

Policy Control for Long Term Evolution (LTE) and Future Internet (FI)

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Policy Control for LTE/FI Agenda

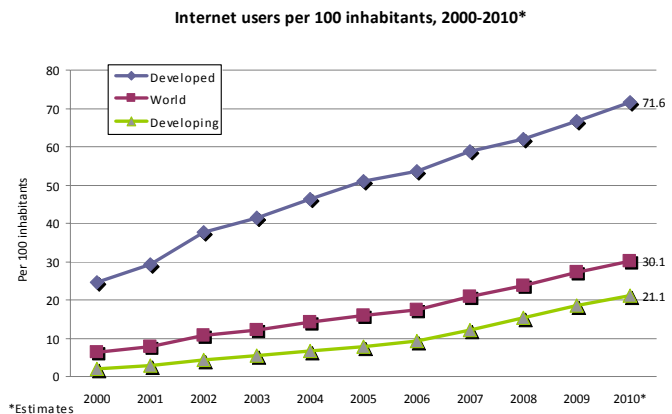
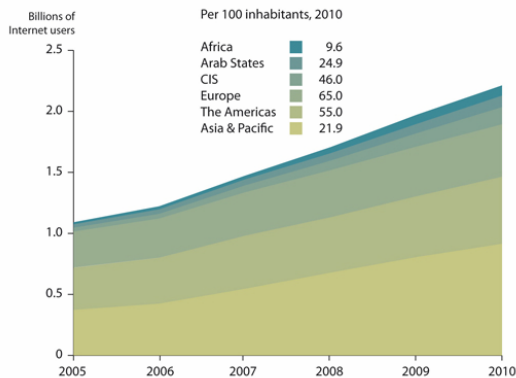


- Introduction and Background
- Architectural Issues
- Implementation Issues
- Conclusion



Introduction and Background Internet Today

- Over 2 billion people on the Internet
 - Internet access at home ~ 1.6 billion in 2010
 - Internet users doubled in the past five years
 - 65% of Europeans compared to only 9.6% of Africans
- Access to mobile networks: over 90% of the global population
 - estimated 5.3 billion mobile subscriptions



Introduction and Background Wireless Networks' Issues

- Multiple technologies → 4G → B4G
 - **Interoperability – Mobility – Scalability**
 - Multi-interface handsets
 - Today: 2G/2.5G/3G/3.5G/3.75G/3.9G, WLAN, Bluetooth, IR
 - Tomorrow: X, Y, Z, ?, ? , ?
 - New form factors
 - tablets, netbooks, MID, smartbooks, USB dongles etc ...
 - Convergence of Fixed and Mobile Networks
- Increased scale
- Increased complexity
- **Increased Cost**
- Increased heterogeneity

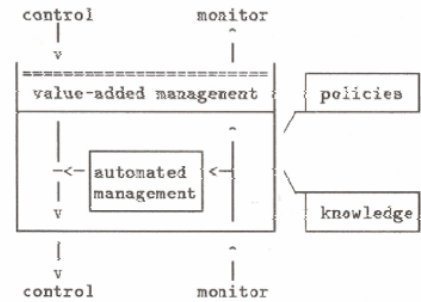


Introduction and Background

Autonomic Management and Self-*

- **Control Loop in Systems Management**

- Fehskens L., "An Architectural Strategy for Enterprise Management" [IFIP/IM 1989]



- **Autonomic Computing:**

- a computing environment with the ability to manage itself and dynamically adapt to change in accordance with business policies and objectives [IBM 2001]

- **Self-management:**

- the ability of independently achieving seamless operation and maintenance by being aware of the surroundings

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Introduction and Background

Policies and PBM

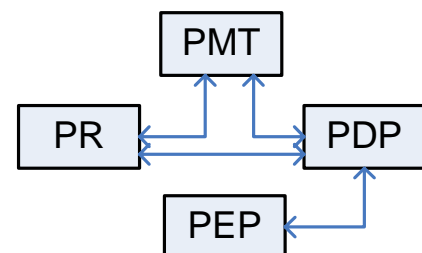
- **The policy-based management (PBM) paradigm**

- Policies capture the high-level management objectives
- The means to integrate self-management capabilities
- PBM offers controlled programmability

