Security Risks in Clouds and Grids

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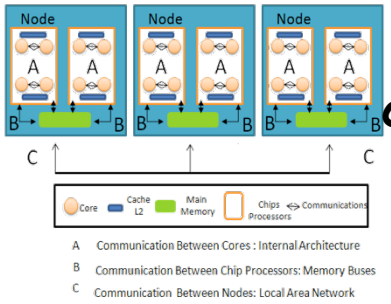
Condor Week
May 5, 2011

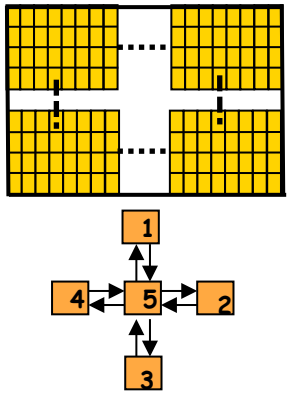
Efficient execution of SPMD Applications on Multicore Environments

Problem

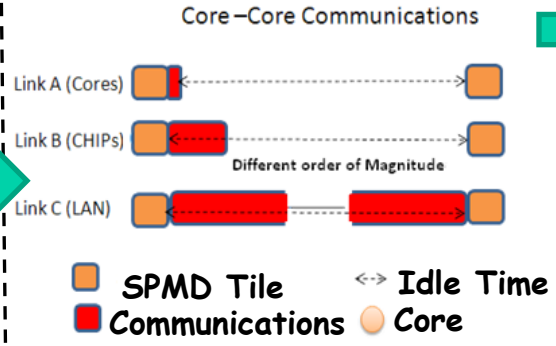
Multicore Environment



Hierarchical communication architecture



SPMD Application Message Passing Interface

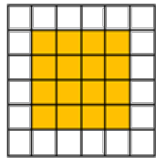


Objective

- Maximum Speedup
- Efficiency over a defined threshold

How?

Methodology



E Edge tile

I Internal tile

SuperTile allows to overlap the internal computation with edge communication

→ **Ideal Size of Supertile**

→ **Ideal Number of Core**

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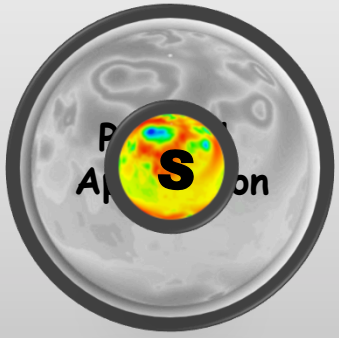
NATO OTAN

NSF

PARALLEL APPLICATION SIGNATURE FOR PERFORMANCE PREDICTION



Instrumentation

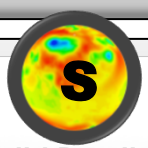
Base Machine

Collection data

Parallel Application Model

Patterns Identification

Extract Phases and Weights



Build Parallel Application Signature

(Coordinated Checkpoint + Phases + Weights)

Time of each Phase by weight

Prediction

Target Machine A

BT-256	128	98.52%	1.5%
SP-256	128	99.23%	6.4%
SMG2000-256	128	98.25%	3.8%
Sweep3D-256	128	92.38%	3.5%

