Protection of Components based on a Smart Card Enhanced Security Module

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Introduction: Starting Point

- Protection of Network Security Components:
  - J. García, S. Castillo, G. Navarro, and J. Borrell
    Mechanisms for Attack Protection on a Prevention Framework
    39th Annual IEEE International Carnahan Conference on Security Technology
- Protection based on an AC integrated in the operating system's kernel
- Implemented as a Linux Security Module through the LSM framework

  $\Rightarrow$ Open architecture for the inclusion of security enhancements at operating system's kernel level

Introduction: Protection strategy

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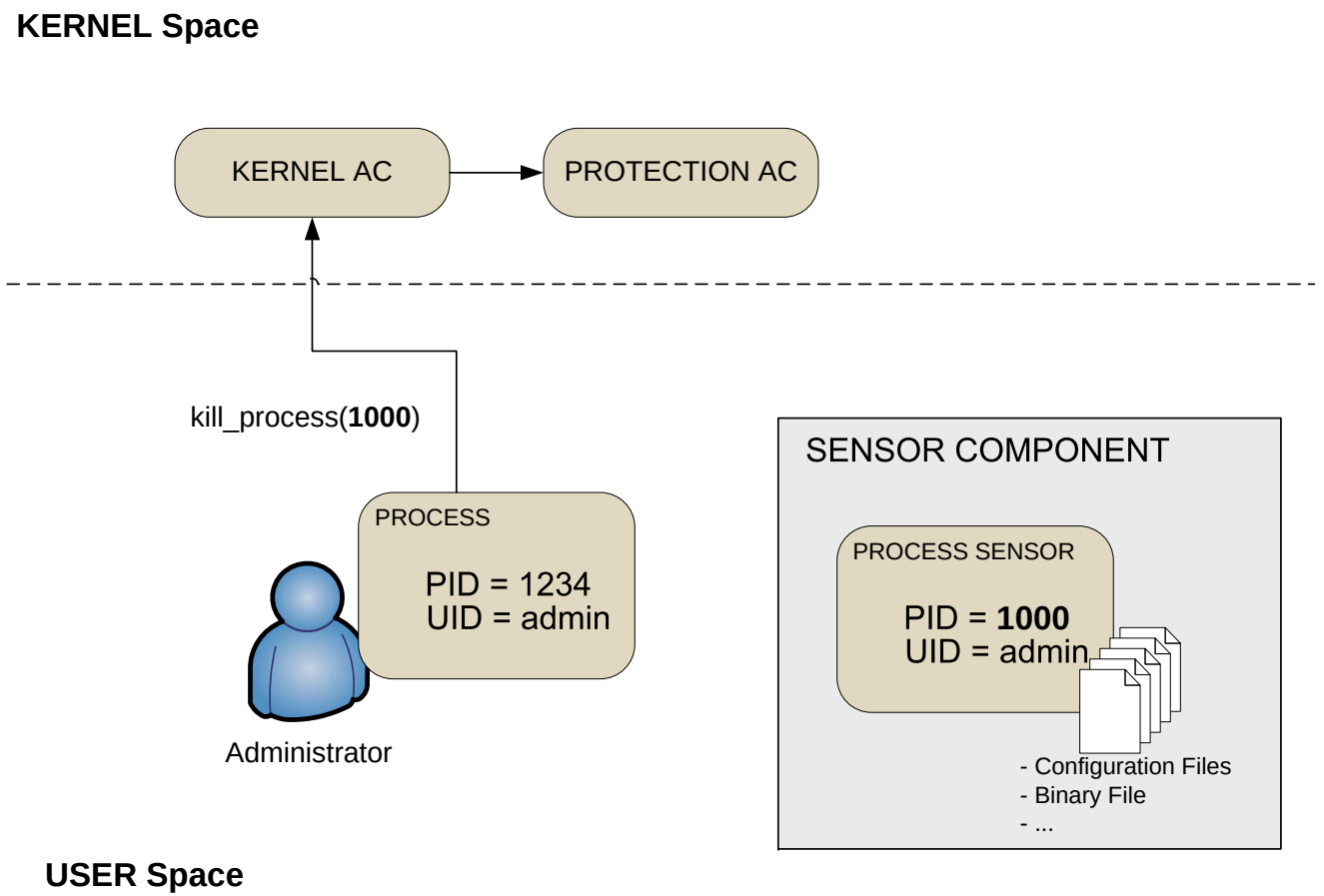
Intra-kernel Access Control

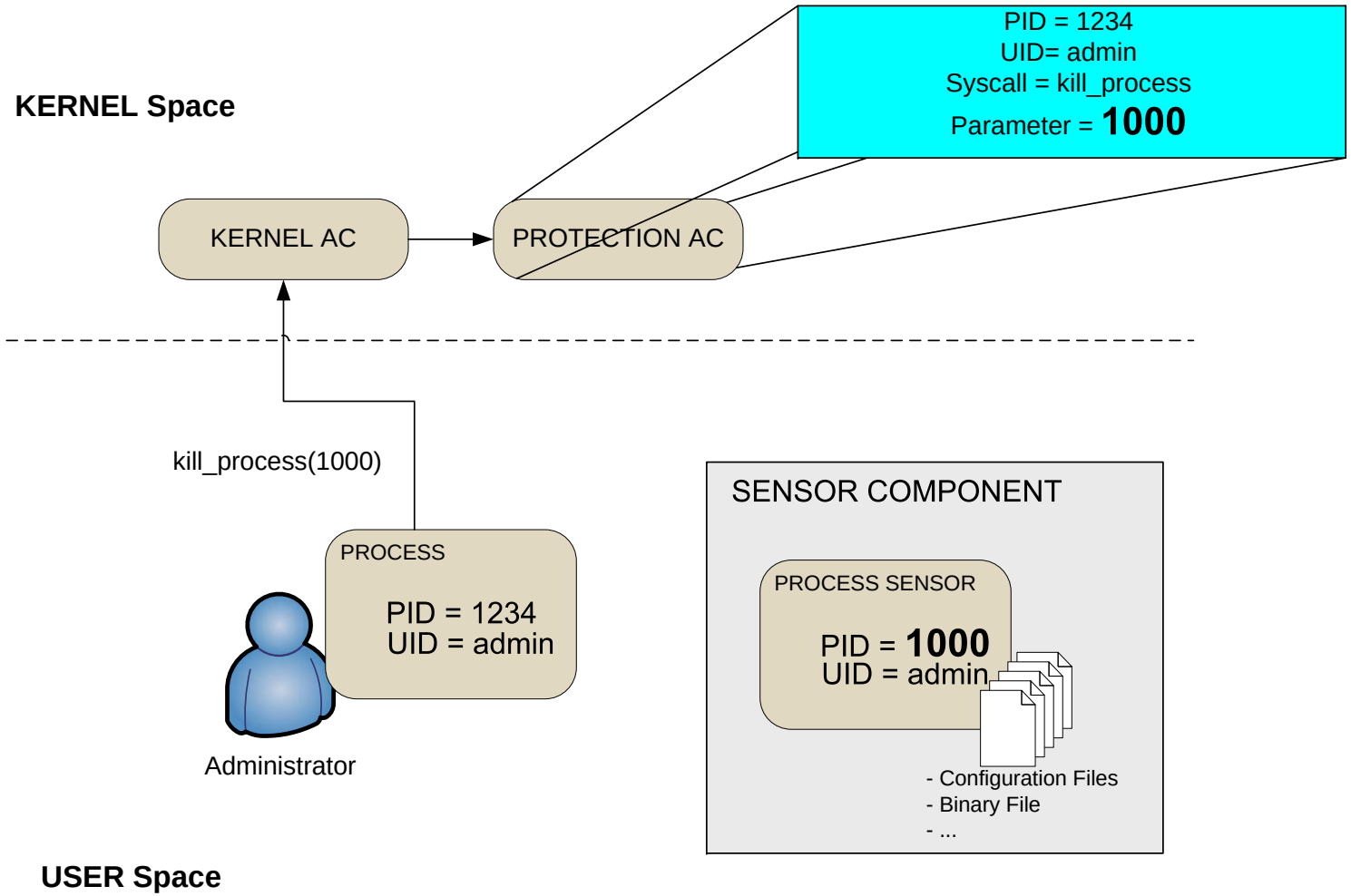
- Coexistence of the protection AC (more restrictive) with the native operating system AC (less restrictive)
- The protected system calls are intercepted and, according to a set of security rules, will be accepted or denied:

$$[\,PID\,]\,[\,UID]\,[Device]\,[inode]\,[Syscall]\,[Parameters]\;\rightarrow\;\{accept, deny\}$$