- **IETF reference framework**

- Four functional elements

- *PMT: Policy Management Tool*
- *PDP: Policy Decision Point*
- *PEP: Policy Enforcement Point*
- *PR: Policy Repository*



- A generic specification of policy rules

- *ECA: on Event if Condition then Action*

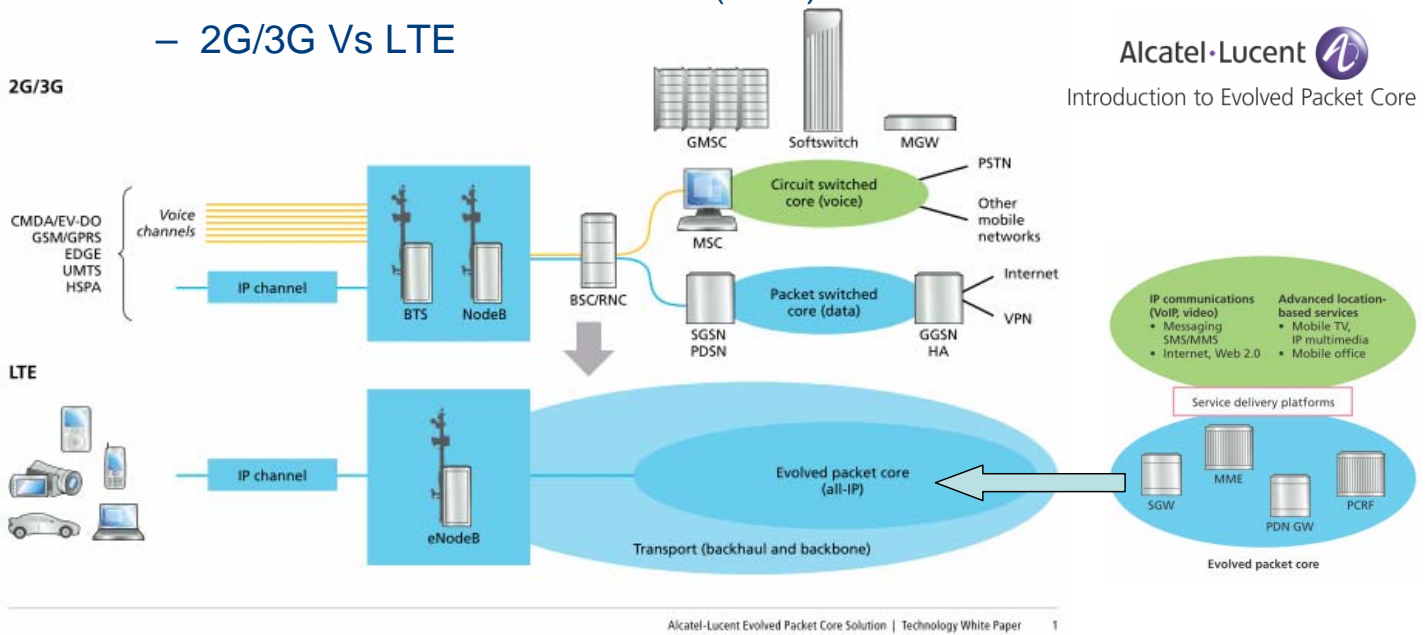
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Architectural Issues

Policy Control

- Mobile Internet and Policies in Long Term Evolution (LTE)
 - LTE: Enhanced Packet Core (EPC) + LTE Radio Access Network
 - 2G/3G Vs LTE