Time of each Phase by weight

Prediction

Target Machine B

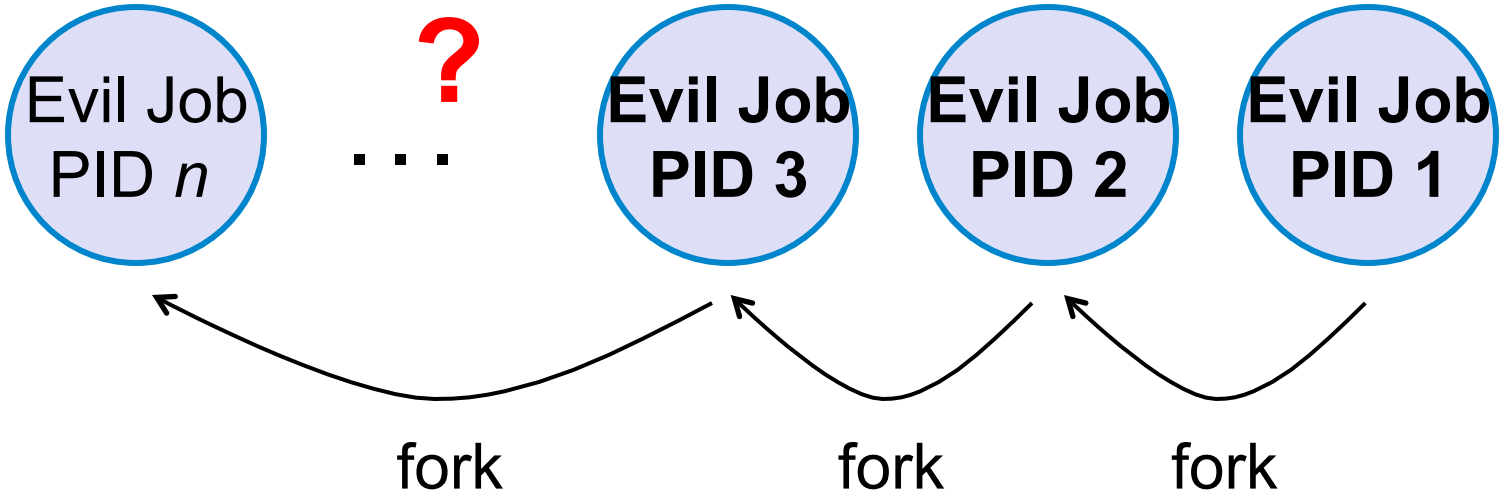
BT-256	256	98.63%	6.4%
SP-256	256	99.37%	3.4%
SMG2000-256	256	98.24%	3.8%
Sweep3D-256	256	92.35%	6.2%

Possible Threat?

- Clouds and Grids have databases with management and operational information
- Denial of Service:
  - Prevent updates in the database

Possible Threat?

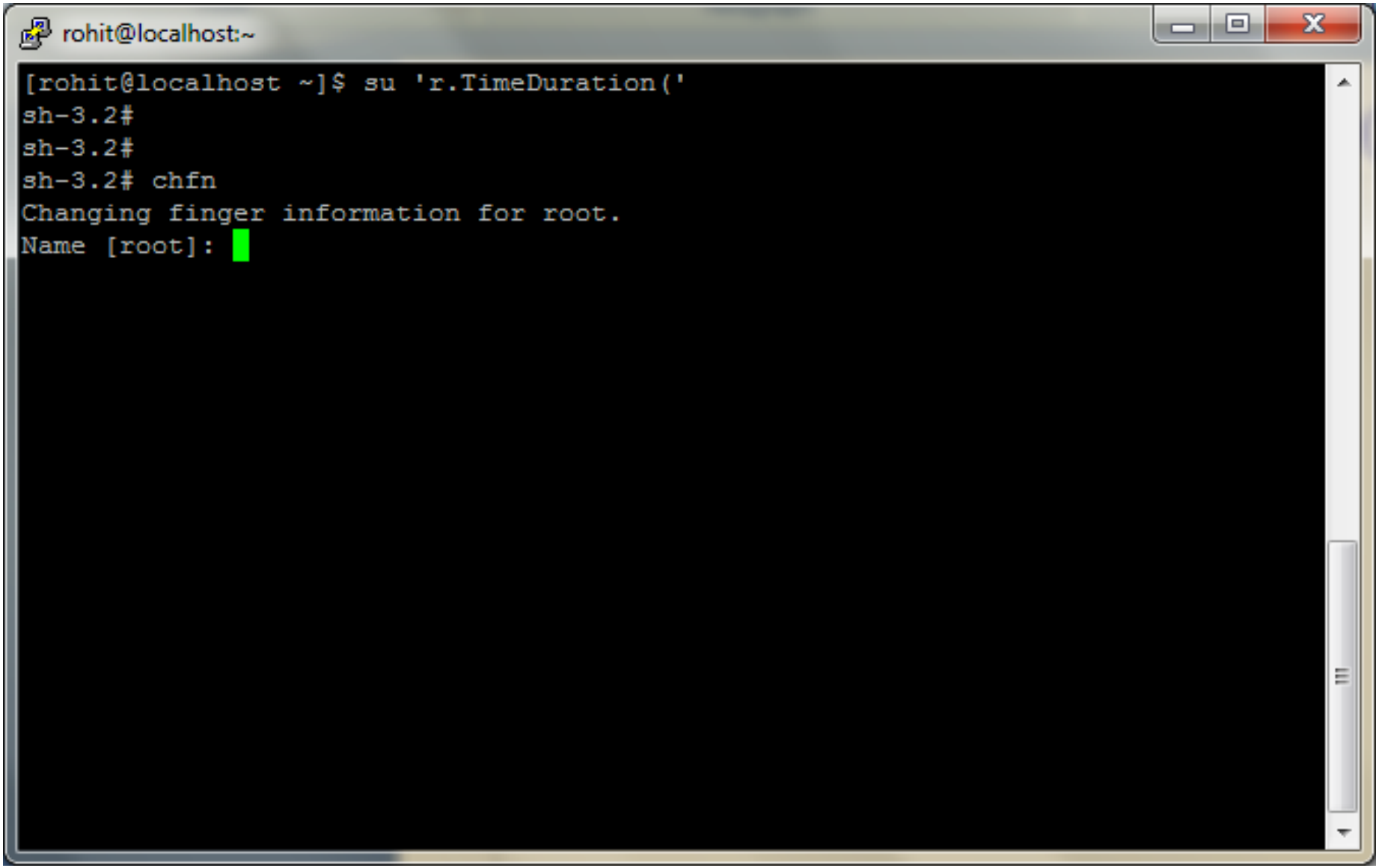
- Hijack machines
  - Process escapes Cloud/Grid/control: Keeps forking and exiting to escape detection.



