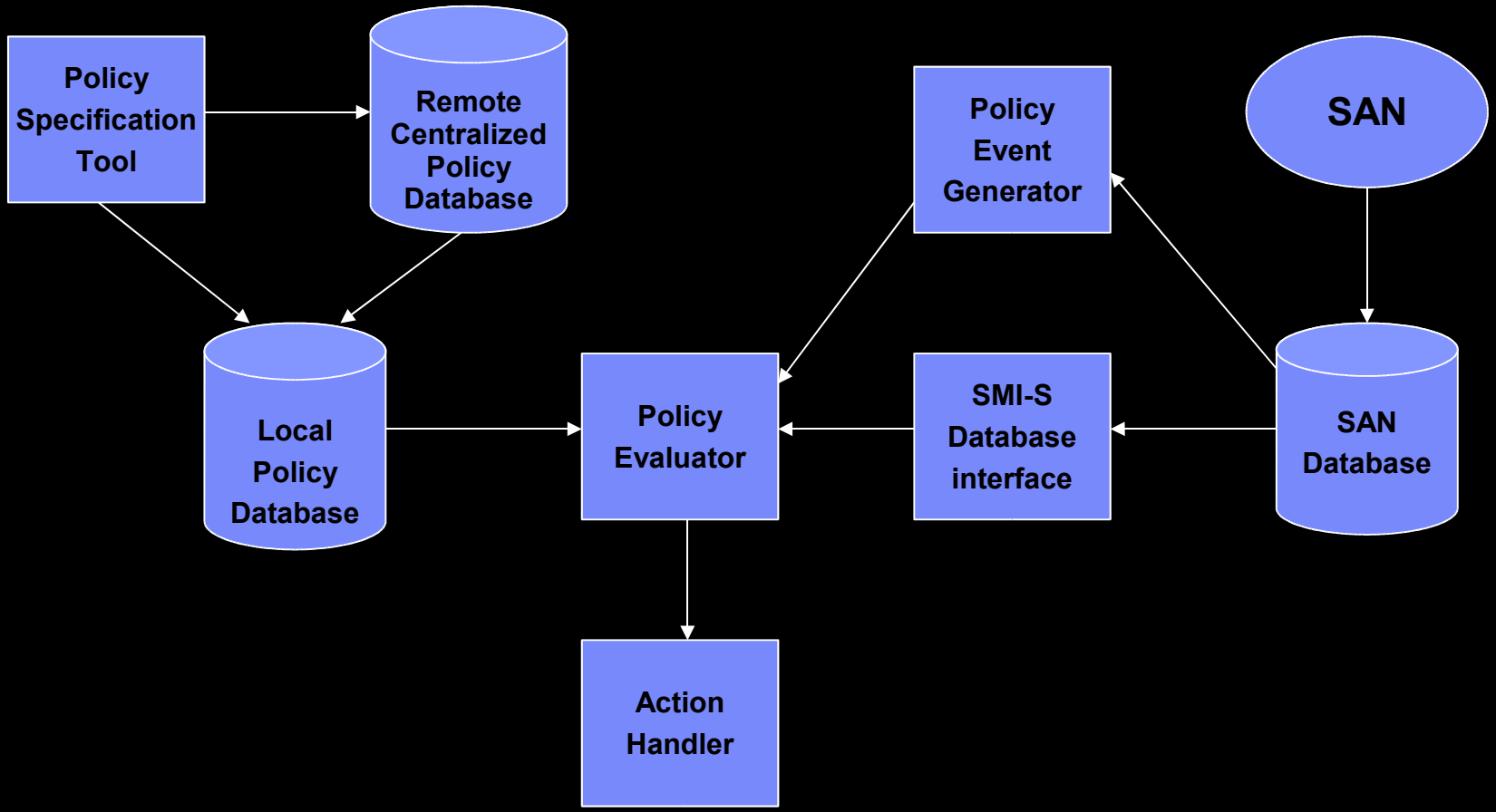
Example Policy for SAN Configuration Validator

- Scope
  - **"SAN Configuration Validation"**
  - **"IntraHBA"**
- Condition
  - **If (hba.Manufacturer.Name = "QLogic") *AND* (hba.firmware.level < 3.41)**
- Decision
  - Two name-value pairs:

