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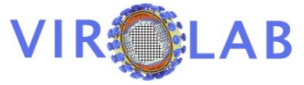

Security in Component Grid Systems

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Master of Science Thesis

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Outline

- Introduction
  - MSc Thesis Goals, Target Environment
- Security Concepts in (Component) Grid Systems on Example of H2O
  - Overview, Authentication in H2O
- Concept of GSI Authenticator
- Authenticator Validation
  - Performed Tests, Threat Analysis, Performance Analysis and Discussion
- Work status
  - Summary of Work Done, Future Work

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MSc Thesis Goals

- Identification and analysis of security architecture and shortages in H2O
- Overview of available solutions for H2O security enhancements
- Concept and development of a security solution for H2O and MOCCA that would answer the presented shortcomings
- Proof of correctness and usefulness of the created solution
- Build, configuration and usage description
- Identification of future work

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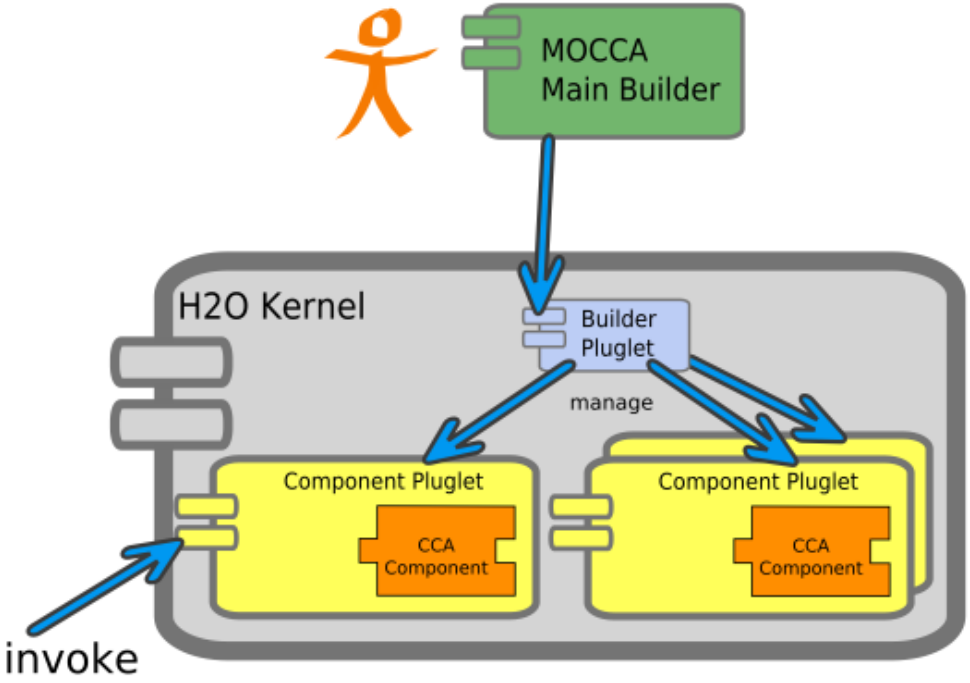
Target Environment

- H2O
  - Middleware platform for distributed computing
  - Providers setup H2O kernel (container)
  - Allowed parties can deploy pluglets (components)
- MOCCA
  - Distributed component framework
  - CCA-compliant
  - Build on top of H2O platform
  - Uses H2O security mechanisms

H2O / MOCCA structure

- CCA components mapped to H2O Component Pluglets and deployed in H2O Kernel
- MOCCA Main Builder and Builder Pluglets used for managing and combining deployed pluglets



Security Concepts in (Component) Grid Systems on Example of H2O

- Authentication
  - Described soon…
- Authorization
  - JAAS; based on authentication 'Subject'
- Communication security
  - Message integrity and confidentiality
  - RMIX framework, TLS / SSL
- Single Sign-On and delegation
- Sandboxing
- Accounting, Audit, …

Authentication in H2O

- Extensible, pluggable architecture
  - Tunneled
  - Chain of authenticators
  - Based on message exchange
  - Similar to Pluggable Authentication Modules
  - Returns Subject object – for JAAS authorization
- Only basic Password Authenticator by default
  - Low level of security
  - Simple to intercept
  - Not applicable for SSO and delegation
  - Hardly possible to manage validity lifetime
  - Careless users…

Our Challenge !

