

# Research Notes - Policy-based Management

Sven van der Meer

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# Discussion (taken from vdm/noms/2018)

Understanding the role of policies and the policy-based approach requires some historical context. The separation of strategy from system (design and process) was first described in (Hansen 1970).

Policy was first used in the 1970's for security (Bell, 1973) where a relation  $W$  provides access control *rules* to govern system security. These rules help to govern state transitions on receiving requests. (Dobson, 1989) states that a system specification describes *what* a system does while a policy describes how. Here, the dynamic features are *policy*, *role*, and *control*.

In the mid 1970's operating systems began using the term policy as an artifact of control (Levin, 1975), where users could influence kernel-space decisions without requiring an expensive kernel to user space switch. In (Jomier, 1981) the authors separate static and dynamic policies for memory allocation, for static memory allocated at scheduling time with dynamic memory changing with the process. The policy/mechanism principle for operating system resource allocation is introduced in (Levin, 1975), while (Day, PNA, 2007) explains how this principle can be applied to networks and their management.

Policies are first used in communication systems in (Rouse, 1979) to control sharing resources as rules for *control*. In (Kamoun, 1981) rules are used to detect and later prevent network congestion.

Event Condition Action (ECA) rules appear first in active databases (Dayal, 1988). A defined event triggers the evaluation of a defined set of queries (condition) and a defined action is executed if the condition is satisfied. The processing of rules is strongly associated to database transactions. Event types for ECA are defined as database operation, temporal, and external notification. An architecture for an active database management system with CA and ECA policies is described in (McCarthy, 1989).

Policy as a paradigm for network management was defined by Sloman's Imperial College research team. This work was, at least partially, based on ODP and OSI's network management (Sloman, 1990), also introducing domains. One of the main focus points was access control (Moffet, 1990). Policy for network management then is originally defined in (Sloman, 1994), based on earlier work (Robinson, 1988) (Twidle, 1988), as well as the PhD thesis' of Robinson (1988), Moffet (1990), and Twidle (1993). Originally focusing on access control, the work introduced domains, subject, and target, plus policy categories (and models) and a policy system (with language and tooling) called Ponder. This is then followed by policy standards, such as the IETF policy framework, DMTF CIM, TMF SID, to name a just view. A detailed historic perspective on policy can be found in (Boutaba, 2007).

A deep understanding of policy requires study of policy frameworks (Triantafyllopoulou, 2013), approaches (Phan, 2008), and concepts for specifications (Damianou, 2002). Policies from different domains were also analyzed, such as cognitive radio (Mitola, 2009), security (Han, 2012), network traffic and QoS (Stone, 2001), and XML and open environments (Yagüe, 2006).

Approaches for models that allow multiple PMs in a single PDM have been developed in (Strassner, 2004) and more recently in (Strassner, 2017). Here, each PM is bound to its specific definitions, for instance an ECA policy is bound to its inherent rule structure, so while being extensible, it is not easy to add new policy models.

A better approach is to specify a formal taxonomy that informs a formal PDM, independent of any specific PM, for instance in (Davy, 2008).

Tool support for syntactic and semantic translation between models can be achieved (Barrett, 2007/GIIS) and (Barrett, 2007/MACE). However, it is important to note that semantic translation cannot be fully automated. In (Brennan, 2010) we study inter-domain relationships and policy translation, both important aspects. We have summarized today's challenges for policy-based management in [39] and [40].

**P. Brinch Hansen:** *The nucleus of a multiprogramming system*, 1970

- Author: P. Brinch Hansen
- Reasons to read: first principle of separation of strategy from process
- Published: Communications of the ACM CACM, Volume 13 Issue 4, April 1970, Pages 238-241
- Links: [DOI](#), [PDF](#)    skb: [yaml src](#)

**D. Elliott Bell et al.:** *Secure Computer Systems: Mathematical Foundations*, 1973

- Authors: D. Elliott Bell, Leonard J. LaPadula
- Reasons to read: access control *rules* to govern system security, relation *W* provides rules of access *control* governing system security, rule helps system in any state to decide on request and move to next state
- Published: MITRE Technical Report 2547, Volume I, March 1, 1973
- Links: [PDF](#)    skb: [yaml src](#)

**R. Levin et al.:** *Policy/Mechanism Separation in Hydra*, 1975

- Authors: R. Levin, E. Cohen, W. Corwin, F. Pollack, W. Wulf
- Reasons to read: first principle of separation of mechanism and policy, policy is artifact of *control* for mechanisms, separates kernel level decision making from user level decision declaration
- Published: SOSP '75 Proceedings of the fifth ACM Symposium on Operating Systems Principles, pages 132-140
- Also: ACM SIGOPS Operating Systems Review 9(5):132-140 · November 1975
- Links: [DOI](#), [ResearchGate](#), [PDF](#)    skb: [yaml src](#)