Possible Threat?

- Cloud/Grid Accounting System
  - Maintains a Grid-wide view of resource utilization.
    - Job Submission (Priority in the batch queue, CPU time, Memory usage)
    - Storage (Disk usage, Tape storage)
  - Accounting Information ***easily*** available to people (web interface) and to applications (Web Services)
- Use the Accounting System for bad purposes.

Possible Threat?



Real Threat!

GRATIA-CONDOR-2010-0003

Summary:

Any user that can submit Condor jobs on the host running Gratia Condor probe, can execute arbitrary code as the root user.

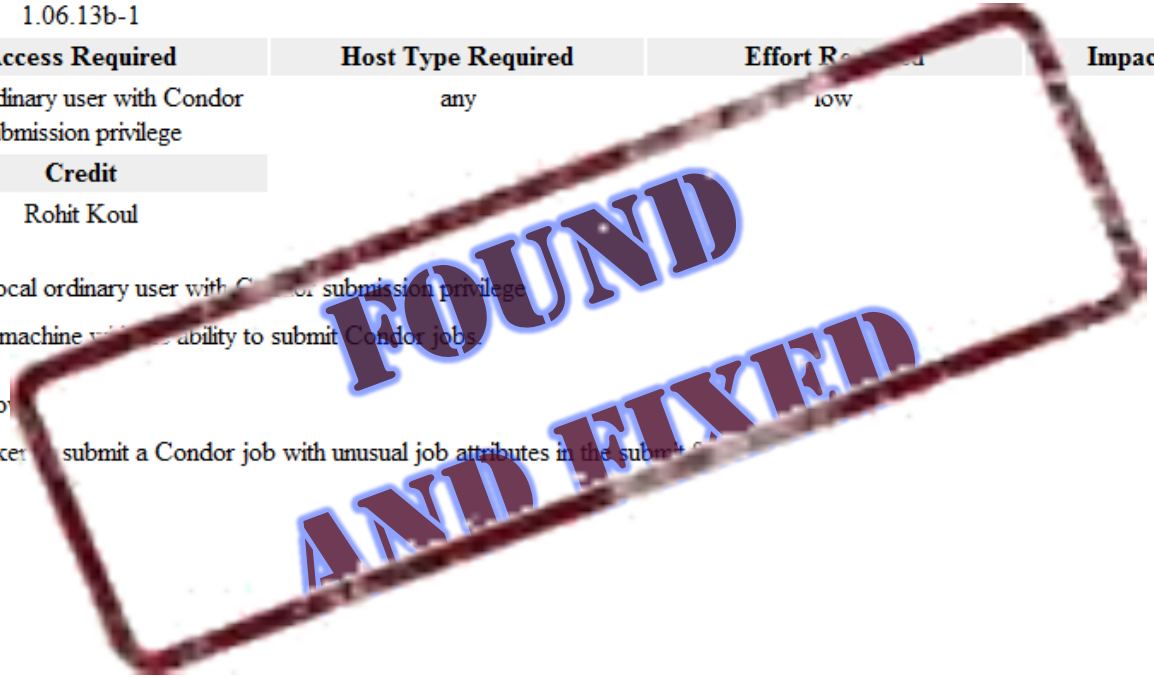
Component	Vulnerable Versions	Platform	Availability	Fix Available
condor_meter	1.04.4d-1 1.06.13b-1	all	not known to be publicly available	no
Status	**Access Required**	**Host Type Required**	**Effort R...**	**Impact/Consequences**
Verified	local ordinary user with Condor submission privilege	any	low	high
Fixed Date	**Credit**			
	Rohit Koul			