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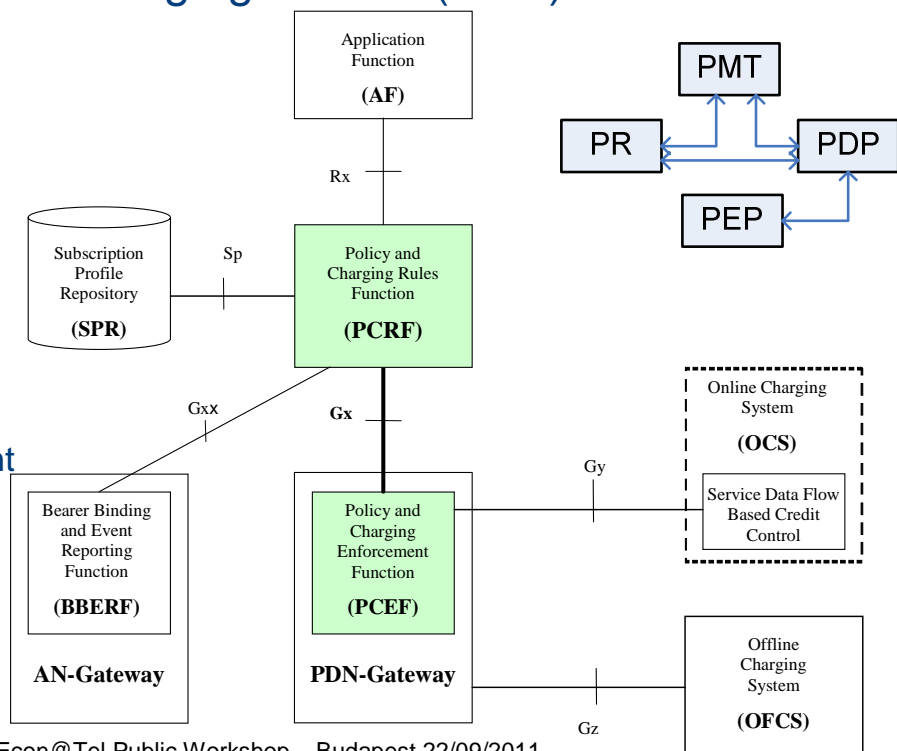


Architectural Issues

Policy Control

- 3GPP Policy and Charging Control (PCC) architecture

- PCRF
 - Policy and
 - Charging
 - Rules
 - Function
- PCEF
 - Policy and
 - Charging
 - Enforcement
 - Function

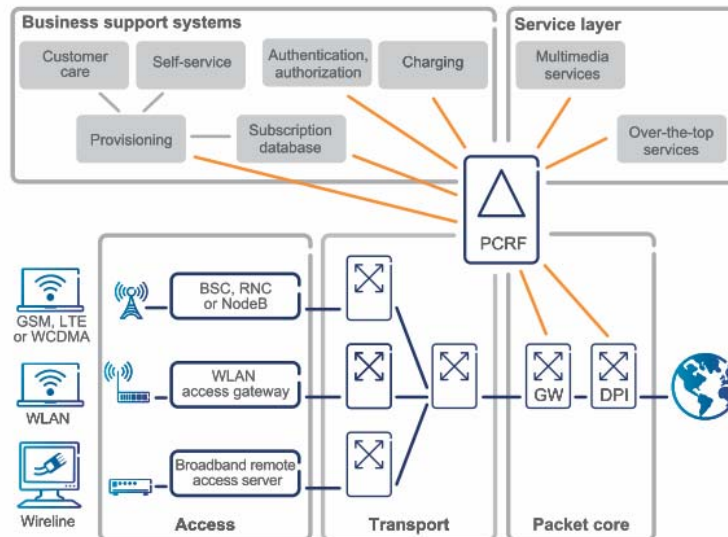


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Architectural Issues Policy Control

- What do operators need?
 - Critical Issue: Service – Transport strata coordination/interactions
 - Intelligent policy decisions, e.g. prioritize delay-sensitive apps
 - Real-time personalised policy enforcement



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POLICY CONTROL –
STRATEGIES FOR
END-TO-END SUPPORT
AND CONVERGENCE



Architectural Issues Policy Control

Mobile Internet and Policies in Future Mobile Internet

- First generation of policy control solutions
 - designed for fixed broadband networks
 - only enforce policies in the core network
 - Not sufficient to manage congestion effectively
- Congestion in mobile networks typically occurs in the radio access or mobile backhaul networks
 - subscribers compete for a limited supply of shared capacity
 - data sessions use bursty applications
- End-to-end versus centralised
 - E2E requires integration of more network elements
 - E2E much more effective in managing traffic