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**William B. Rouse:** *A Model-Based Approach to Policy Analysis in Library Networks*, 1979

- Author: William B. Rouse
- Reasons to read: policy to control sharing resources, rules for the *control* of how to share resources (and rule analysis)
- Published: IEEE Transactions on Systems, Man, and Cybernetics (Volume: 9, Issue: 9, Sept. 1979)
- Links: [DOI](#)    skb: [yaml](#) [src](#)

**Geneviève Jomier:** *A Mathematical Model for the Comparison of Static and Dynamic Memory Allocation in a Paged System*, 1981

- Author: Geneviève Jomier
- Reasons to read: separate static and dynamic policies for memory allocation, static: memory allocated at scheduling time, dynamic: memory evolves with process
- Published: IEEE Transactions on Software Engineering (Volume: SE-7, Issue: 4, July 1981)
- Links: [DOI](#)    skb: [yaml](#) [src](#)

**Farouk Kamoun:** *A Drop and Throttle Flow Control Policy for Computer Networks*, 1981

- Author: Farouk Kamoun
  - Reasons to read: rules to detect and later prevent network congestion
  - Published: IEEE Transactions on Communications (Volume: 29, Issue: 4, Apr 1981)
  - Links: [DOI](#)    skb: [yaml](#) [src](#)
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**Umeshwar Dayal et al.:** *The HiPAC project: combining active databases and timing constraints*, 1988

- Authors: Umeshwar Dayal, Barbara Blaustein, Alejandro Buchmann, Sharma Chakravarthy, Meichun Hsu, R. Ledin, Dennis R. McCarthy, Arnon Rosenthal, A. Sarin, M. J. Carey, Miron Livny, R. Jauhari
- Reasons to read: origin of Event Condition Action (ECA) rules
  - Defines ECA rules – Event, Condition, Action
    - Event triggers rule, i.e. condition evaluation
    - Condition is set of queries
    - Action is executed when rule is triggered and condition is satisfied
  - Processing rules is strongly related to database transactions
  - Two couplings are defined: E-C and C-A
  - Event types: database operation, temporal, external notification
  - Funded by DARPA
- Published: ACM SIGMOD Record - Special Issue on Real-Time Database Systems, Volume 17 Issue 1, March, 1988, Pages 51 - 70
- Links: [DOI](#), [ResearchGate](#)    skb: [yaml src](#)

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**Dennis R. McCarthy et al.:** *The Architecture Of An Active Data Base Management System*, 1989

- Authors: Dennis R. McCarthy, Umeshwar Dayal
- Reasons to read: extension of ECA rules for databases, architecture of a resulting active database management system
- Published: SIGMOD '89 Proceedings of the 1989 ACM SIGMOD international conference on Management of data, Pages 215-224, Portland, Oregon, USA
- Links: [link::https://doi.org/10.1145/67544.66946](https://doi.org/10.1145/67544.66946)[DOI], [PDF](#)    skb: [yaml src](#)

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**D.C. Robinson et al.:** *Domains: a new Approach to Distributed System Management*, 1988

- Authors: D.C. Robinson, Morris J. Sloman
  - Reasons to read: early work on policy in network management
  - Published: 1988 Proceedings. Workshop on the Future Trends of Distributed Computing Systems in the 1990s
  - Links: [DOI](#), [PDF](#)    skb: [yaml src](#)
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**Kevin Twidle** et al.: *Domain based Configuration and Name Management for Distributed Systems*, 19888

- Authors: Kevin Twidle, Morris J. Sloman
- Reasons to read: early work on policy in network management
- Published: 1988 Proceedings. Workshop on the Future Trends of Distributed Computing Systems in the 1990s
- Links: [DOI](#), [PDF](#)    skb: [yaml src](#)

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**J. E. Dobson** et al.: *A Framework for expressing Models of Security Policy*, 1989

- Authors: J. E. Dobson, J. A. McDermid
- Reasons to read: system specification describes *what* a system does while a policy describes how, dynamic features are *policy*, *role*, and *control*
- Published: Proceedings. 1989 IEEE Symposium on Security and Privacy
- Links: [DOI](#)    skb: [yaml src](#)

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**Jonathan Moffett** et al.: *Specifying Discretionary Access Control Policy for Distributed Systems*, 1990

- Authors: Jonathan Moffett, Morris J. Sloman, Kevin Twidle
- Reasons to read: defines policy as a paradigm for network management
- Published: Computer Communications, Volume 13, Issue 9, November 1990, Pages 571-580
- Links: [DOI](#), [PDF](#)    skb: [yaml src](#)

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**Morris J. Sloman**: *Management for Open Distributed Processing*, 1990