Discussion of Available Solutions

Globus Security Infrastructure

- Official specification for safe communication in grid environment
- Widely deployed on production infrastructures (EGEE)
- Based on existing mechanisms:
  - Public Key Cryptography, Public Key Infrastructure, X.509, TLS
- Single Sign-On and delegation using proxy certificates:
  - based on a new key pair
  - digitally signed by the owner of the original certificate
  - with limited lifetime

MyProxy - software for managing security credentials

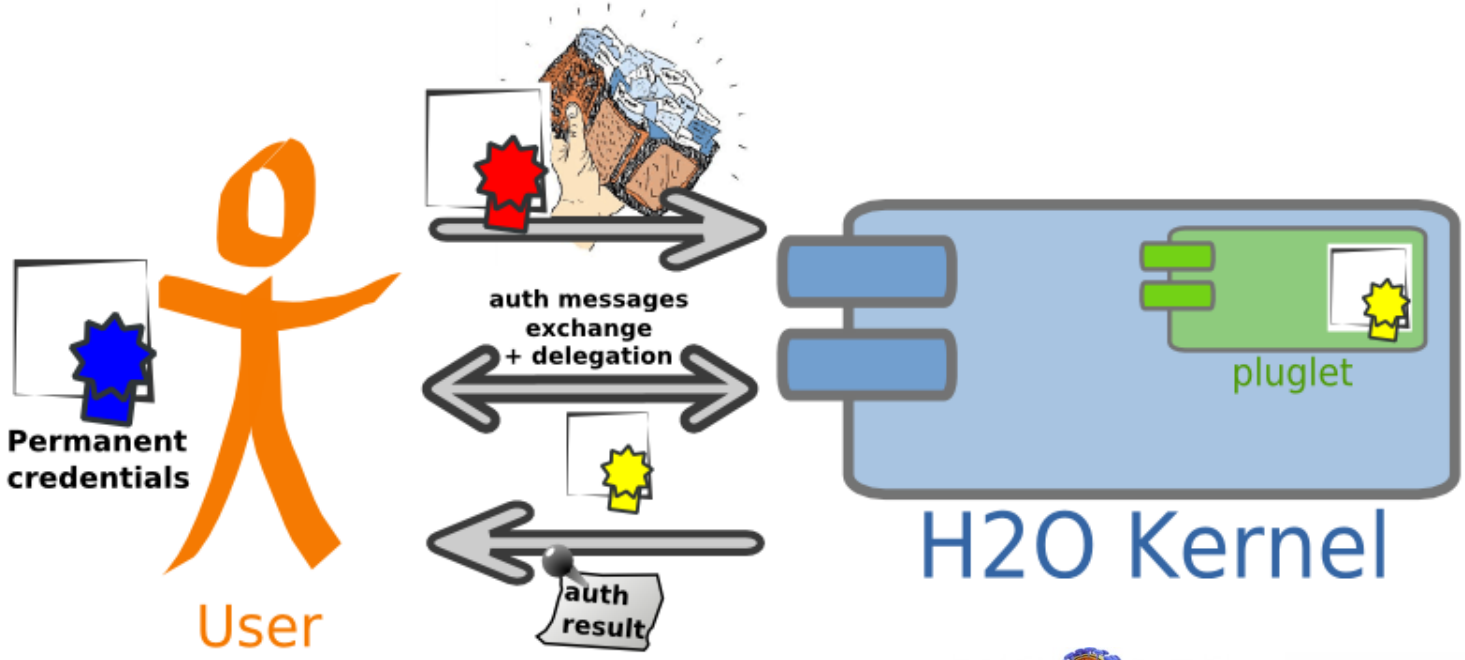
- release from the location of our permanent credentials
- use grid services from different locations and terminals