Example: protection of processes



Example: protection of processes



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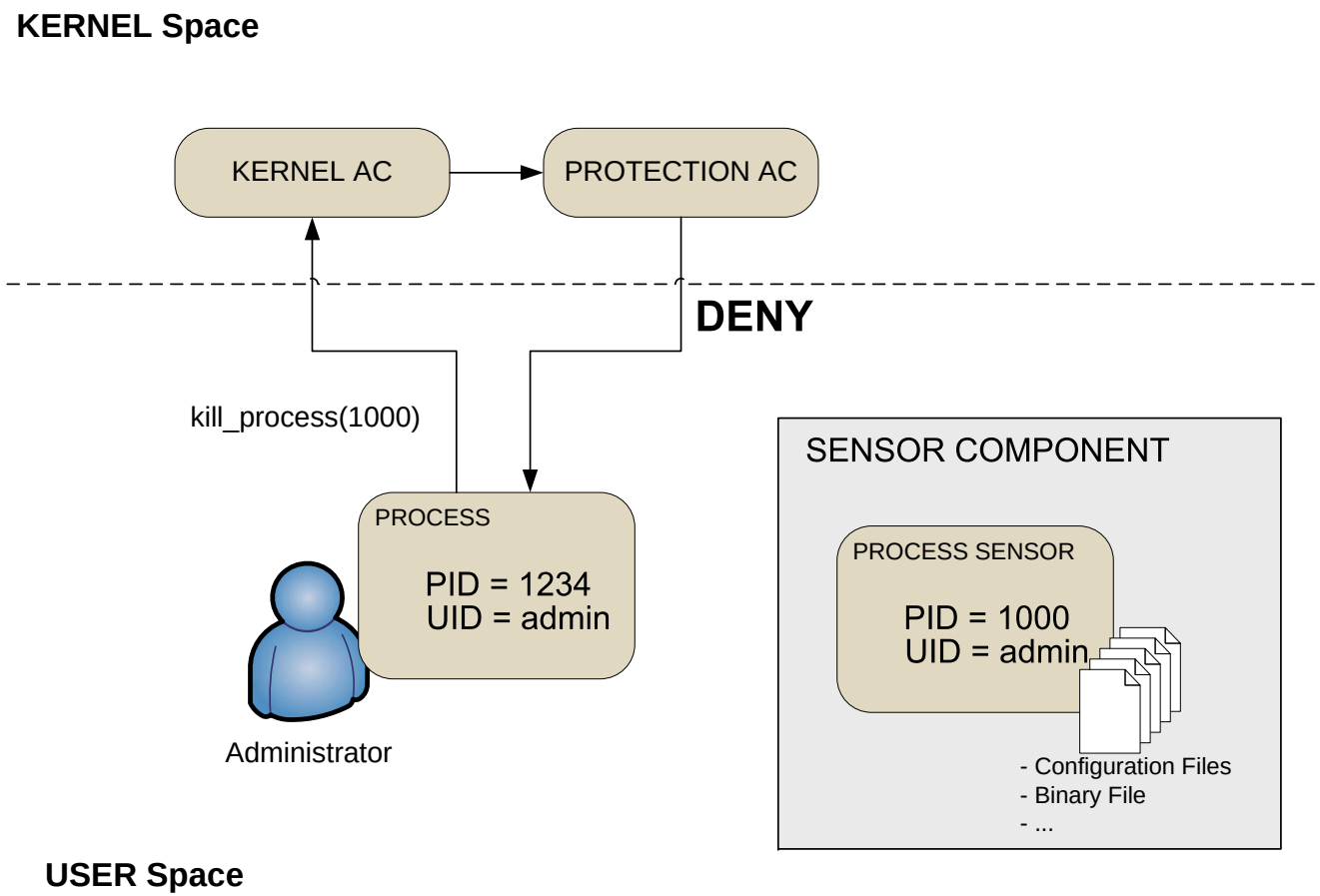
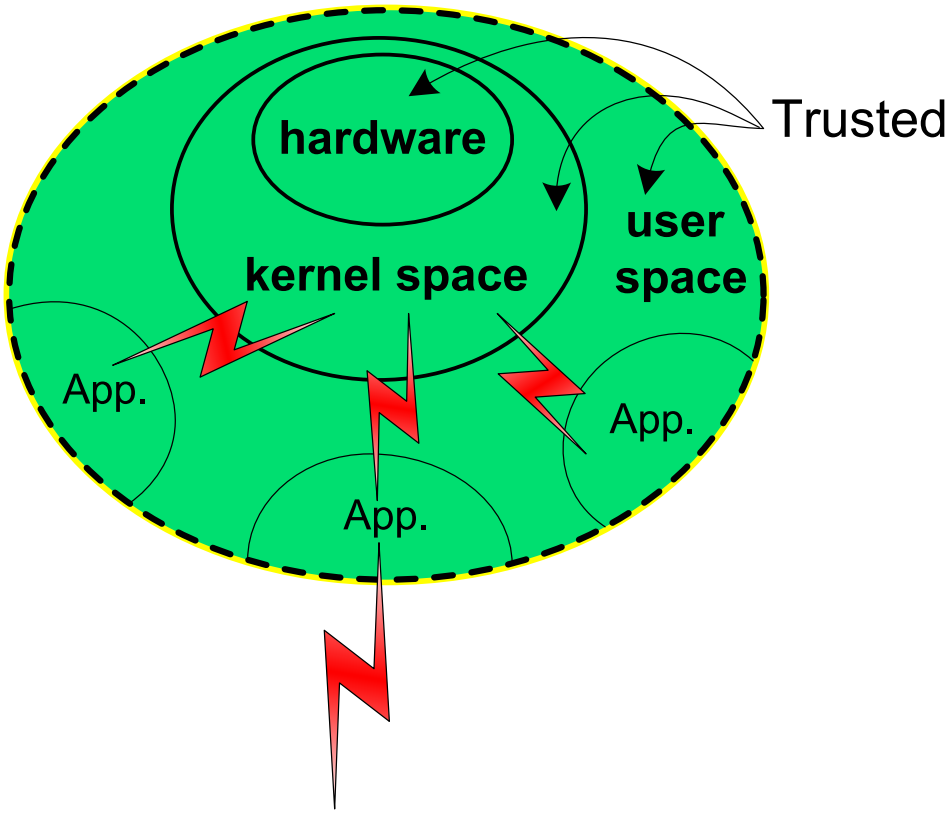
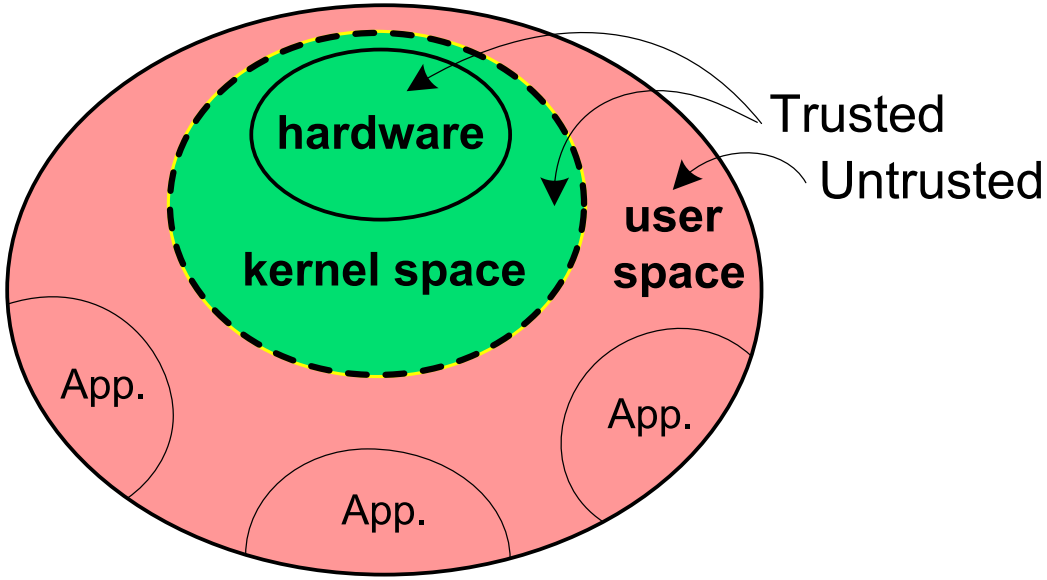


