Policy-based Management (PBM) for Unified Traffic Engineering

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Outline

- Introduction (Unified TE context)
- Terminology
- Information Models
- Requirements
- Key Challenges
  - Scalability
  - Efficiency
  - Adaptive/Flexibility
- Implementation
- Conclusion

Introduction: Policy-based Management

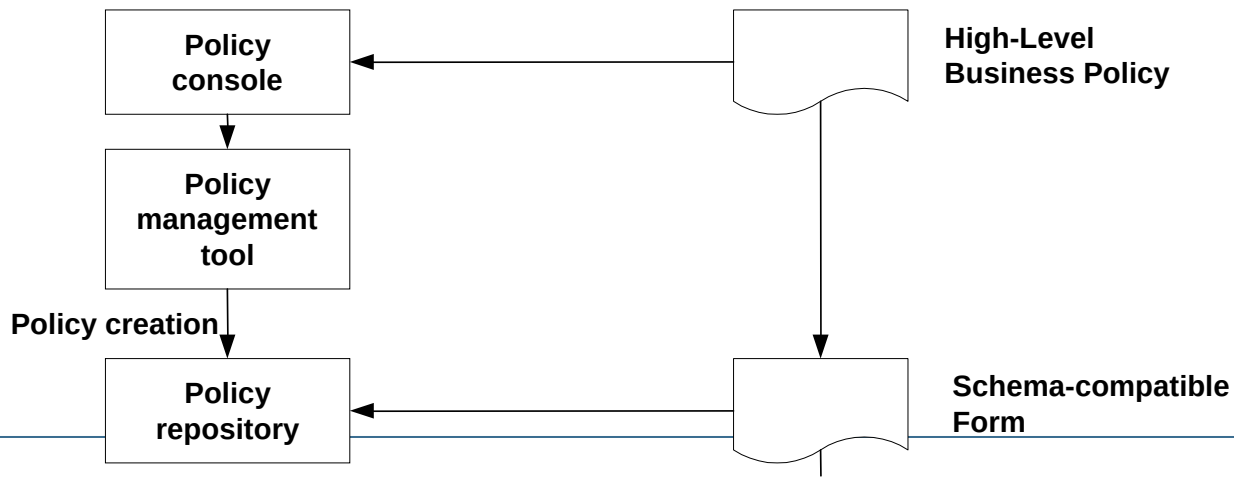
- PBM is an enabling technology for
  - dynamic & global control of large scale distributed systems
  - enforcing operational coherency through policy rules
- PBM enforces
  - Admission conditions
  - Consistent service provisioning, administration, and maintenance
  - Performance monitoring of services
- PBM enable network administrators to automate their distributed network operations through rule-based policies
  - Role of dynamicity: policy enables network state changing (reaction to an event)

Introduction: Unified TE and GMPLS Control Plane

- Traffic Engineering ⇒ effectively control the usage of available network resources & adapt traffic routing to network conditions with joint traffic and resource-oriented performance objectives (during provisioning and recovery)
- Multi-layer/Multi-region TE ⇒ unification of TE objectives, principles and mechanisms to any switching technology
- GMPLS = Set of unified control mechanisms communicating via distributed IP protocols to make Packet (MPLS), Layer 2 (i.e. Ethernet), TDM (i.e. SONET/SDH) and Optical data planes more efficient, flexible, scalable, and resilient in their operation and maintenance

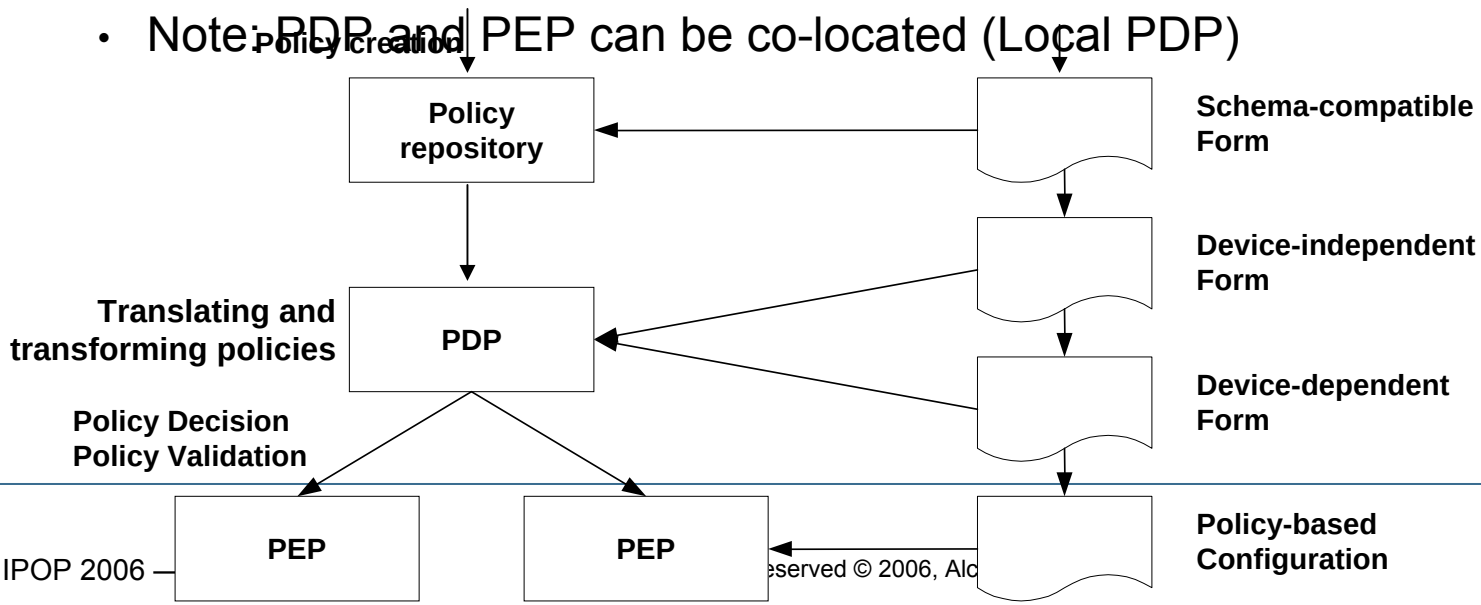
Policy: Terminology (1)

