Are Programmable Networks Unmanageable?

Are Networks Manageable with Programmable Networks?

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Big Challenges For Network Operators

- Scalability
  - Bandwidth grows at least as fast as the processing power on network elements
  - The number of users is growing faster than everything else
  - The time between two network reconfigurations is quickly decreasing
  - ➪ New technologies must be highly scalable in order to be more than toys
  - ➪ Self-management of devices/protocols/services is needed in order to survive

- Security
  - Operators can not trust network users
  - Operators can only have limited trust in employees or programs
  - ➪ Useable security and access control mechanisms must be built into management solutions from the very beginning

Hyped Programmable Network Technologies I

Active Networks

- Great toy for Universities and Research Labs (since it is easy to get funding)
- Useless for any real production network that must be up and running 24 hours on 365 days per year
- Common execution platform across all networking devices is unrealistic
- Scalability?
- Security?

Hyped Programmable Network Technologies II

Intelligent Mobile Agents

- Only a small subset of (management) problems benefits from code mobility
- Need smart algorithms rather than (uncontrollable) artificial intelligence
- Control problems: Watch out for mobile agent wars in the network near you
- Scalability?
- Security?

Hyped Programmable Network Technologies III

Policy-Based Network Management

- Rules are not enough to deal with (the bugs and mis-features) of real-world devices
- Getting the abstraction level right is difficult:
  - Too high-level: need humans for interpretation of policy rules
  - Too low-level: only little gain but complex infrastructure
- Policy translation between abstraction levels difficult
- Policy installation on heterogenous devices is a problem
- Scalability?
- Security?

Real Programmable Network Technologies

- Programmable Networks are nothing new:
  - UNIX systems are advanced programmable network nodes
  - ➪ Learn from the experience gained of running large UNIX clusters
- So how will the near future look like?
  - Future network devices will be operated like UNIX clusters today
  - Access will be restricted to authorized operators acting in well defined roles
  - Scripts keep UNIX systems running $\Rightarrow$ scripts will keep future networks running
  - High-level policies will be translated into scripts running on network devices
  - Delegation is a tool for controlled distribution of management scripts