Native operating system's AC



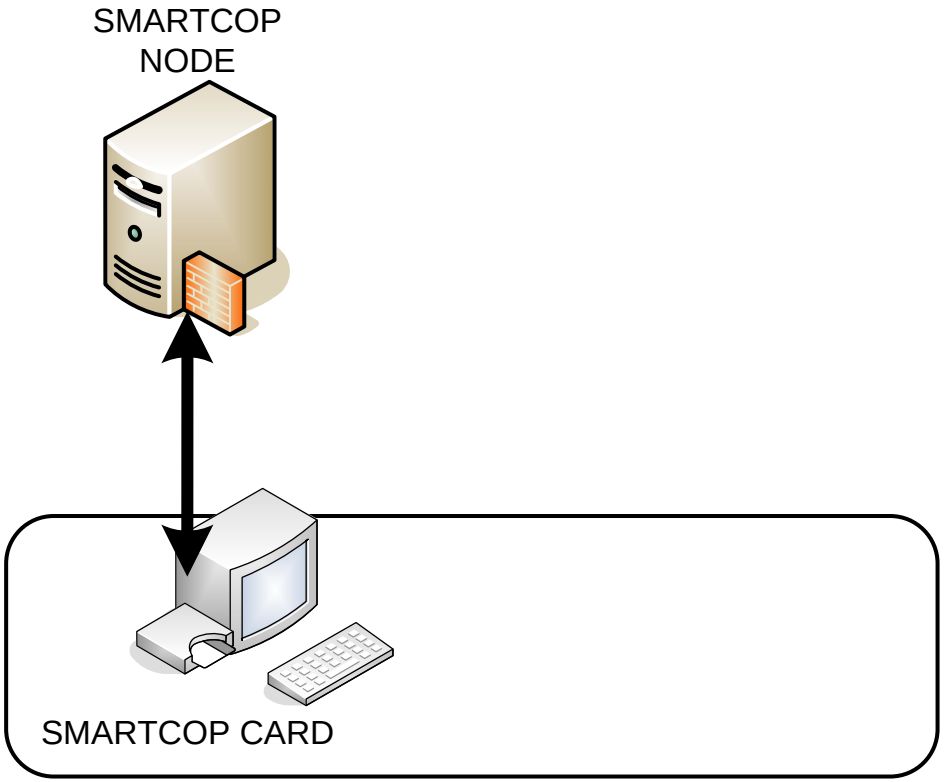
Intra-kernel Access Control



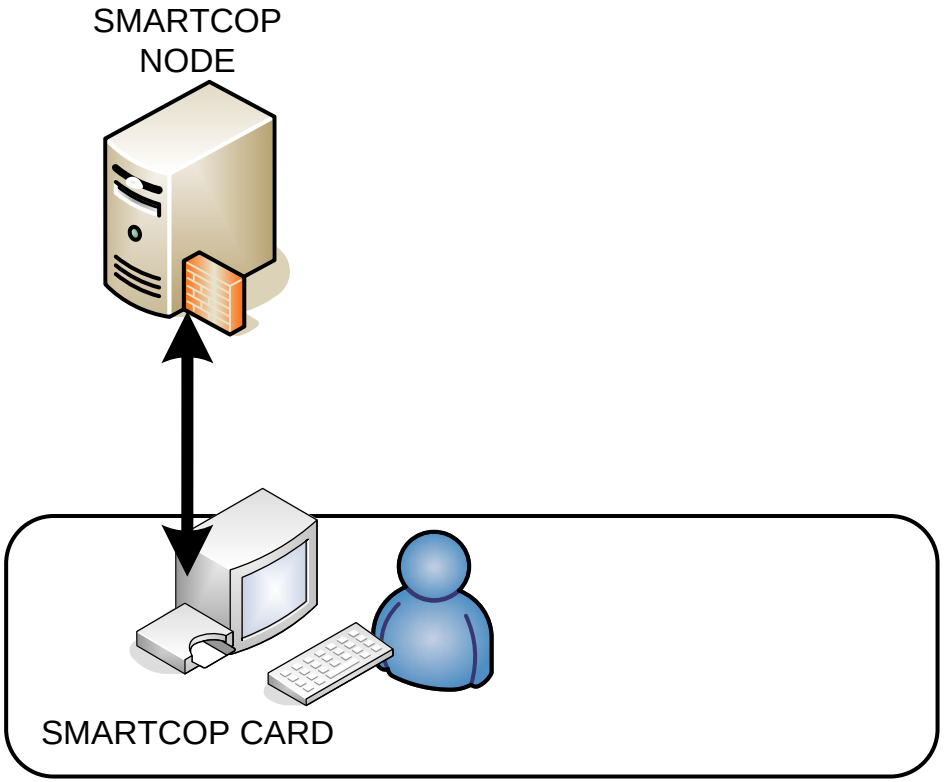
Constraints of our approach

- It introduces some administration constraints
  - $\Rightarrow$ Officers are not longer allowed to throw system calls which may suppose a threat to the protected component
- To solve these constraints, we propose the use of a two-factor authentication mechanism
  - $\Rightarrow$ Based on a cryptographic protocol and a smart card token
  - $\Rightarrow$ Holds to the officer the indispensable privileges to carry out management activities after ensuring the administrator's identity