- Policy: set of rules and instructions to guide and determine present and future network's decisions
  - Policy rule: If (a set of policy conditions) then (a set of policy actions)
  - Example: set of rules & instructions to administer, manage, and control access to network resources
- Policy management: set of tools allowing network administrator to configure, maintain and monitor usage of policies
- Policy repository: a database storing policy rules, their conditions and actions, and related policy data (policy DB)

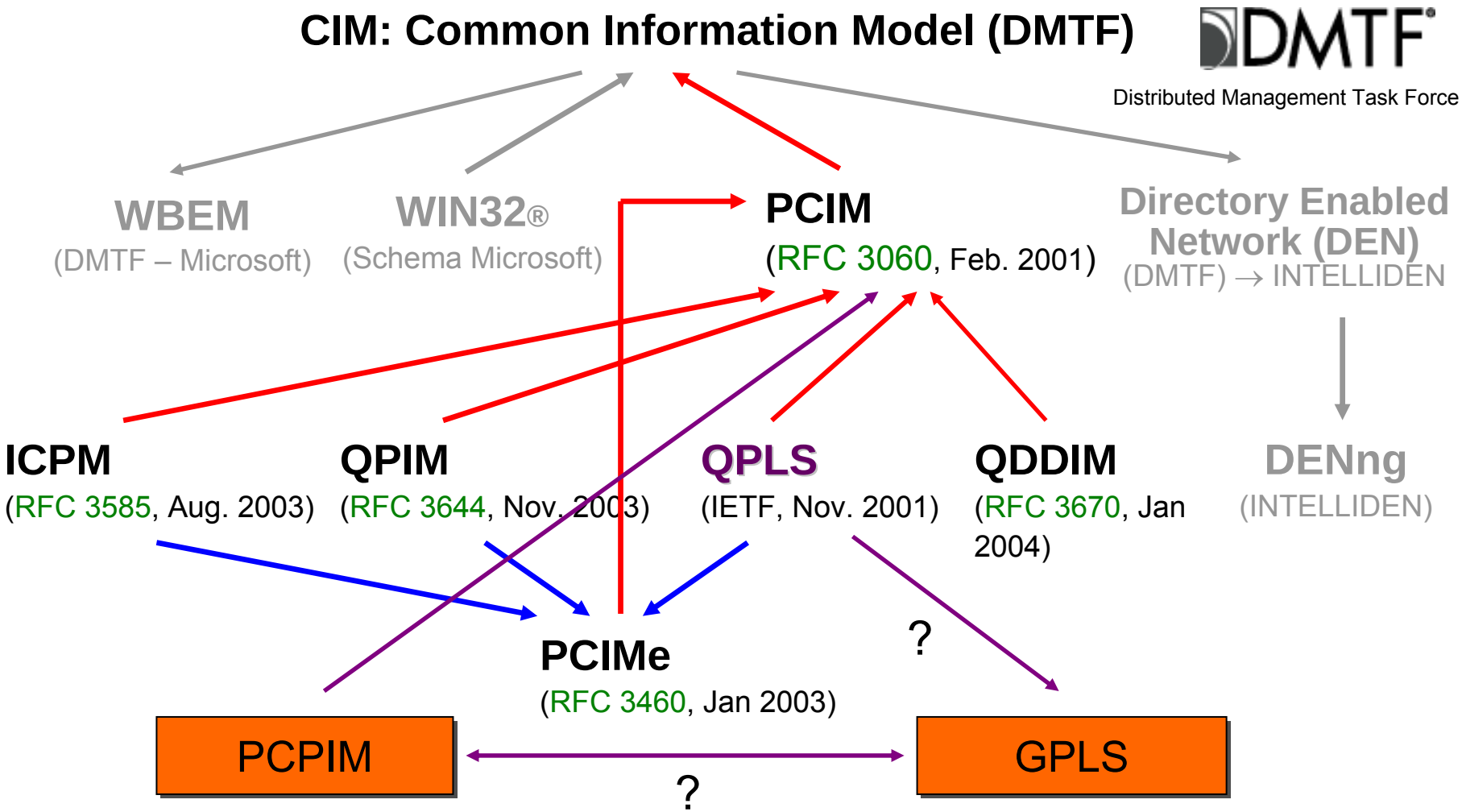


Policy: Terminology (2)