- Author: Morris J. Sloman
- Reasons to read: management in context of ODP and OSI, introduces domains
- Published: 1990 Proceedings Second IEEE Workshop on Future Trends of Distributed Computing Systems
- Links: [DOI](#), [PDF](#)    skb: [yaml src](#)

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**Morris J. Sloman**: *Policy driven Management for Distributed Systems*, 1994

- Author: Morris J. Sloman
  - Reasons to read: defines policy as a paradigm for network management
  - Published: Journal of Network and Systems Management (JNSM), December 1994, Volume 2, Issue 4, pp 333–360
  - Links: [DOI](#), [PDF](#)    skb: [yaml src](#)
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**Gary N. Stone et al.:** *Network Policy Languages: A Survey and a New Approach*, 2001

- Authors: Gary N. Stone, Bert Lundy, Geoffrey G. Xie
- Reasons to read: survey of policy languages, and an approach for them
- Published: IEEE Network (Volume: 15, Issue: 1, Jan/Feb 2001)
- Links: [DOI](#), [PDF](#)    skb: [yaml src](#)

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**Nicodemos C. Damianou et al.:** *A Survey of Policy Specification Approaches*, 2002

- Authors: Nicodemos C. Damianou, Arosha K. Bandara, Morris J. Sloman, Emil C. Lupu
- Reasons to read: survey of policy specification approaches / languages
- Published: Imperial College, London, Tech. Rep., 2002. [Online]
- Links: [CiteSeer](#), [PDF: IC](#), [PDF: ResearchGate](#)    skb: [yaml src](#)

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**John C. Strassner:** *Policy-based Network Management: Solutions for the Next Generation*, 2004

- Author: John C. Strassner
- Publisher: Morgan Kaufman
- Links: [ScienceDirect](#)    skb: [yaml src](#)

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**Mariemma I. Yagüe:** *Survey on XML-Based Policy Languages for Open Environments*, 2006

- Author: Mariemma I. Yagüe
- Reasons to read: early work on policy in network management
- Published: Journal of Information Assurance and Security 1 (2006) 11-20
- Links: [CiteSeer](#), [ResearchGate](#), [PDF](#)    skb: [yaml src](#)

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**Keara Barrett et al.:** *A Model Based Approach for Policy Tool Generation and Policy Analysis*, 2007

- Authors: Keara Barrett, Steven Davy, John C. Strassner, Brendan Jennings, Sven van der Meer, Willie Donnelly
  - Reasons to read: tool support for syntactic and semantic translation between models can be achieved
  - Published: 2007 First International Global Information Infrastructure Symposium, GIIS
  - Links: [DOI](#), [ResearchGate](#)    skb: [yaml src](#)
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**Keara Barrett et al.:** *Determining the Feasibility of Policy Translation*, 2007

- Authors: Keara Barrett, John C. Strassner, Sven van der Meer, Willie Donnelly
- Reasons to read: policy translation is possible
- Published: Second IEEE International Workshop on Modelling Autonomic Communications Environments, MACE 2007
- Links: skb: [yaml src](#)

**Raouf Boutaba et al.:** *Policy-based Management: A Historical Perspective*, 2007

- Authors: Raouf Boutaba, Issam Aib
- Reasons to read: history and evolution of policy in management, recursive models, good source for references on policy
- Published: Journal of Network and Systems Management, December 2007, Volume 15, Issue 4, pp 447–480
- Links: [DOI](#), [PDF](#)    skb: [yaml src](#)

**Steven Davy et al.:** *The Policy Continuum – Policy Authoring and Conflict Analysis*, 2008

- Authors: Steven Davy, Brendan Jennings, John C. Strassner
- Reasons to read: a continuum for policies, multiple policy models
- Published: Computer Communications, Volume 31, Issue 13, 15 August 2008, Pages 2981-2995
- Links: [DOI](#), [PDF](#)    skb: [yaml src](#)

**Tan Phan et al.:** *A Survey of Policy-Based Management Approaches for Service Oriented Systems*, 2008

- Authors: Tan Phan, Jun Han, Jean-Guy Schneider, Tim Ebringer, Tony Rogers
- Reasons to read: survey of policy-based management approaches
- Published: 19th Australian Conference on Software Engineering (aswec 2008)
- Links: [DOI](#), [ResearchGate](#)    skb: [yaml src](#)

**Joseph Mitola III:** *Cognitive Radio Policy Languages*, 2009

- Author: Joseph Mitola III
  - Reasons to read: survey of policy languages, here cognitive radio
  - Published: 2009 IEEE International Conference on Communications
  - Links: [DOI](#)    skb: [yaml src](#)
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**Rob Brennan** et al.: *Multidomain IT Architectures for Next-Generation Communications Service Providers*, 2010