Shibboleth - Federated Web Single Sign-On framework

- no user certificates
- login requests are redirected to user's home organization
- attribute-based access control
- used mainly for integrating Web resources of educational institutions

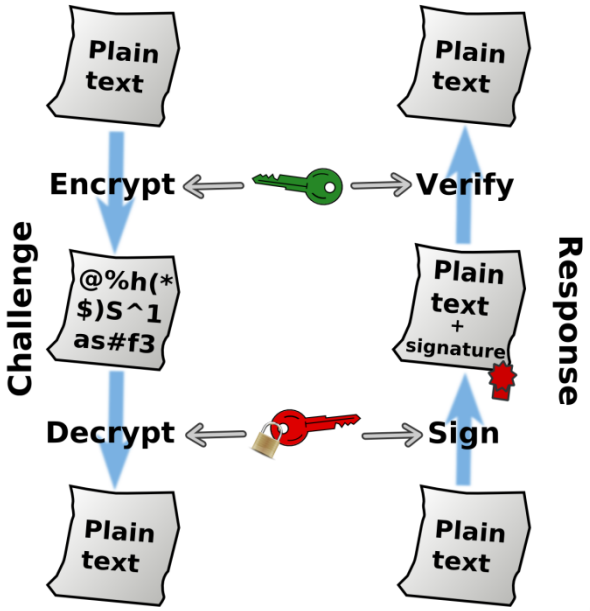
Concept of GSI Authenticator

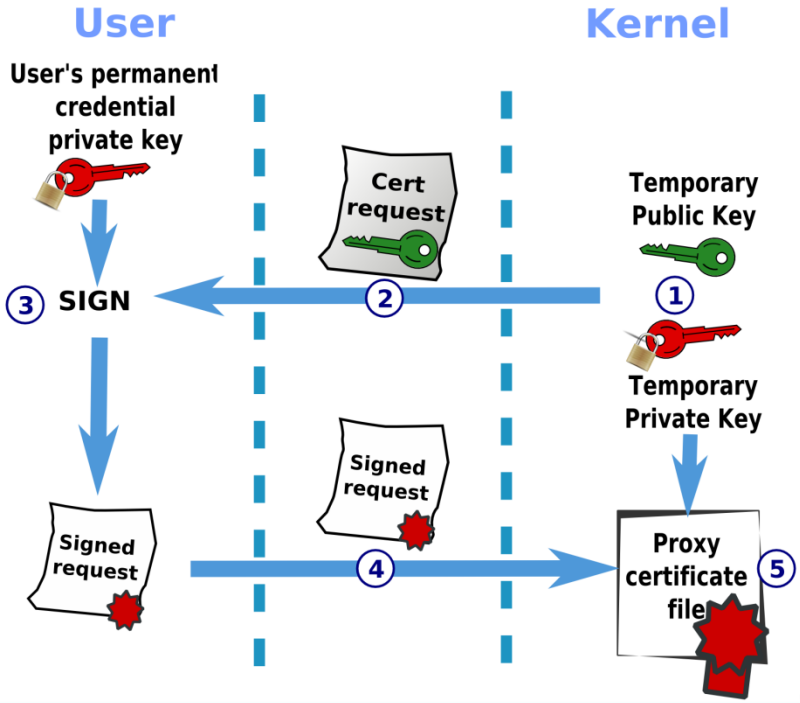
- H2O-applicable authenticator
  - based on PKI and X.509
  - compliant with GSI
  - providing delegation based on proxy certificates



Implementation of GSI Authenticator

- Identity introduction – with (proxy) certificate
  - Kernel verifies validity and checks if the issuing CA is trusted
- Identity confirmation – simple challenge-response algorithm:
  - Kernel encrypts a nonce and sends it to the client
  - Client decrypts and signs the nonce and sends back to the kernel
- Credential delegation