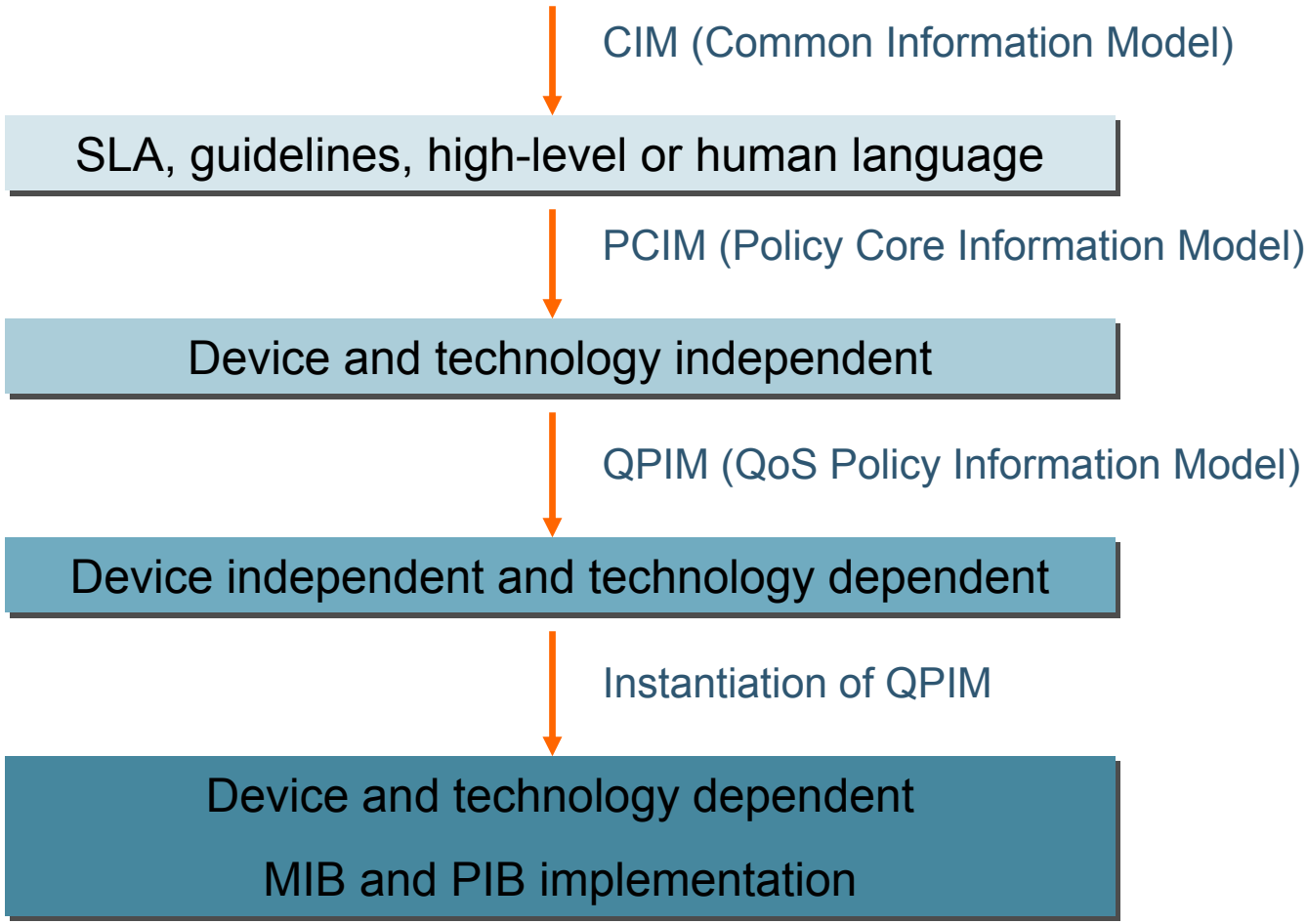
- Policy Decision Point (PDP): logical entity that makes policy decisions for itself or for other network elements that request such decisions
  - "process" perspective: evaluation of policy rule's conditions
  - "result" perspective: actions for enforcement, when the conditions of a policy rule are TRUE
- Policy Enforcement Point (PEP): logical entity that enforces policy decisions
  - Note: PDP and PEP can be co-located (Local PDP)



Policy Information Models: Background (1)



Policy Information Models: Background (2)