Authentication Mechanism



Authentication Mechanism



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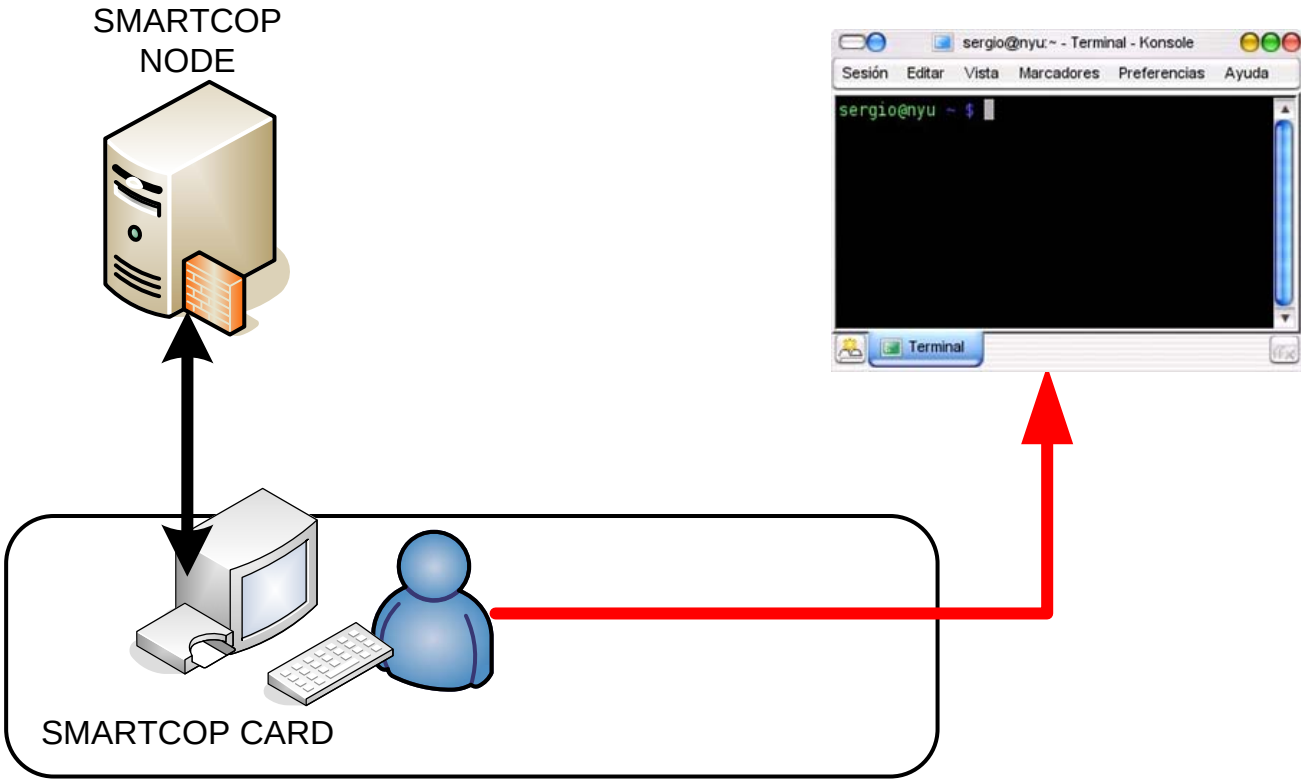

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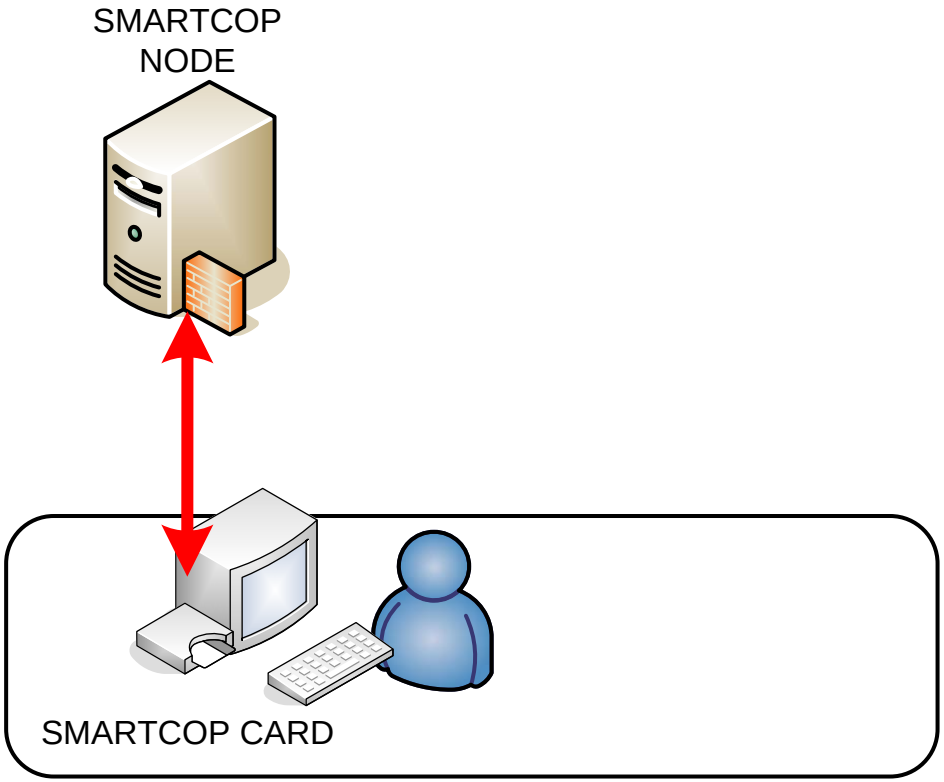

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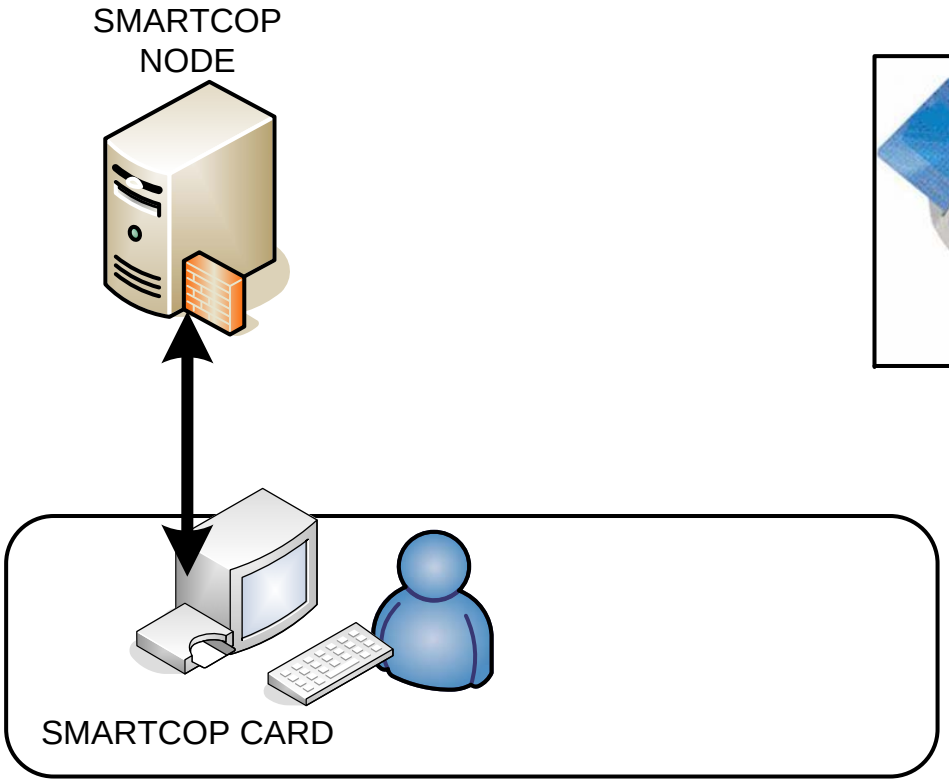