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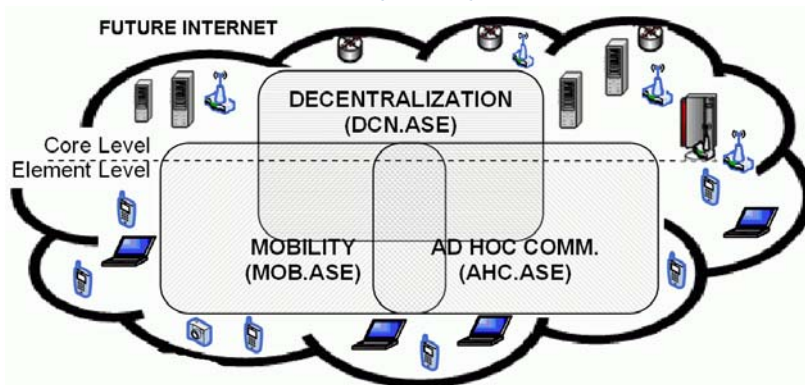
Architectural Issues Policy Control

- Ericsson study
 - Investigates how peak-hour traffic patterns and trends affect the need for investment in network capacity
 - Compares the impacts of applying centralized policy control and end-to-end policy control as the proportion of sites requiring upgrades
 - No traffic management: 20%
 - Centralized policy control: 14 %
 - End-to-end policy control: 9 %
 - The end-to-end approach is four times more profitable
 - Centralized solutions lack good, timely feedback mechanisms for their policy decisions
 - may result in instabilities



Architectural Issues Autonomic Networking for Future Internet

- Autonomic Support Entities
 - Three cooperating ASEs
 1. Decentralisation (DCN)
 2. Mobility (MOB)
 3. Ad hoc communications (AHC)



- Entities will operate and cooperate at different levels
 - Core level: operator-owned network core
 - Element level: user-owned devices / embedded devices



Architectural Issues Decentralisation ASE

- Purpose
 - enable collaborative management of large-scale networks: wireless access networks & their interconnection with fixed ones
- Challenges
 - efficient & scalable management of wireless PAN (WPAN).
 - secure interactions of mobile and nomadic WPANs with authorised or non-authorised WLANs, as well as WANs
- Functionality
 - based on **distributed policy-based management (DPBM)**
 - spans equally between core and element levels
 - Core: policy definition, conflict resolution, business planning
 - Element: policy distribution, user preference enforcement



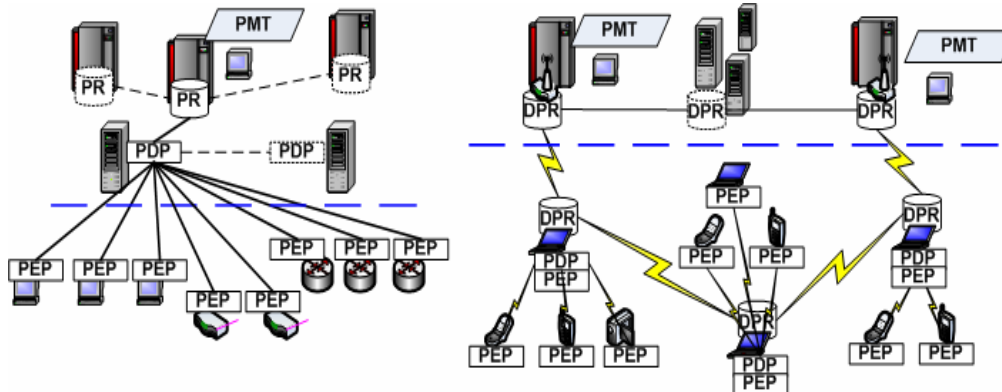
Implementation Issues Decentralisation ASE

- Distributed Policy-Based Management (DPBM) Tools
 - Need to address the issues of collaborative policy definition, policy distribution and replication, and distributed policy enforcement
- Implementation of DPBM → assessed, based on the overheads induced on the managed network
- Critical issue: distributed enforcement and monitoring
- Case study: feasibility and efficiency of a distributed policy repository (DPR) and DPBM



Implementation Issues Decentralisation ASE

- Distributed policy-based management (DPBM)
 - Distributed Policy Repository (DPR): a physically distributed set of interconnected directories hosted on selected nodes.
 - DPR design glues together the distributed nodes responsible for collaborative management.