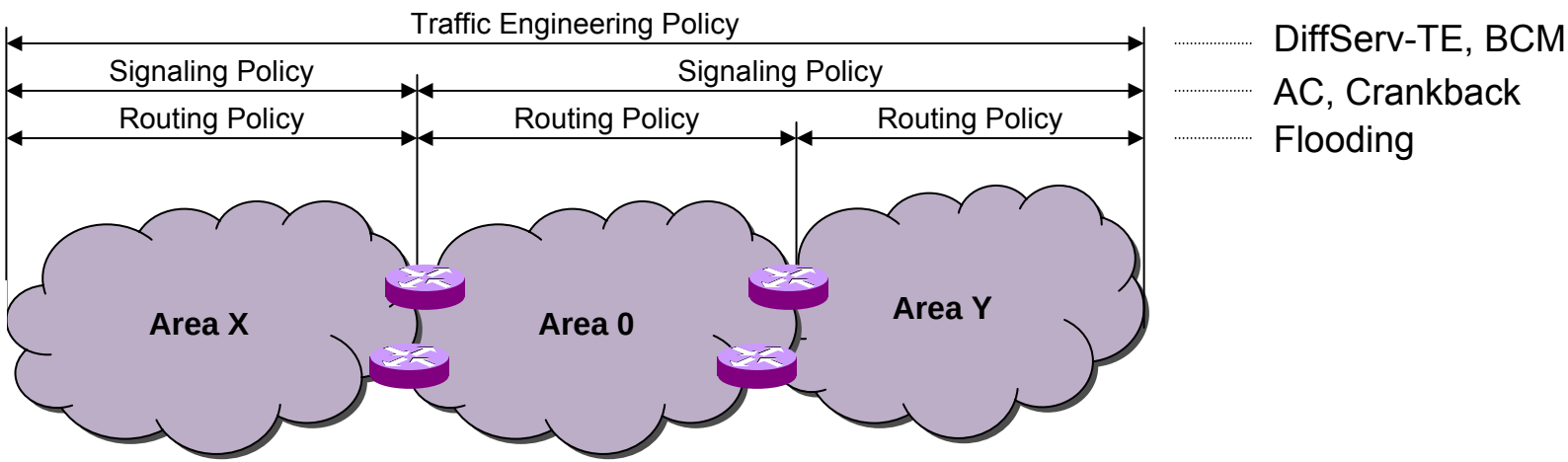


Requirements

- Developing mechanisms and protocols that enable policy-based control over Unified TE decision process
  - Support for many policies and configurations (responsibility of the service provider)
  - Support for monitoring policy state, and provide access/accounting information
  - Fault tolerance and recovery from failure cases such as failure of PDPs, disruption in communication that separate a PDP from its associated PEPs
  - Scalability:
    - timing (messaging, processing, #request/time_unit), path (length), network size (#links, #nodes)
    - fundamental during internal trigger event such as re-routing
  - Support for policy ignorant node (interoperability)

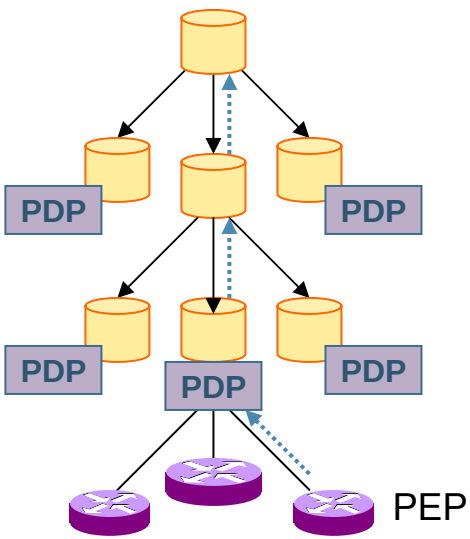
Relationship b/w Domains and Policy

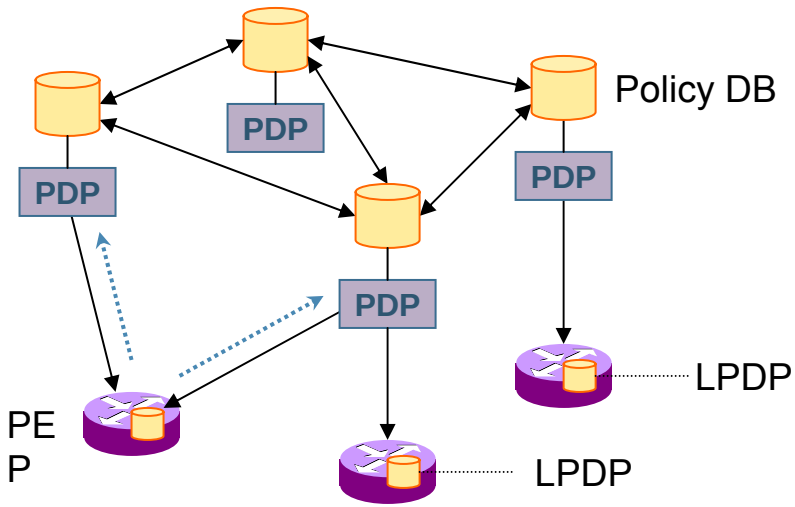
- Domain ⇒ controlled by a single administrative authority
  - Routing domain → build LSDB/TED
    - group of LSRs that enforces a *common routing and forwarding policy*
  - TE domain → compute path (CSPF)
    - group of LSRs that enforces a *common TE policy*
  - Signaling domain → end-to-end LSP provisioning/re-routing
    - group of LSRs that enforces a *common signalling policy*