Access Required: local ordinary user with C... submission privilege

The vulnerability requires local access to the machine ... ability to submit Condor jobs.

Effort Required: lo...

Exploiting this vulnerability requires the attacker ... submit a Condor job with unusual job attributes in the submit ...



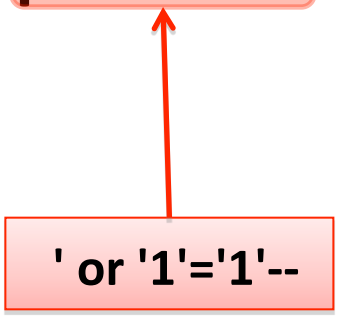
What the bad guys can do

- Gain root access
- Privilege escalation
  - Gain higher privilege access (admin, condor)
- Hijack machines
  - Attack the process running there

What the bad guys can do

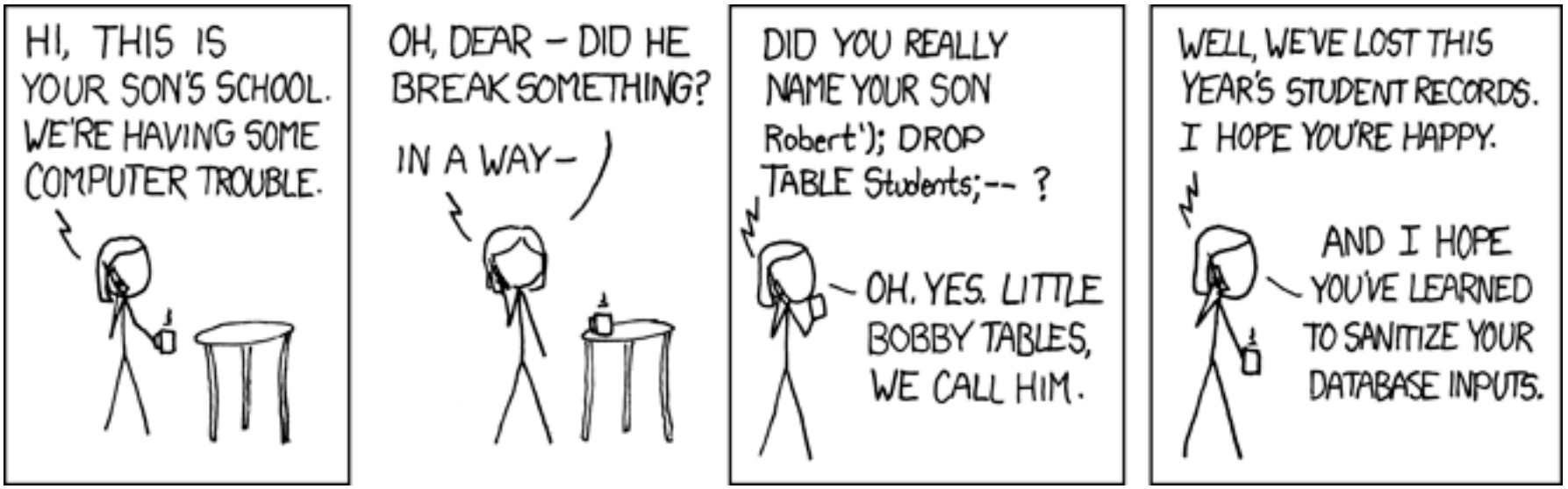
- Injections
  - Command
  - SQL

1. String user = request.getParameter("user");
2. String password = request.getParameter ("password");
3. String sql = "select * from user where username=' " + user + " ' and password=' " + password + " ' ";