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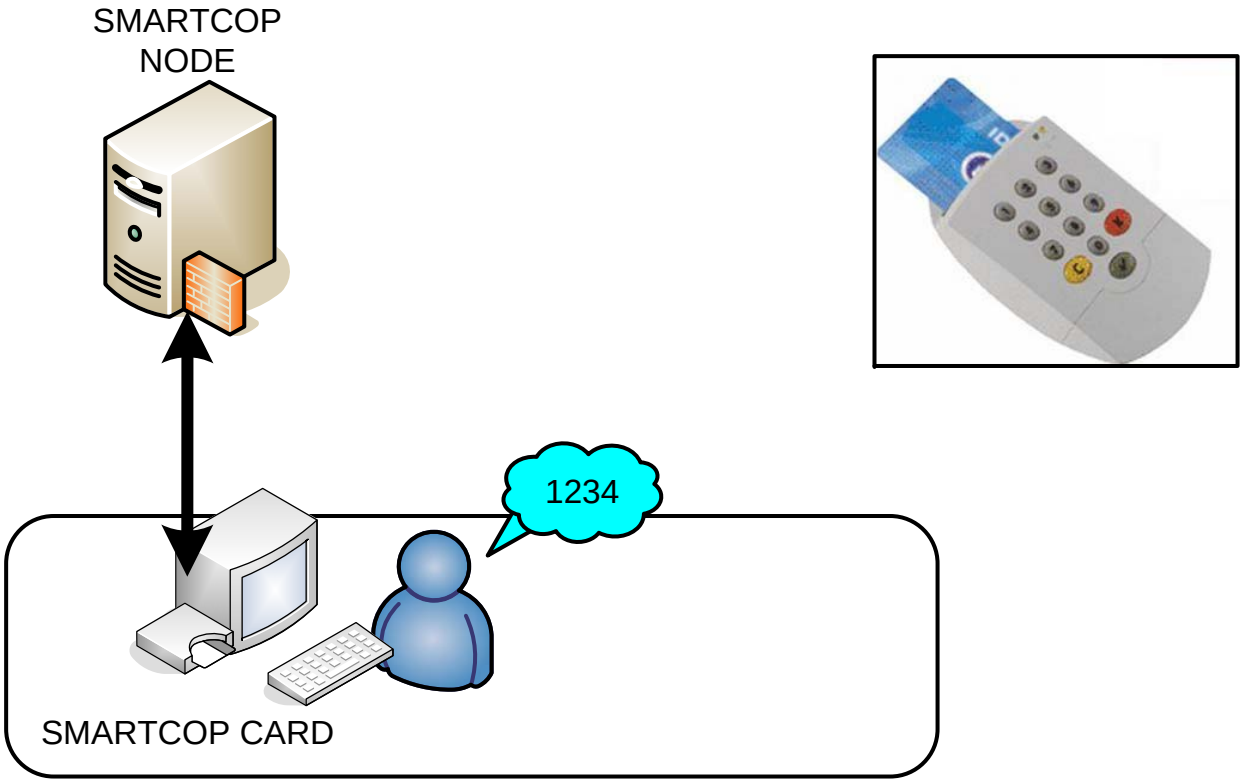

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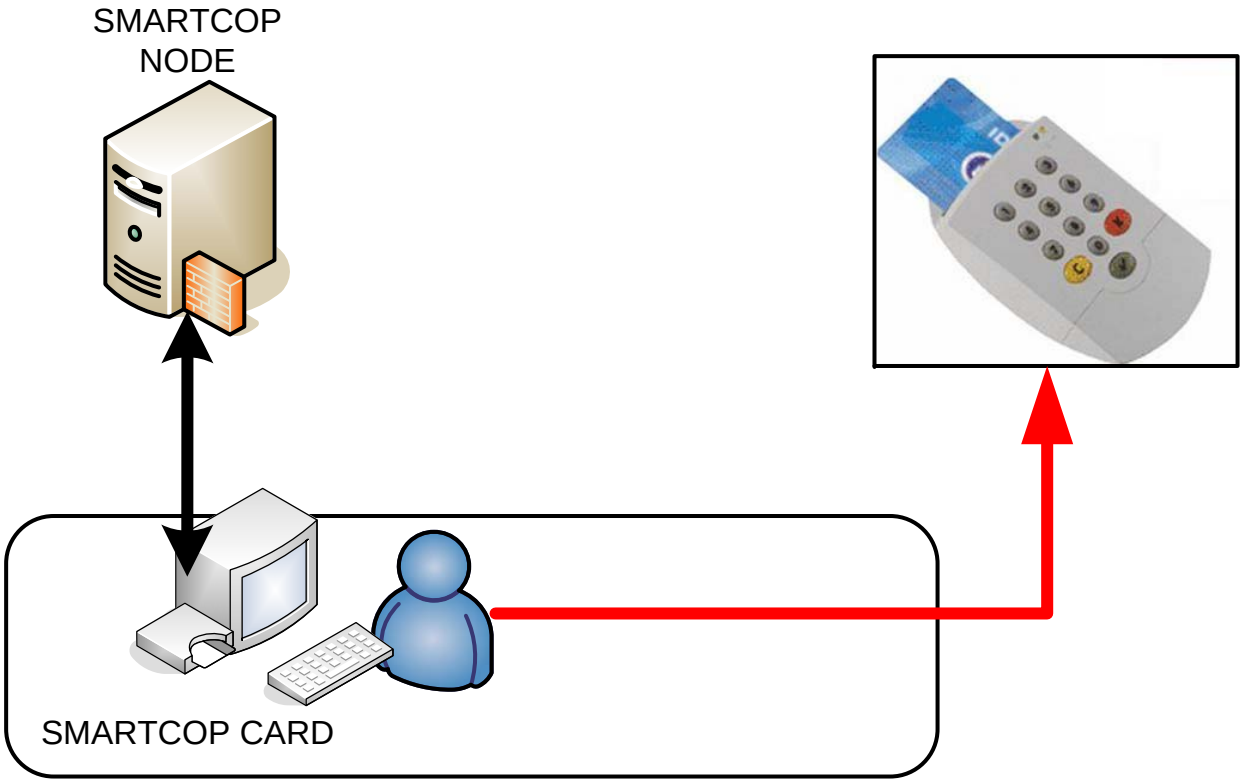

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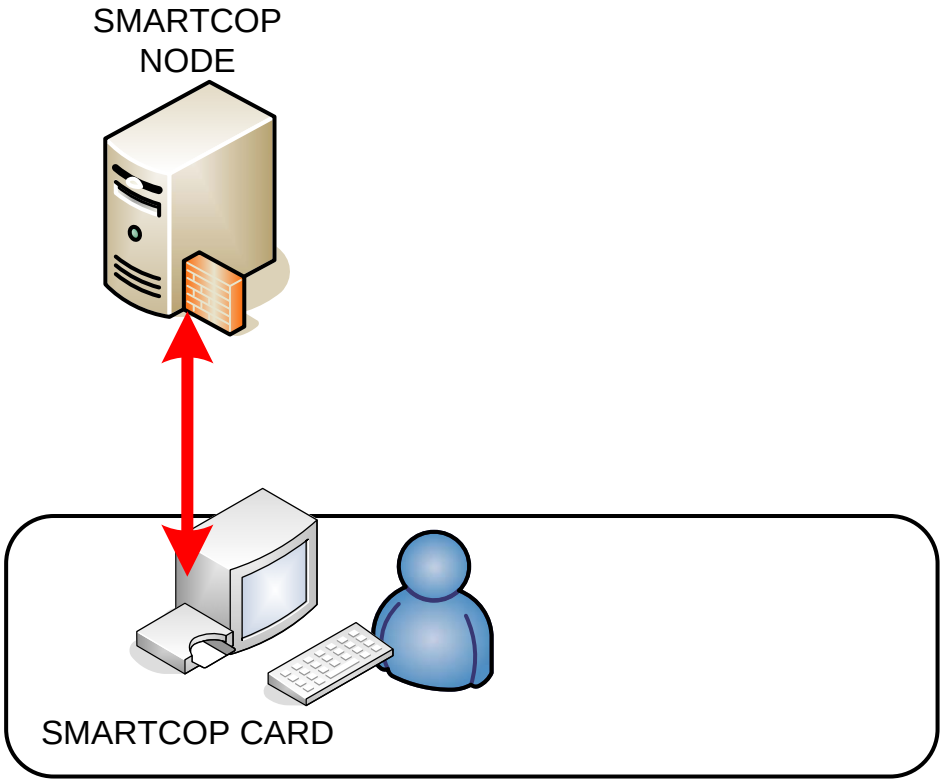