Key Challenges: Scalability

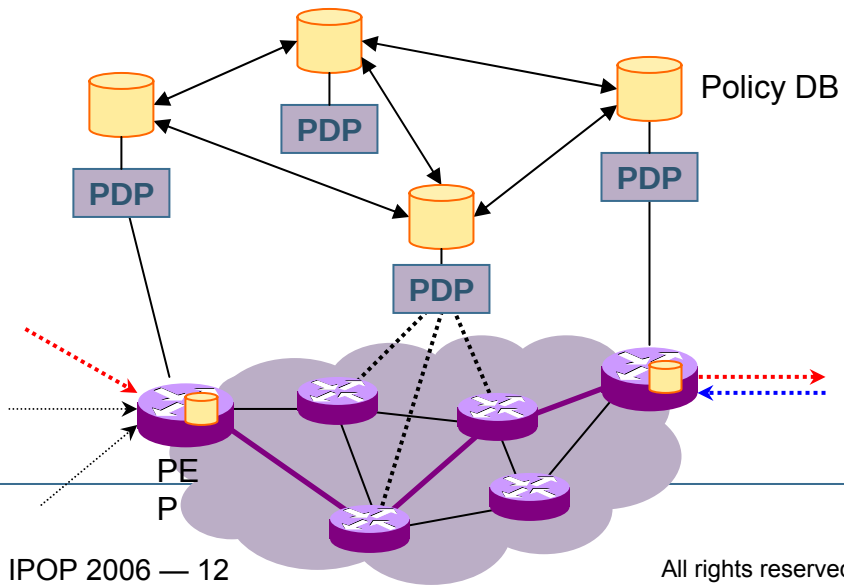
- Scalability
  - Multiple Policy Decision Point (PDP)
  - Multiple Policy Enforcement Point (PEP)
- Implementation
  - Distribution: Hierarchy vs Distributed
  - Control: Request/Maintenance

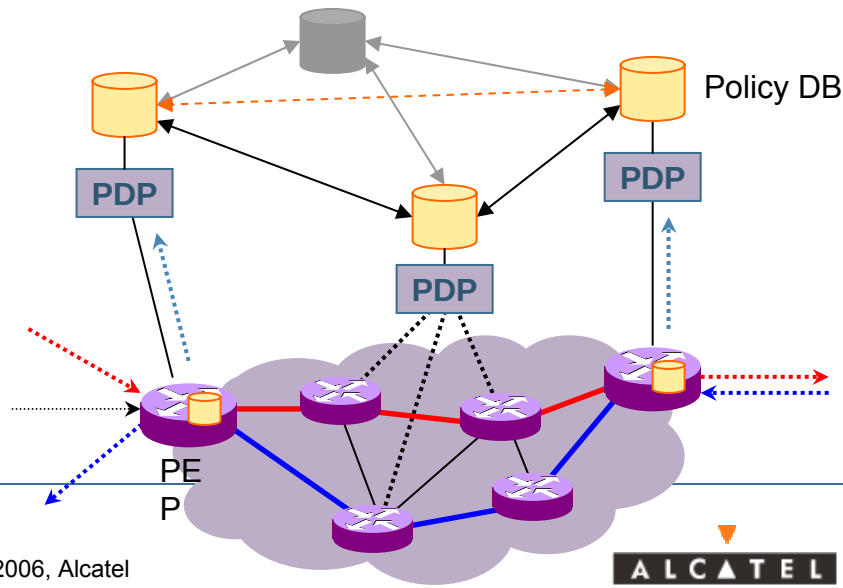




Key Challenges: Efficiency

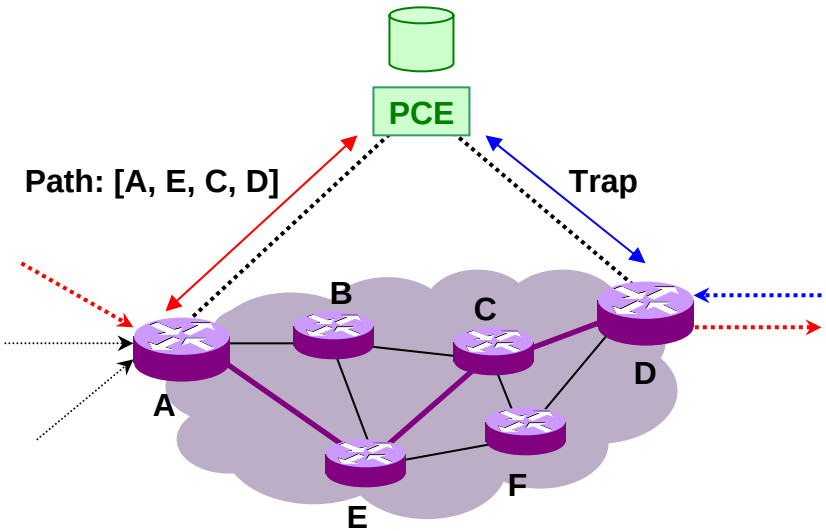
- Efficiency
  - Synchronization PDP decision
  - Timely PEP operations
- Implementation
  - Improved responsivity (TE + AC)
  - External triggers: from services and associated requirements
  - Internal triggers: failure (re-routing), measurement (re-optimization), etc.