- Authors: Rob Brennan, Kevin Chekov Feeney, John Keeney, Declan O’Sullivan, Joel J. Fleck II, Simon Foley, Sven van der Meer
- Reasons to read: inter-domain relationships and policy translation
- Published: IEEE Communications Magazine (Volume: 48, Issue: 8, August 2010)
- Links: [DOI](#), [ResearchGate](#), [PDF: TCD](#)    skb: [yaml src](#)

**Weili Han** et al.: *A Survey on Policy Languages in Network and Security Management*, 2012

- Authors: Weili Han, Chang Lei
- Reasons to read: survey of policy languages, here for security
- Published: Computer Networks, Volume 56, Issue 1, 12 January 2012, Pages 477-489
- Links: [DOI](#), [PDF](#)    skb: [yaml src](#)

**Dionysia Triantafyllopoulou** et al.: *Existing Policy Frameworks: An Overview*, 2013

- Authors: Dionysia Triantafyllopoulou, Adrian Kliks, Valentin Rakovic, Liljana Gavrilovska
- Reasons to read: survey of policy frameworks
- Published: ISWCS 2013; The Tenth International Symposium on Wireless Communication Systems, Cognitive Radio Advances, Applications and Future Emerging Technologies (CRAFT) Workshop
- Links: [eXplore](#), [Surrey](#)    skb: [yaml src](#)

**John C. Strassner** et al.: *Generic Policy Information Model for simplified use of poLicy Abstractions (SUPA)*, 2017

- Authors: John C. Strassner, Joel Halpern, Sven van der Meer
- Published: IETF draft, version 3, May 2017
- Links: [IETF](#)    skb: [yaml src](#)

## APEX

**John Keeney** et al.: *Towards Real-time Management of Virtualized Telecommunication Networks*, 2014

- Authors: John Keeney, Sven van der Meer, Liam Fallon
- Published: 10th International Conference on Network and Service Management (CNSM) and Workshop, 2014
- Links: [DOI](#), [ResearchGate](#)    skb: [yaml src](#)

**Sven van der Meer** et al.: *Dynamically Adaptive Policies for Dynamically Adaptive Telecommunications Networks*, 2015

- Authors: Sven van der Meer, John Keeney, Liam Fallon
- Published: 2015 11th International Conference on Network and Service Management (CNSM)
- Links: [DOI](#), [ResearchGate](#)    skb: [yaml src](#)

**Liam Fallon** et al.: *APEX: An Engine for Dynamic Adaptive Policy Execution*, 2016

- Authors: Liam Fallon, Sven van der Meer, John Keeney
- Published: 2016 IEEE/IFIP Network Operations and Management Symposium, NOMS 2016
- Links: [DOI](#), [ResearchGate](#)    skb: [yaml src](#)

**Liam Fallon** et al.: *Distributed Management Information Models*, 2017

- Authors: Liam Fallon, John Keeney, Sven van der Meer
- Published: 2017 IFIP/IEEE Symposium on Integrated Network and Service Management (IM), IM 2017
- Links: [DOI](#), [ResearchGate](#)    skb: [yaml src](#)

**Liam Fallon** et al.: *Using the COMPA Autonomous Architecture for Mobile Network Security*, 2017

- Authors: Liam Fallon, John Keeney, Mark McFadden, John Quilty, Sven van der Meer
- Published: 2017 IFIP/IEEE Symposium on Integrated Network and Service Management (IM), IM 2017
- Links: [DOI](#), [ResearchGate](#)    skb: [yaml src](#)

**Joseph McNamara** et al.: *A Testbed For Policy Driven Closed Loop Network Management*, 2018

- Authors: Joseph McNamara, John Keeney, Liam Fallon, Sven van der Meer, Enda Fallon
- Published: 2018 IEEE/IFIP Network Operations and Management Symposium, NOMS 2018
- Links: [DOI](#), [ResearchGate](#)    skb: [yaml src](#)

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**Sven van der Meer et al.: *Taming Policy Complexity: Model to Execution*, 2018**

- Authors: Sven van der Meer, John Keeney, Liam Fallon
- Published: 2018 IEEE/IFIP Network Operations and Management Symposium, NOMS 2018
- Links: [DOI](#), [ResearchGate](#)    skb: [yaml src](#)

**Sven van der Meer et al.: *5G Networks Must Be Autonomic!*, 2018**

- Authors: Sven van der Meer, John Keeney, Liam Fallon
- Published: 2018 IEEE/IFIP Network Operations and Management Symposium, NOMS 2018
- Links: [DOI](#), [ResearchGate](#)    skb: [yaml src](#)

**Sven van der Meer et al.: *Demo: Adaptive Policy Execution (APEX)*, 2018**

- Authors: Sven van der Meer, John Keeney, Liam Fallon, Joseph McNamara
- Published: 2018 IEEE/IFIP Network Operations and Management Symposium, NOMS 2018
- Links: [DOI](#), [ResearchGate](#)    skb: [yaml src](#)