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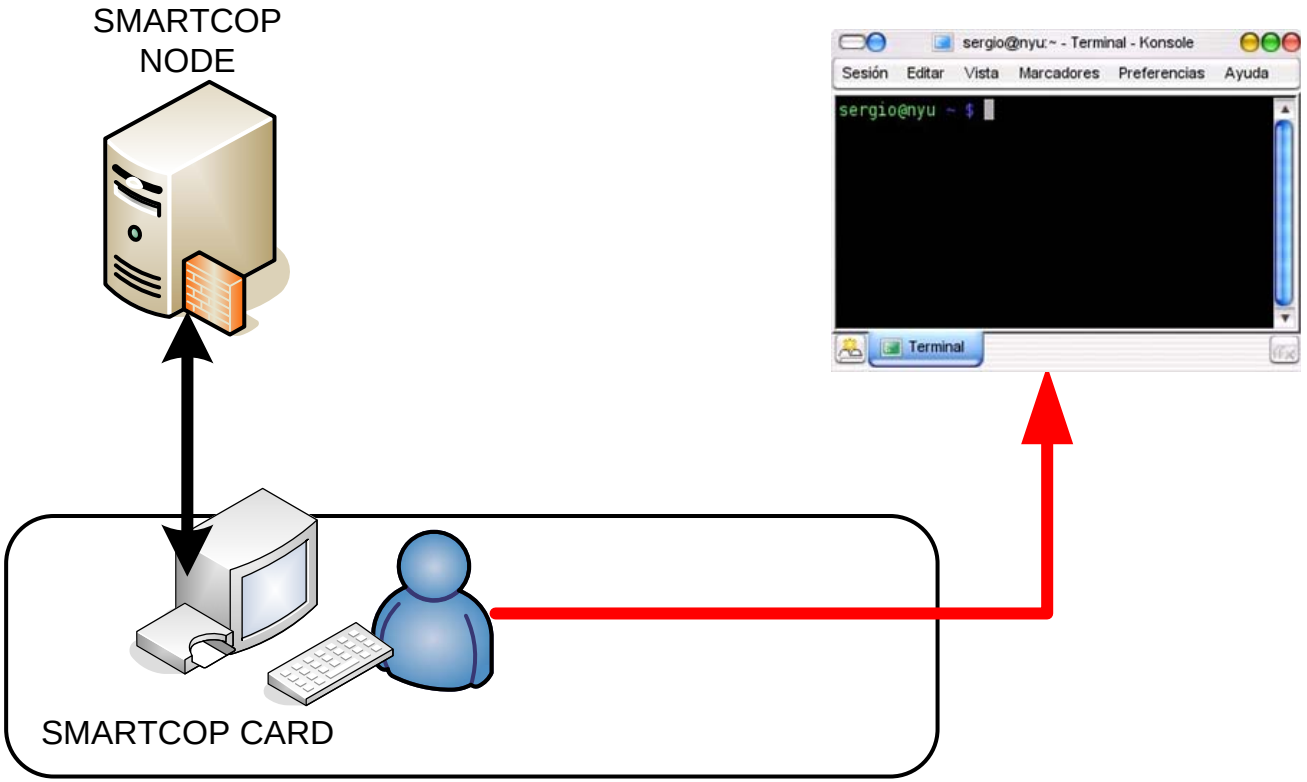
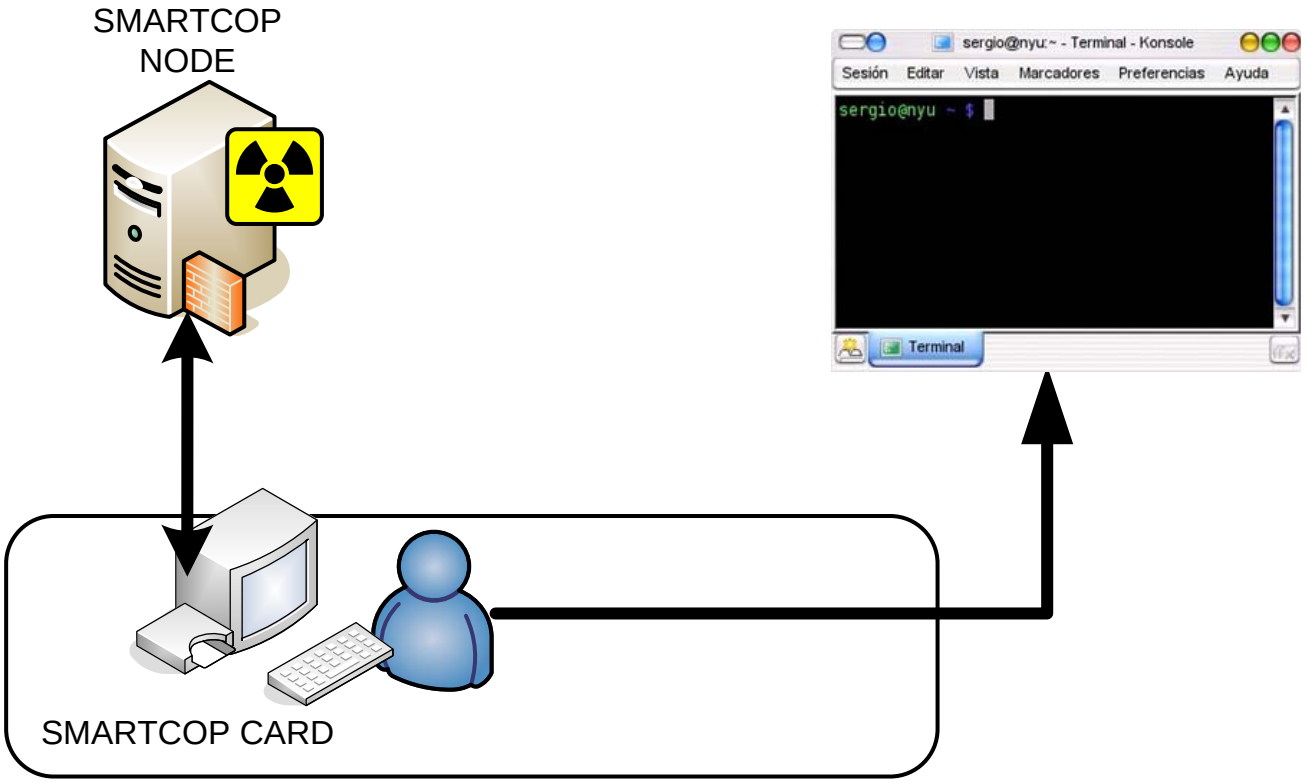
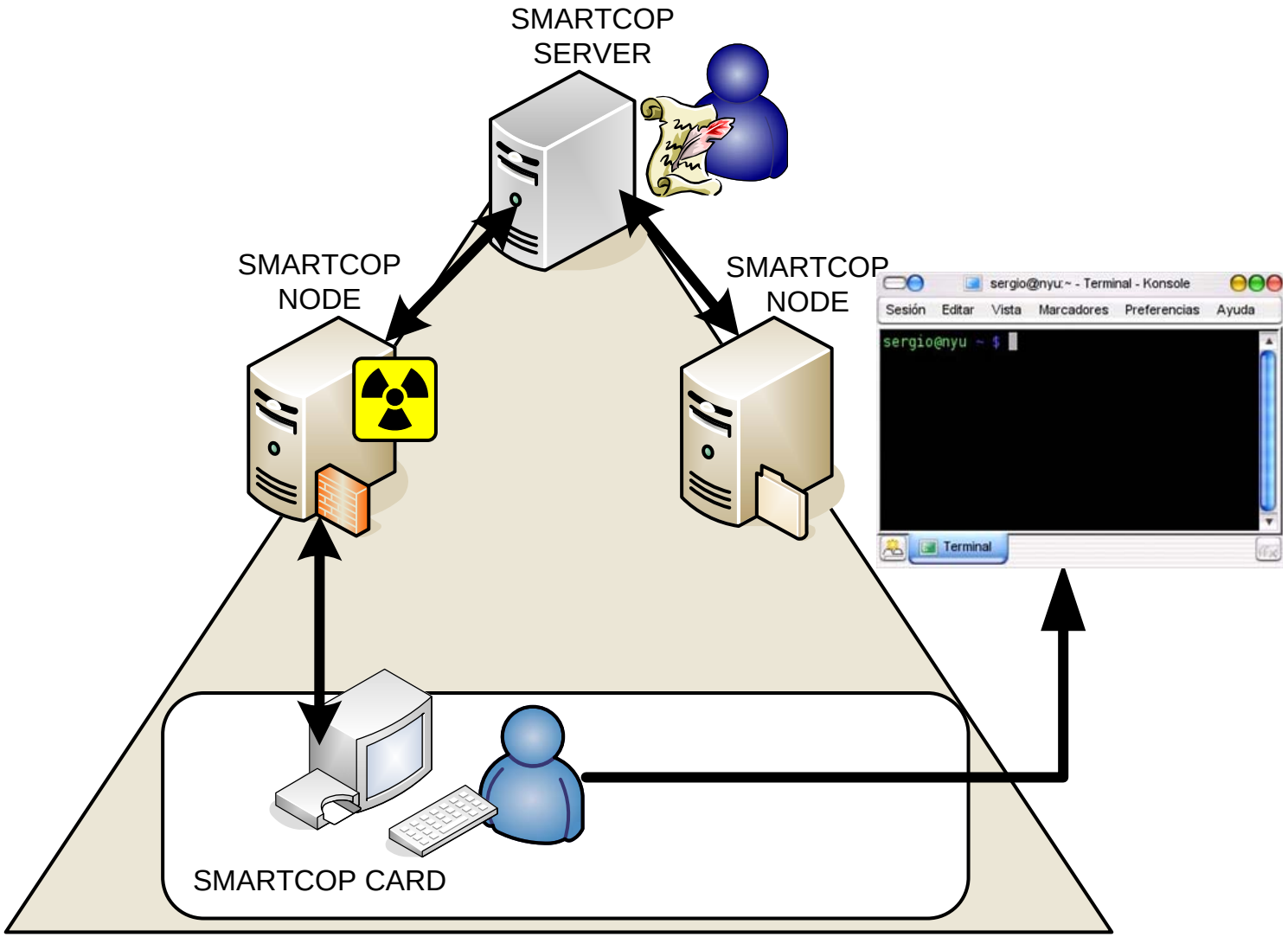