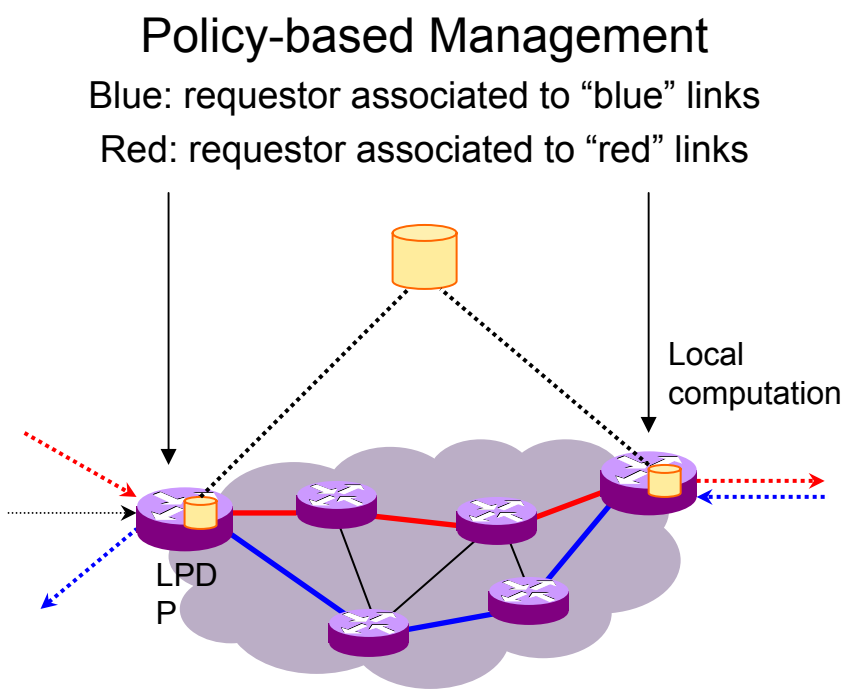




Key Challenges: Efficiency (1)

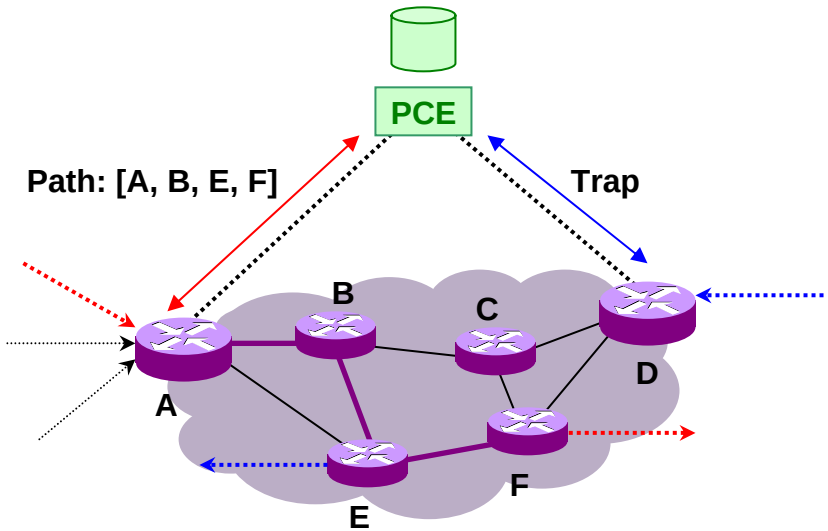
- PCE doesn't help in reducing blocking
- … since not a computation but AC + TE problem





Key Challenges: Efficiency (2)

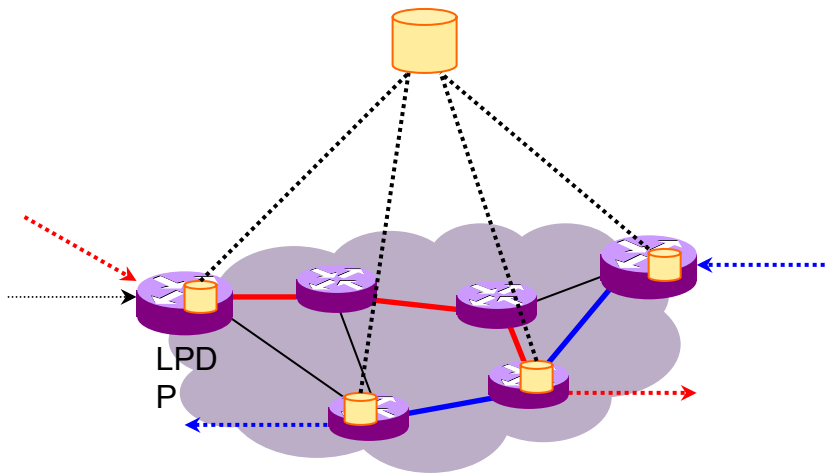
- PCE doesn't help in reducing blocking
- … since not a computation but AC + TE problem



Policy-based Management

Blue: requestor associated to "blue" links

Red: requestor associated to "red" links



Key Challenges: Efficiency (3)

- External event (provisioning of lower bandwidth LSP) may trigger
  - Higher bandwidth LSP (triggered FA-LSP)
  - Exclusively make use of pre-provisioned FA-LSP
- … too coarse, set of conditions/rules derived from
  - Prevent link capacity exhaustion (pro-active creation after unreserved bandwidth drops below certain %)
  - Prevent link capacity waste (pro-active deletion after unreserved bandwidth above certain %) $\Rightarrow$ re-routing
  - Minimize or only limit resulting unreserved bandwidth of FA-LSP (e.g. trigger STM-64 for a 2Mb packet LSP ?)
  - TE metric setting (default setting or more elaborated ?)
  - Etc.
- Policy is a MUST for controlling two key dimensions: time and resources

Key Challenges: Flexibility

- Adaptive/Flexible
  - Network dynamics
    - external ⇒ internal triggers
    - Multi-region: internal ⇒ internal triggers
  - Prevent blocking due to unknown conditions/rules
- Implementation
  - Roles (policy selector): generalized to cope with diversity (types and properties)
    - (set of) component links ⇒ TE link
    - FA-LSP ⇒ component link
    - LSP ⇒ FA-LSP