What the bad guys can do

- Injections
  - Command
  - SQL



What the bad guys can do

- Injections
  - Command
  - SQL
  - Directory traversal
  - Log
- Denial of Service (DoS)

Why do we care

- Machines belonging to a cloud/grid site are accessible from the Internet
- Hundred of thousands of machines are appealing
- Those machines are continuously probed:
  - Attackers trying to brute-force passwords
  - Attackers trying to break Web applications
  - Attackers trying to break into servers and obtain administrator rights

Why do we do it

- SW has vulnerabilities
- Cloud and Grid SW is complex and large
- Vulnerabilities can be exploited by legal users or by others

Why do we do it

- Attacker chooses the time, place, method, …
- Defender needs to protect against all possible attacks (currently known, and those yet to be discovered)

Key Issues for Security

- Need independent assessment
  - Software engineers have long known that testing groups must be independent of development groups
- Need an assessment process that is NOT based solely on known vulnerabilities
  - Such approaches will not find new types and variations of attacks

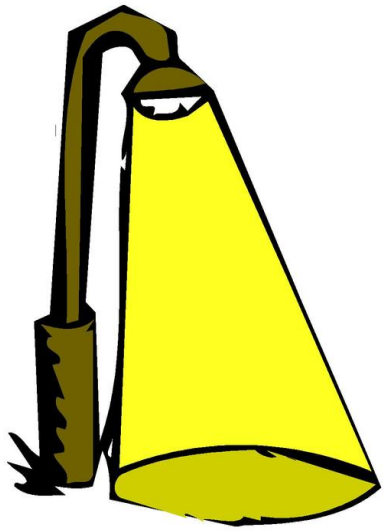
Our Piece of the Solution Space

First Principles Vulnerability Assessment:

- An analyst-centric (manual) assessment process.
- You can't look carefully at every line of code so:

Don't start with known threats …

… instead, identify high value assets in the code and work outward to derive threats.