Authentication Mechanism



Public key protocol



Authentication Mechanism: security considerations

- The console's executable is compiled in a static manner
- The LSM module, moreover, protects:
  - the AC itself
  - the binary file of the console
  - the normal execution flow of the console's process
  - the communication channel between the LSM module, the smart-card, and the console process

Related Works

- SELINUX: P. Loscocco and S. Smalley. “Integrating Flexible Support for Security Policies into the Linux Operating System”. *11th FREENIX Track: 2001 USENIX Annual Technical Conference, USA, 2001*

- RSBAC: A. Ott. “The Role Compatibility Security Model”. *7th Nordic Workshop on Secure IT Systems (Nordsec 2002), Karlstad University, Sweden, 2002.*

  - Reinforce traditional operating system security features
  - Control of the outcoming system calls

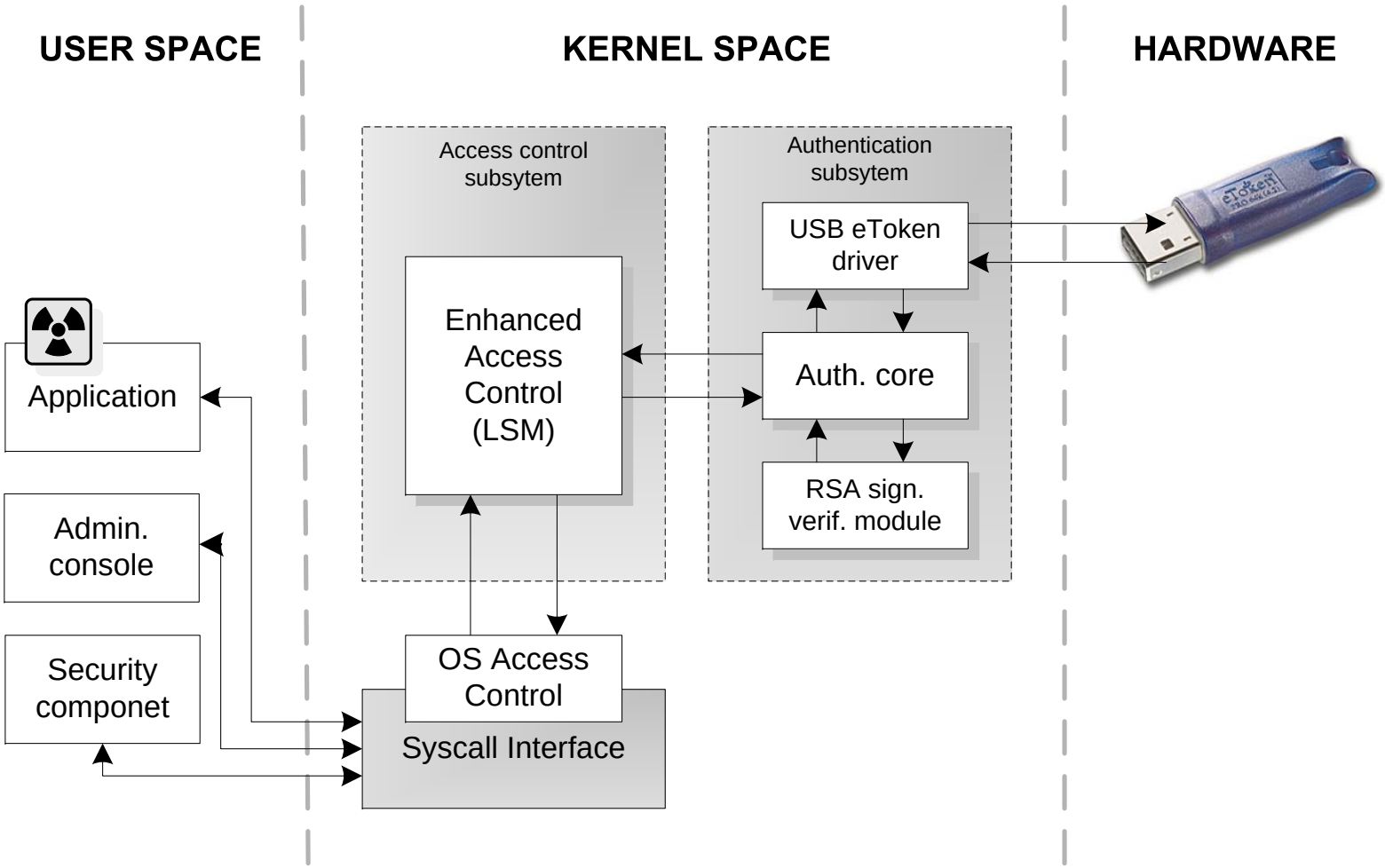
Benefits of our intra-kernel AC approach

- Unified methodology
  - $\Rightarrow$ Integrated in the system as a LSM module, without having to modifile and recompile the kernel
- Two-factor authentication mechanism
  - $\Rightarrow$ Solves the administration and configuration constraints of such an enhanced reinforcement