    } Role combination
  - Non-Static / Adaptive rules
  - Self-tuning / learning

Implementation (1)

- Each component (routing, signaling, TE, etc.) can be the object of a policy
- Two classes of TE policies

  Class 1: TE routing information dissemination and distribution

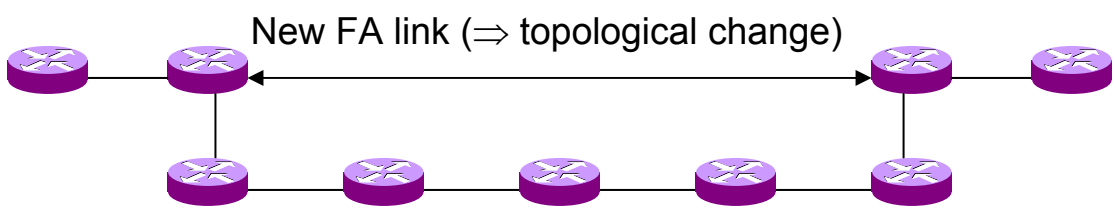
  1. TE information flooding
     - frequency (pacing between MinLSInterval and LSRefreshTime)
     - filtering of TE information (e.g. at LSP region boundaries)
     - aggregation i.e. bundling (component link information kept link local)
     - inheritance rules
  2. TE information quality: in addition to the link identification information, per-priority bandwidth (unreserved, maximum reservable and maximum LSP bandwidth), TE metric, resource class and SRLG information

Implementation (2)

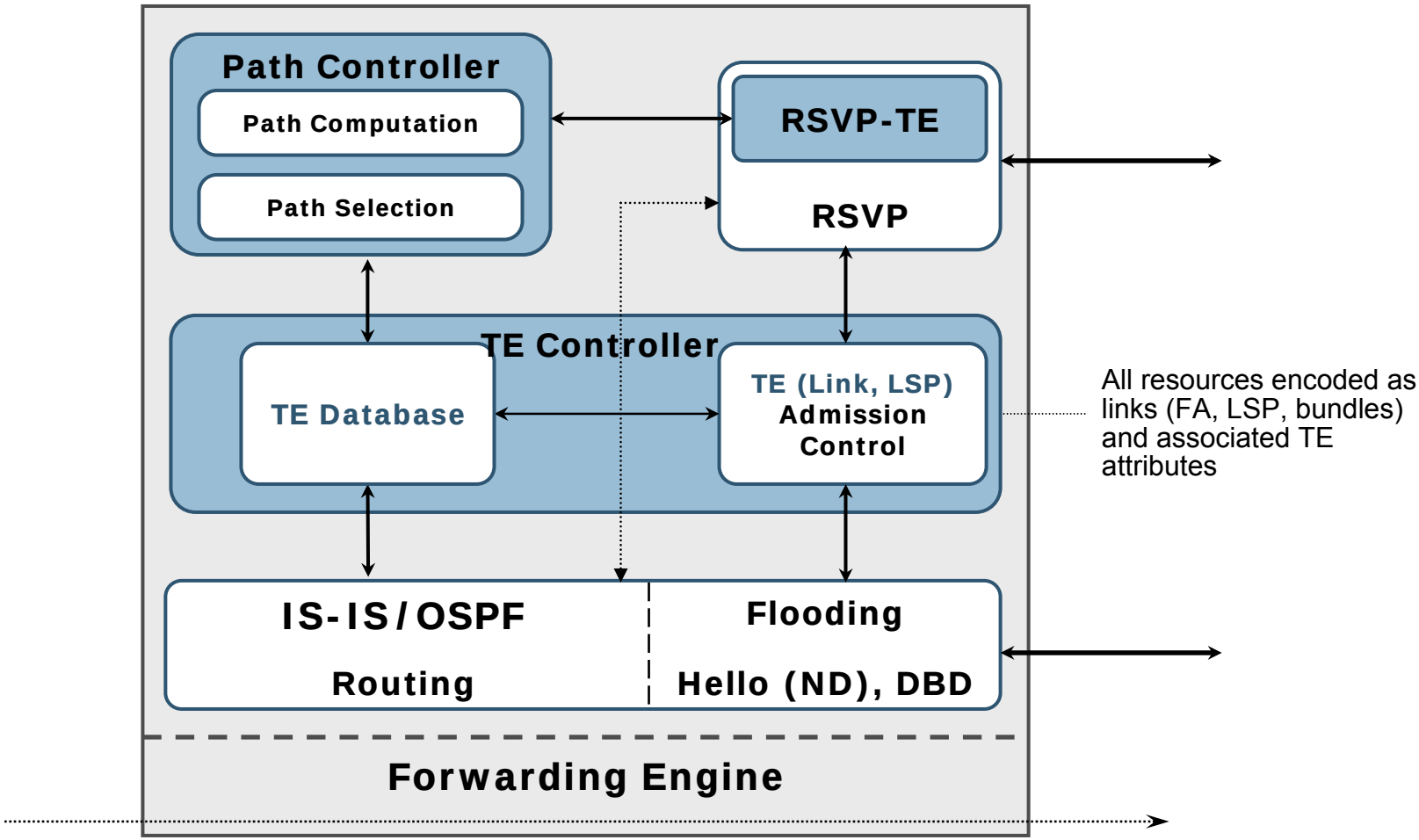
- Class 2: TE information usage
  - Pro-active vs Reactive: in case one or more thresholds crossed
    - setting up/tearing down a set of one or more working and/or protecting LSPs including the triggering of new FA-LSPs
    - re-optimization a set of one or more working and/or protecting LSPs in case of topological and/or resource utilization change
  - TE information usage
    - Corrective: prescribes a course of action to address an existing anomaly (reactive) or a predicted anomaly (proactive)
    - Perfective: prescribes a course of action to evolve and improve network performance (reactive) even when no anomalies are evident (proactive)