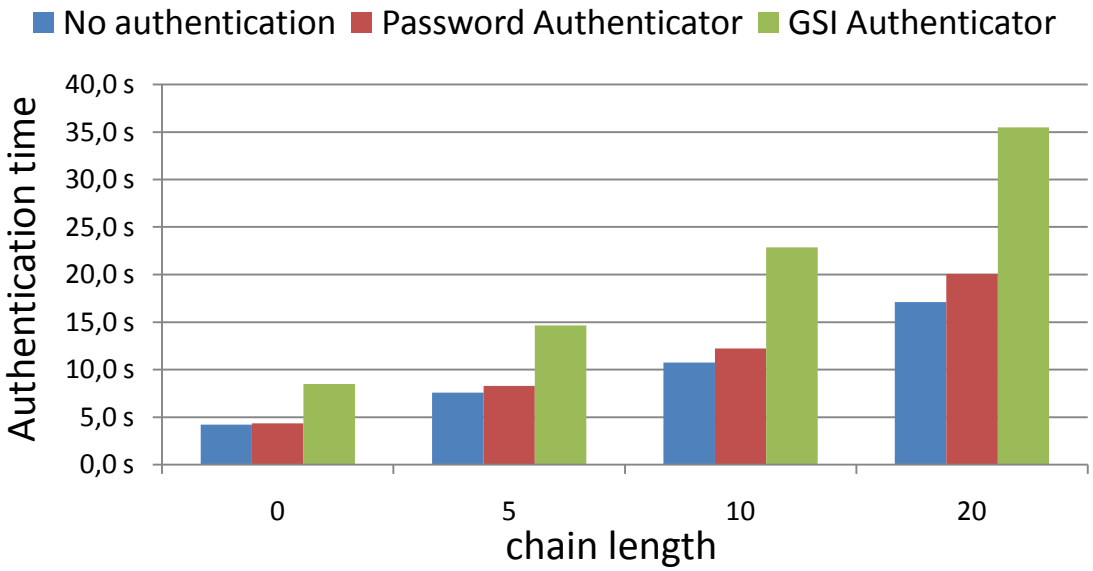


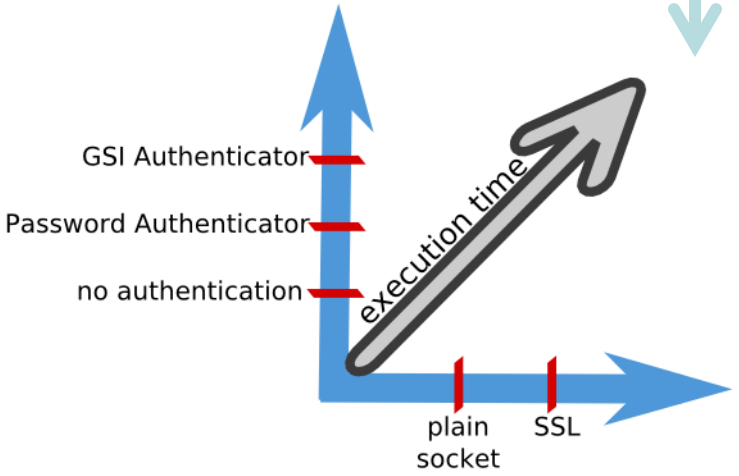
Authenticator Validation

- Verified cases:
  - Valid credentials — correct
  - The lifetime of the proxy is over — incorrect
  - The subject is unknown to the kernel — incorrect
  - The issuer is not trusted by the kernel — incorrect
  - The certificate is revoked — incorrect
- Threat analysis
  - Attacks on the system
    - Cryptanalysis attacks, network eavesdropping, session hijacking, man-in-the-middle attack
  - Attacks on the authenticator

Performance Analysis and Discussion (1/2)