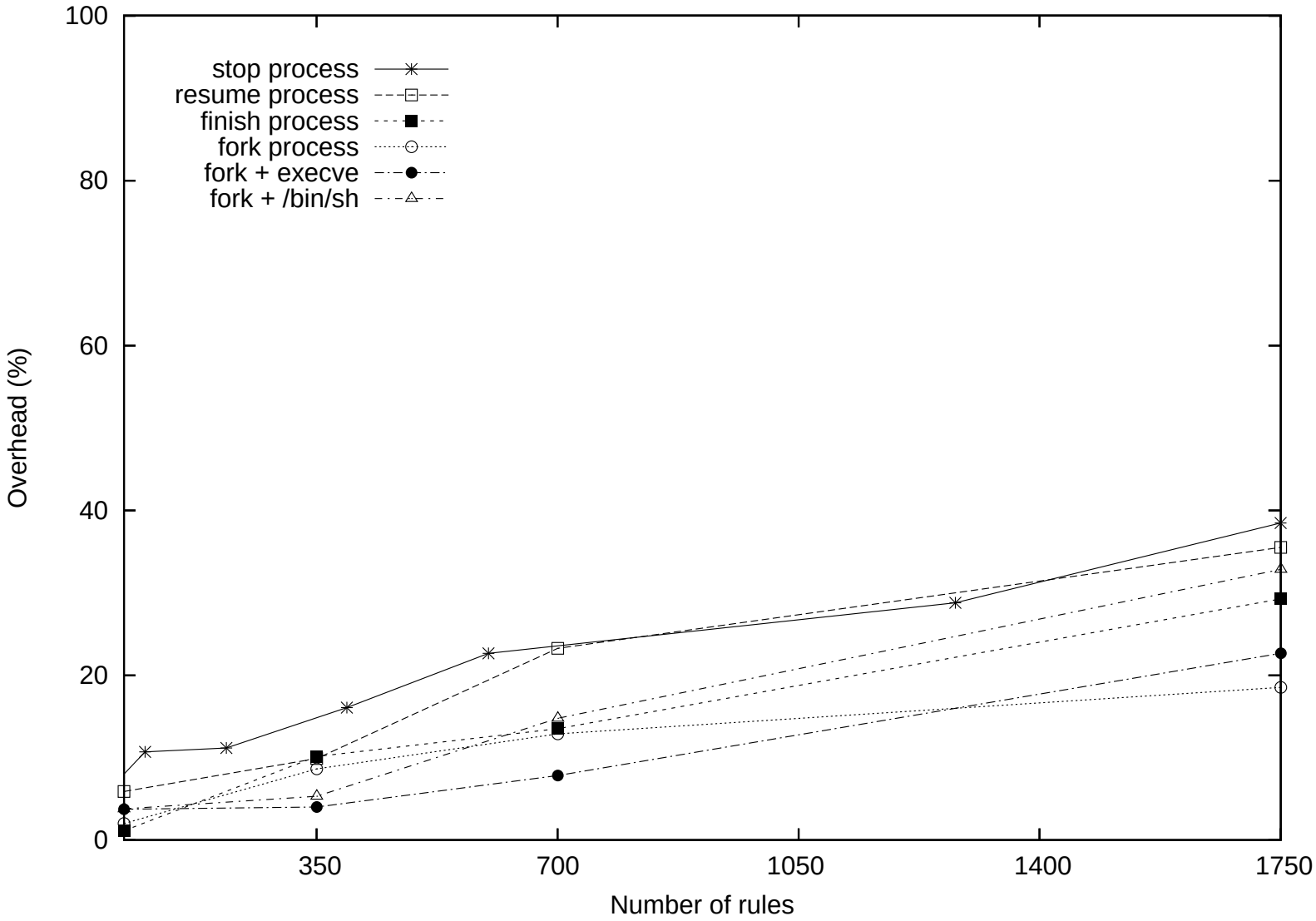
Deployment and Evaluation (1)

- Written in C as a set of modules through the LSM (*Linux Security Modules*) framework
- Smart card authentication:
  - $\Rightarrow$ LSM and smart card communication and cryptographic operations based on eToken PRO (Aladdin) cards
- Deployed over the components of our platform, implemented for *GNU/Linux 2.6* systems

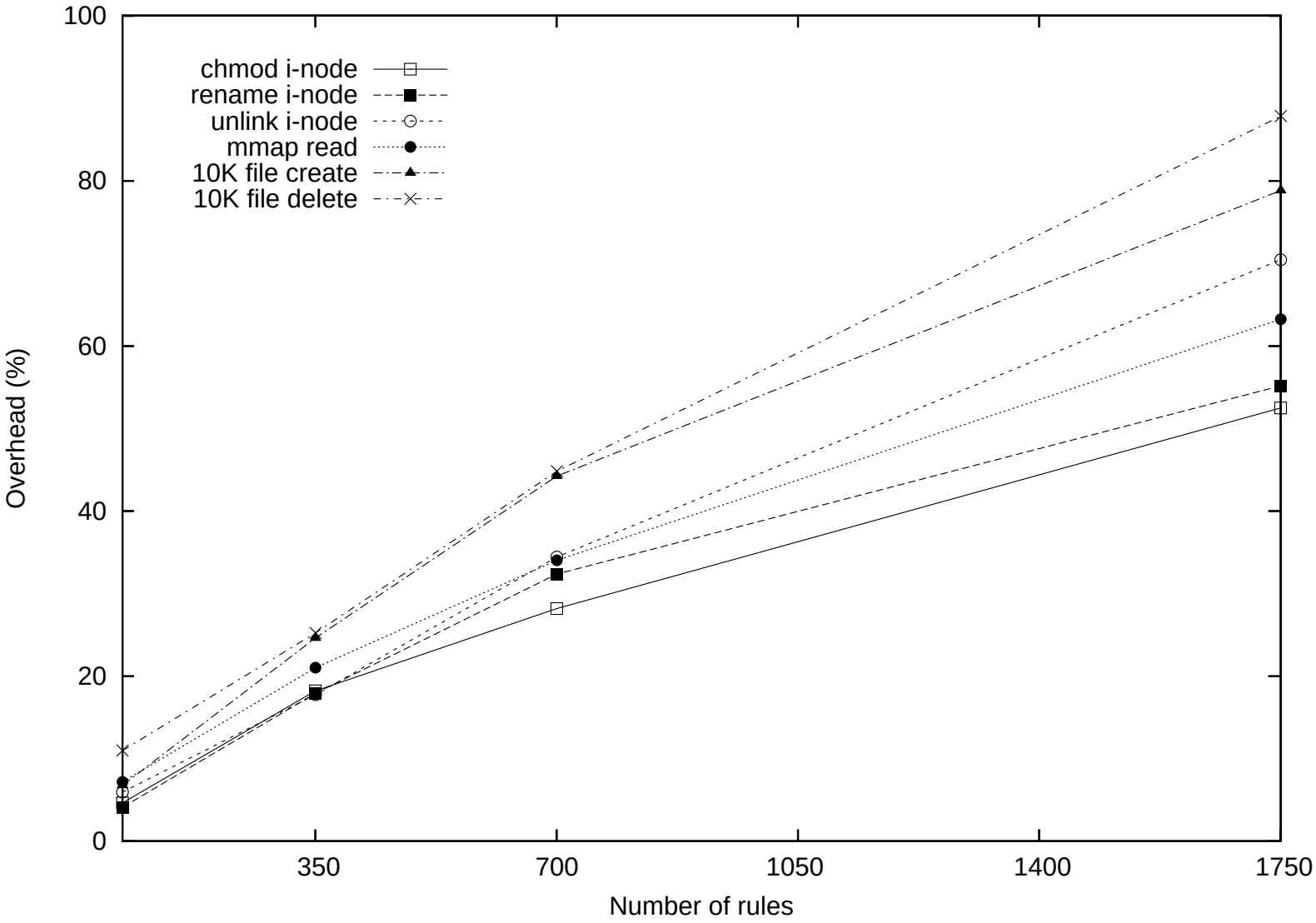
Deployment and Evaluation (2)



Evaluation: processes tests



Evaluation: filesystem and communications



Conclusions and Future Work

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  - Protection of critical processes and resources based on an AC integrated into the operating system's kernel
  - Smart card based authentication protocol for management and configuration activities
  - Good degree of transparency and reasonable performance penalty
- **Future Work:**
  - Improving the customizing of policies
    $\Rightarrow$ Possibility of reload of policies at runtime
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Thank you for your attention!

Questions?