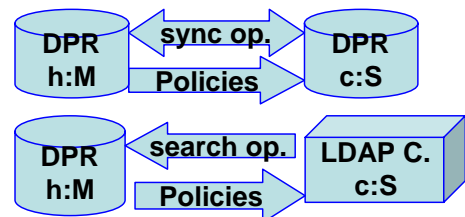
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Implementation Issues Decentralisation ASE

- Comparison of Distributed and Centralised Policy Access Methods

- Four methods examined
 - sr-push : push replication
 - sr-pull : pull replication
 - ls-best : client informed of changes
 - ls-avg : client discovers changes



- Evaluation scenario for policy retrieval and updates

- t0: Master DSA holds 200 policies (800 entries)
- t1: PDP requests all policies
- t2: PDP holds all policies
- t3: 10 policies added at Master DSA
- t4: PDP update completed
- t5: 10 policies deleted from Master DSA
- t6: PDP update completed
- Tp : total policy retrieval and update time
- $T_p = (t_2 - t_1) + (t_4 - t_3) + (t_6 - t_5) = T_a + T_b + T_c$

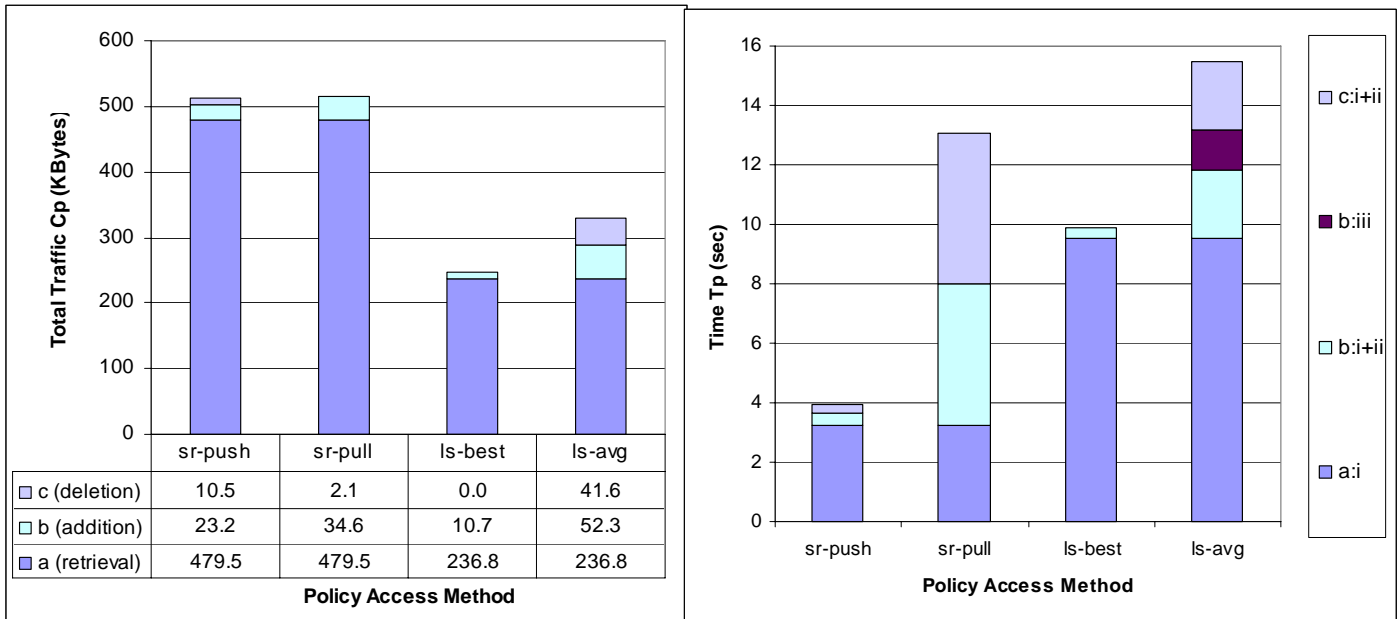
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Implementation Issues

Decentralisation ASE

- Comparison of Distributed and Centralised Policy Access Methods
- Total Policy Access Traffic and Time



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Conclusion

Summary and Outlook

- Mobile Network Operators can benefit significantly from policy control and policy-based management
 - Increase management automation
 - Decrease network operator costs
 - Policy engine functionality aims at improving QoE
- Critical issues remain open:
 - Scalability and interoperability
 - Centralised vs. distributed control
 - Conflicting policies and policy analysis
 - Net Neutrality/Transparency controversy

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Thanks for your attention...

Questions?



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