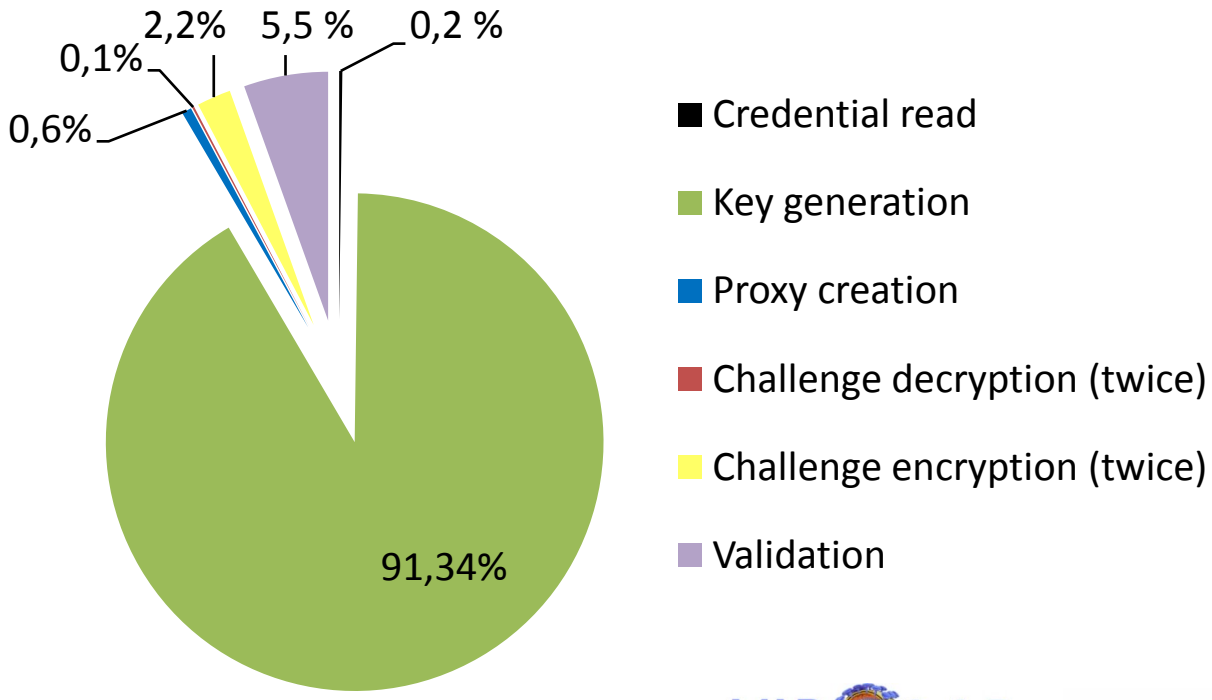
- Authentication mechanism analysis:
  - Authenticators comparison
  - SSL/TLS and server authentication overhead
  - Risk analysis
    - How much performance can we gain?
    - How much security are we ready we loose?





Performance Analysis and Discussion (2/2)

- GSI Authenticator analysis
  - Chain validation time
  - Execution time of particular elements



Summary of Work Done

- Identification and analysis of security architecture and shortages in H2O
  - ✓ **performed**
- Overview of available solutions for H2O security enhancements
  - ✓ **GSI-based solution selected**
- Concept and development of a security solution for H2O and MOCCA that would answer the presented shortcomings
  - ✓ **GSI Authenticator created, integrated with H2O**
- Proof of correctness and usefulness of the created solution
  - ✓ **performance and usage tests, threat analysis, usage examples for both H2O and MOCCA performed**
- Build, configuration and usage description
  - ✓ **provided in MSc Thesis**
- Identification of future work
  - ✓ **see next page**

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Future Work

- Delegation of trust anchors
- CRL update and the Online Certificate Status Protocol (OSCP) for certificate revocation verification
- MyProxy for credentials storage
- More sophisticated authorization mechanisms

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GSI Authenticator

Please visit the following websites:

- H2O : *http://dcl.mathcs.emory.edu/h2o*
- MOCCA : *http://mocca.icsr.agh.edu.pl*
- VIROLAB : *http://virolab.cyfronet.pl*