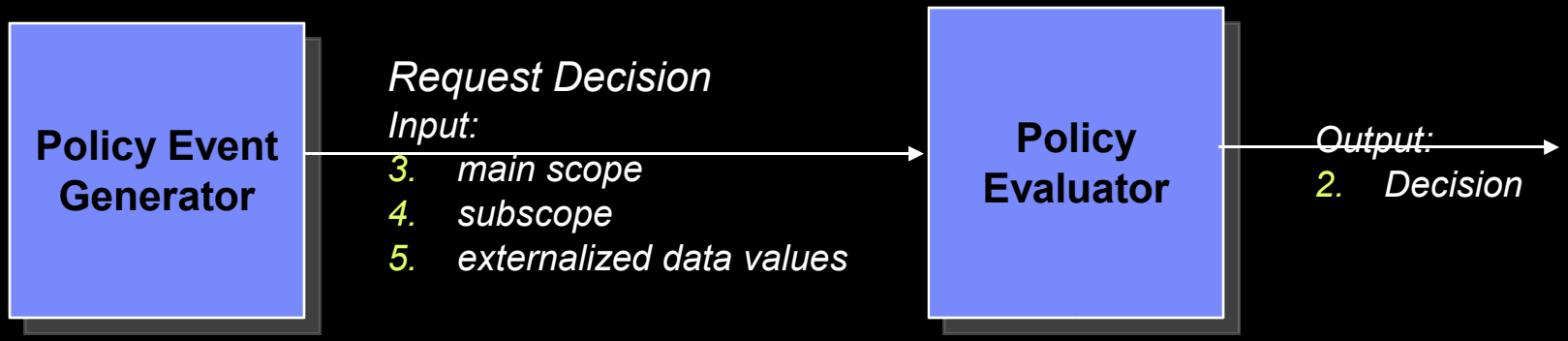
```
synopsis= "QLogic HBAs should have firmware level greater
  than or equal to 3.41". HBA with id: " + hba.id + "
  violates this policy."
severity = ERROR
```

- Priority
  - currently not used

How it works (walk through the validation process)



Interaction between Event Generator and Evaluator



- **Main policy scope identifies a broad area of policy application.**
  - policy evaluator can be configured to follow different modes of operation for different main scopes, e.g. choosing an evaluation engine, solicited/unsolicited.

- **Subscope establishes a narrower context under which policies are written, distributed, and evaluated.**

Subscope

- **Subscope establishes a context for policies**
  - policies under subscope `"InterHostHBA"` should be related to properties of a host and a resident HBA.

- **Subscope limits the data that can occur in a policy**
  - Event generator needs to send only relevant data to the evaluator
  - a policy author may find that none of the defined subscopes are suitable for a particular policy

Defining a policy scope taxonomy

1. **Collect sample policies to be implemented as plain English statements.**
2. **Model subscopes and corresponding data available for policies. SMI-S is a good starting point for SANs.**
3. **Translate plain English statements to policy 4-tuple using the data model.**
4. **Iterate between Step 2 and Step 3, until a satisfactory list of subscopes has been achieved .**

SAN Configuration Policy Analysis

- **Collected a comprehensive set of SAN configuration rules of thumb used by field experts.**
- **Analyzed the collected rules and extracted 64 representative policies.**
- **Defined policy language constructs to express these policies (in addition to traditional operators such as Numeric, Boolean, String operators).**

Subscopes for SAN Configuration Validation

- **One subscope for each component**
  - HBA, Host, Storage Device, Switch, Link, Zone etc.
- **One subscope for each pair of associated components**
  - HostHBA, HBASwitch etc.
- **subscopes for special collections of components**
  - AllSwitches, AllHosts, etc.