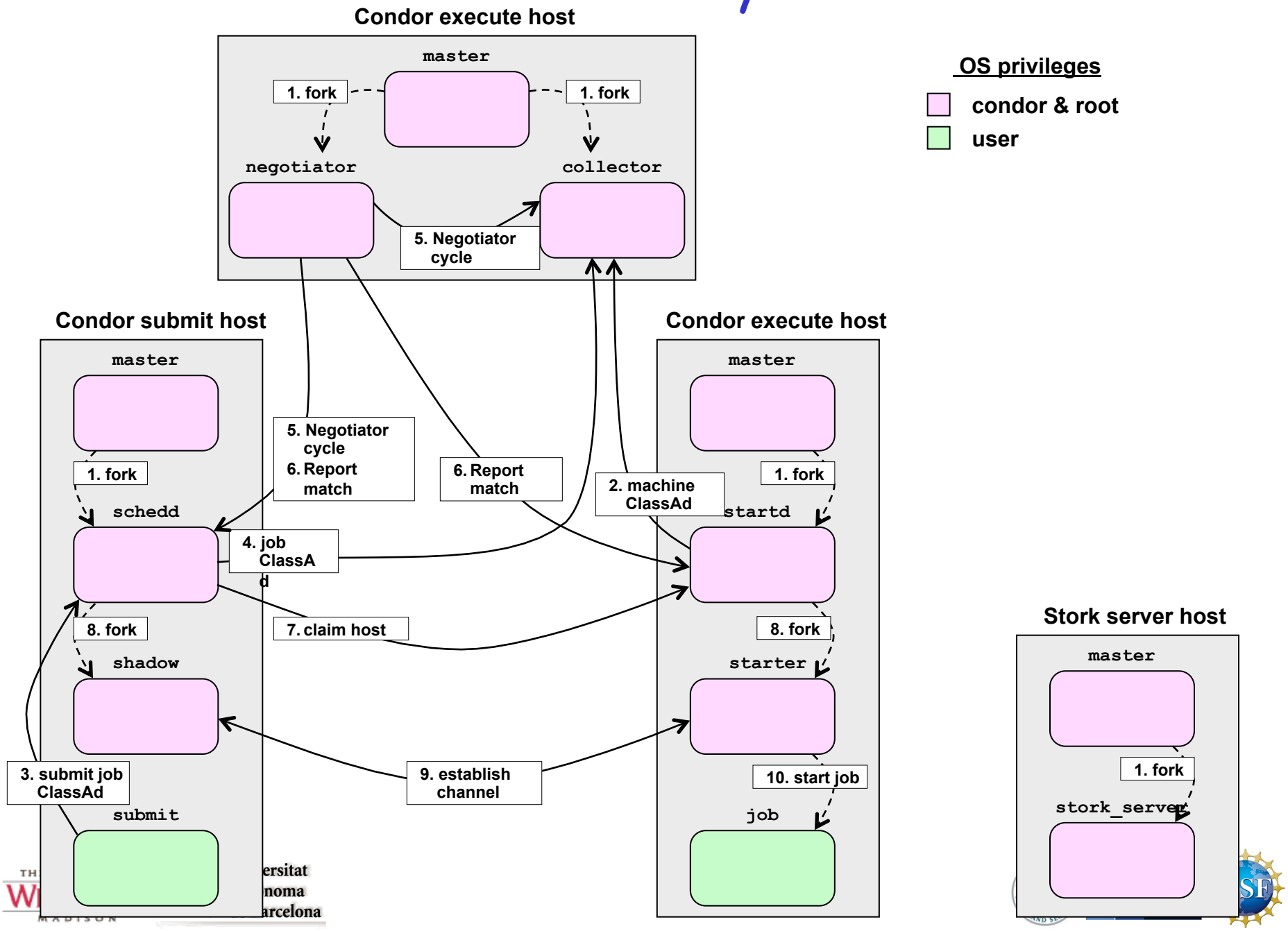
- Start with architectural analysis, then identify key resources and privilege levels, component interactions and trust delegation, then focused component analysis.

First Principles Vulnerability Assessment
Understanding the System

Step 1: Architectural Analysis

- Functionality and structure of the system, major components (modules, threads, processes), communication channels
- Interactions among components and with users