Implementation: Some Remarks

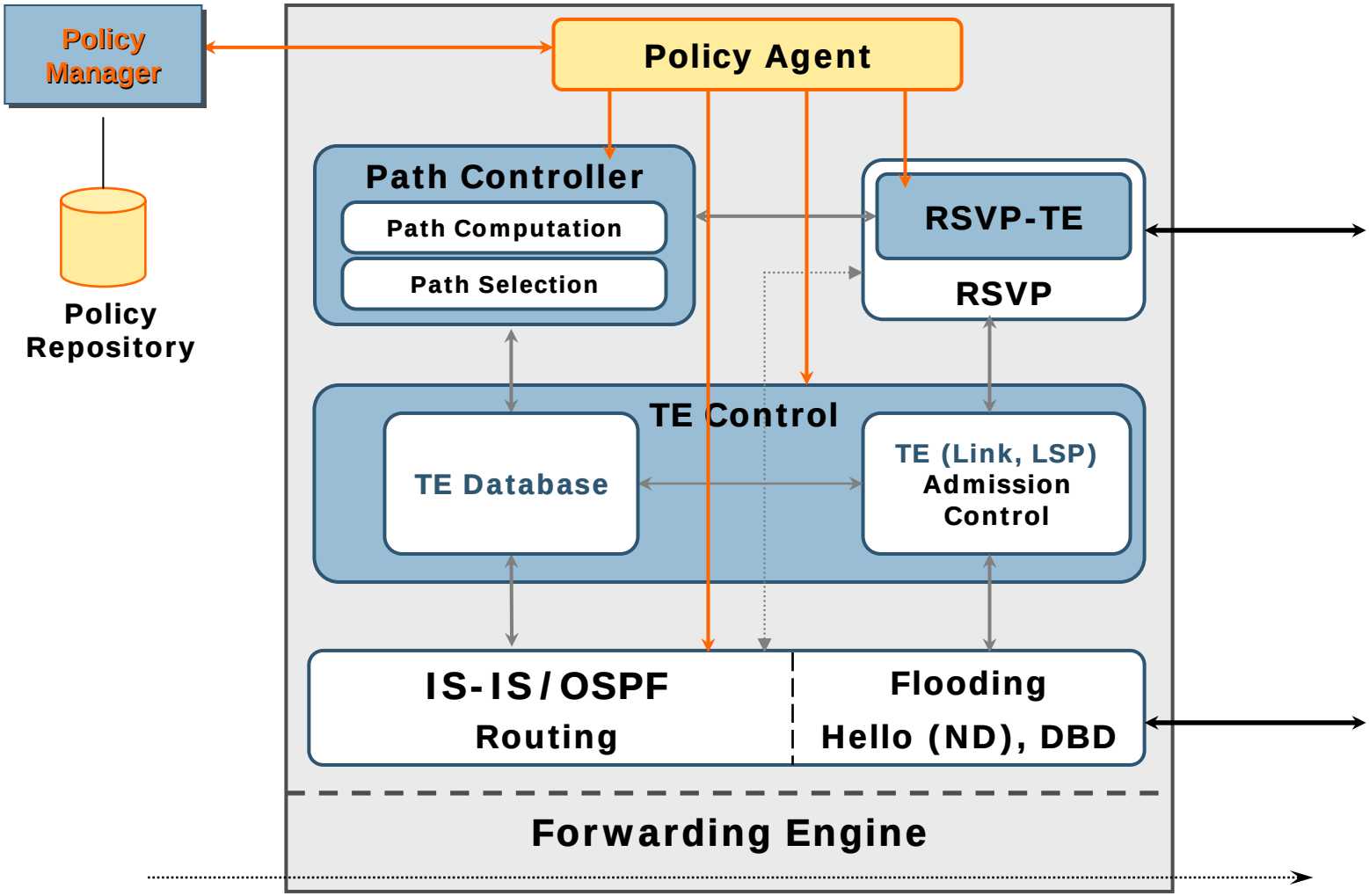
- TE LSA information flooding: driven by soft-state mechanisms
  - Loss of non refreshed values in case of reception of another value set
  - Workaround: use a specific LSA ID per set of advertized sub-TLVs for the same topological link (but increases complexity)
- Only sub-TLVs that are showing any variation due to an internal event are related to bandwidth availability
  - Derivable conditions related to modifications of link resource utilisation
- Multi-region network: different situation due to the inheritance mechanisms from FA LSPs to FA Links TE attributes - Example:



G/MPLS-TE Control Components



G/MPLS-TE Control Components: Policy Agent



Conclusion

- Policy information model for MPLS-TE left in the starting blocks

- Need for policing becomes crucial in multi-layer/region network
  - Dynamic & global control of large scale distributed systems
  - Enforcement of operational coherency
  - Automation of distributed operations

- … in brief, PBM is a must for operators to fully benefit from GMPLS toolbox

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