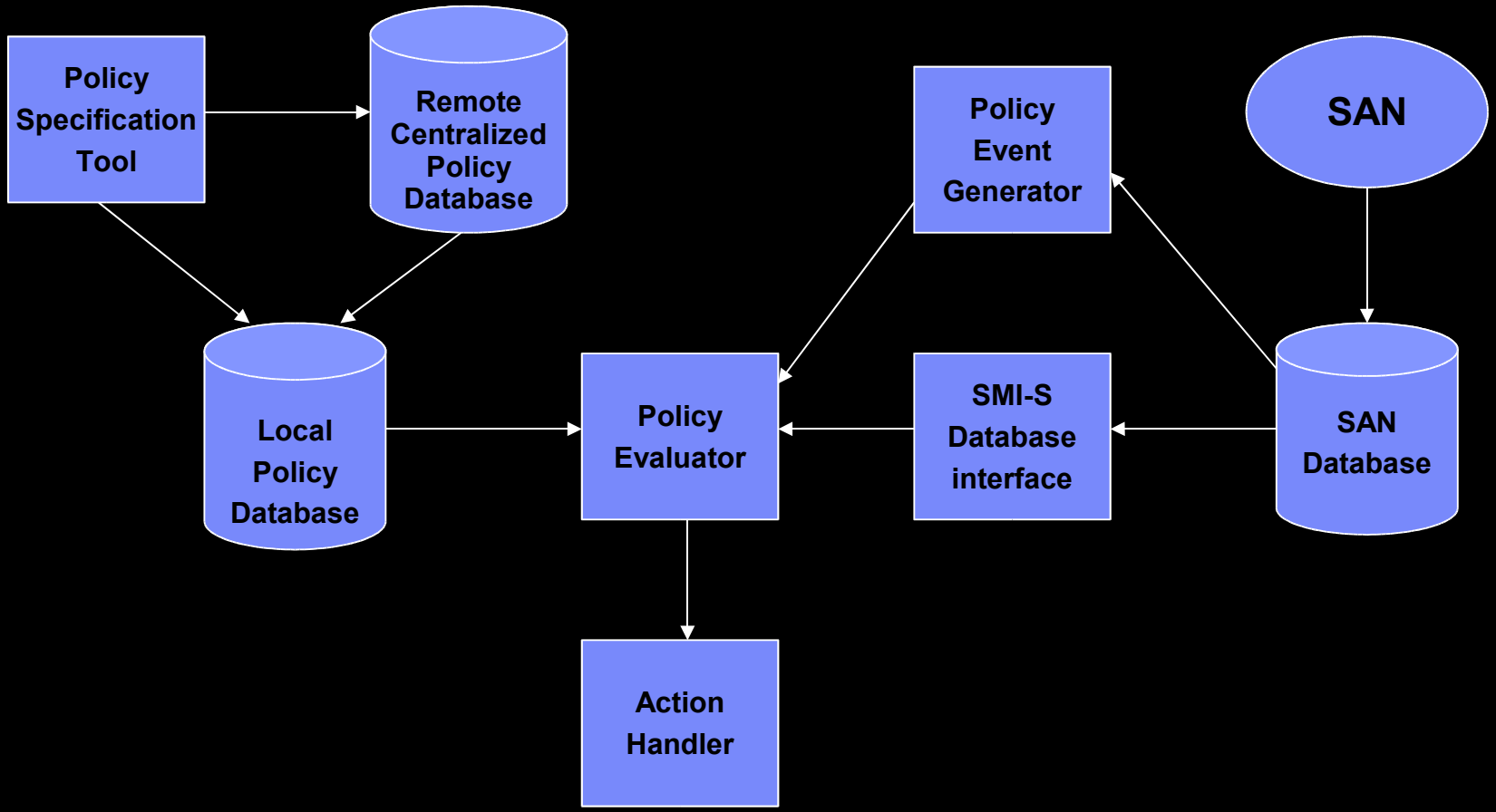
Policy Aspects

- **Policy language**
  - XML based: ease of parsing, compatible with Web Services
  - Seamlessly extensible: addition of new functions and data types
- **Collection policies**
  - requires adding new functions to the policy language
- **Two evaluation engines**
  - general purpose engine
  - hyperspace-based fast engine
- **Policy evaluator is capable of gathering data required for policy evaluation**

Collection Operators

- **We determined five collection operators are necessary to fully express SAN policies.**
  - Given a collection C with elements O1, … On, where each element has m attributes p1, …, pm.
  2. Cartesian operator: Given sets of values A1, … , Am for attributes p1, …, pm, respectively, return all elements Oi that satisfy (Oi.p1 ∈ A1) AND … (Oi.pm ∈ Am).
  3. Exclusion: Given sets of values A1, …, Am and B1, …, Bm, return all elements in C that satisfy (Oi.p1 ∈ A1) AND … (Oi.pm ∈ Am) and (Oj.p1 ∈ B1) AND … (Oj.pm ∈ Bm)
  4. Many-to-One: Test if the value of an attribute pi be the same for all elements in C.
  5. One-to-One: Test if the value of an attribute pi be different for all elements in C.
  6. Graph: Given a directed graph G = (E, C) and two elements Oi and Oj, return all directed paths between them.

How it works (walk through the validation process)



Related Work

- **EMC Storage Architect and CA BrightStor SAN Designer have SAN configuration checking tools**
- **PCIM, SNIA SMI-S standards**
- **This approach is compatible with different policy evaluation engines**
- **Ongoing work on policy based management for IP network Security and QoS services**

Conclusion and Future Work

- **Incorporating configuration validator features into other storage management functions:**
  - storage capacity planning tools
  - storage provisioning tools
- **Working on how to scale this system across thousands of devices with thousands of policies**
- **Extending this work to check for inconsistencies across integrated application/database/file system/SAN deployment**

Examples of SAN Best Practice Rules

- **There should be at least 2 paths from the host to the storage controller.**
- **Hosts should be connected to department class (16 port) switches.**
- **Storage Controllers should be connected to director class (64 port) switches.**
- **The same HBA should not be used to access both tape and disk storage.**