Architectural Analysis: Condor



First Principles Vulnerability Assessment
Understanding the System

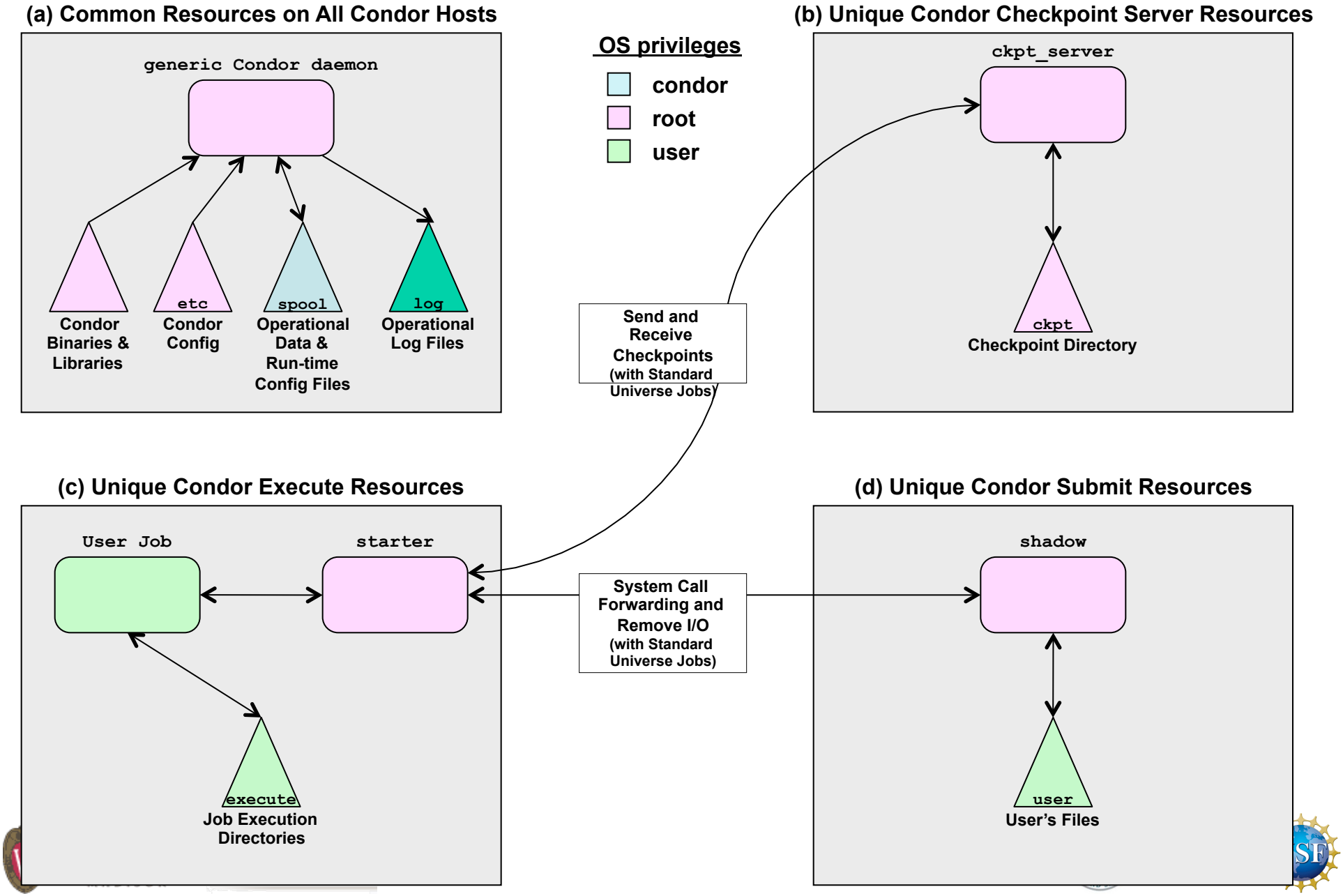
Step 2: Resource Identification

- Key resources accessed by each component
- Operations allowed on those resources

Step 3: Trust & Privilege Analysis

- How components are protected and who can access them
- Privilege level at which each component runs
- Trust delegation

Resource Analysis: Condor



First Principles Vulnerability Assessment
Search for Vulnerabilities

Step 4: Component Evaluation

- Examine critical components in depth
- Guide search using:
  - Diagrams from steps 1-3
  - Knowledge of vulnerabilities
- Helped by Automated scanning tools

First Principles Vulnerability Assessment
Taking Actions

Step 5: Dissemination of Results

- Report vulnerabilities
- Interaction with developers
- Disclosure of vulnerabilities

Our Experience

Condor, University of Wisconsin
Batch queuing workload management system
15 vulnerabilities — 600 KLOC of C and C++

SRB, SDSC
Storage Resource Broker - data grid
5 vulnerabilities — 280 KLOC of C

MyProxy, NCSA
Credential Management System
5 vulnerabilities — 25 KLOC of C

glExec, Nikhef
Identity mapping service
5 vulnerabilities — 48 KLOC of C

Gratia Condor Probe, FNAL and Open Science Grid
Feeds Condor Usage into Gratia Accounting System
3 vulnerabilities — 1.7 KLOC of Perl and Bash

Condor Quill, University of Wisconsin
DBMS Storage of Condor Operational and Historical Data
6 vulnerabilities — 7.9 KLOC of C and C++

Our Experience

Wireshark, wireshark.org
Network Protocol Analyzer
in progress 2400 KLOC of C

Condor Privilege Separation, Univ. of Wisconsin
Restricted Identity Switching Module
21 KLOC of C and C++

VOMS Admin, INFN
Web management interface to VOMS data
35 KLOC of Java and PHP

CrossBroker, Universitat Autònoma de Barcelona
Resource Mgr for Parallel & Interactive Applications
97 KLOC of C++

Our Experience

ARGUS 1.2, HIP, INFN, NIKHEF, SWITCH
gLite Authorization Service
in progress

NIKHEF

glExec 0.8, Nikhef
Identity mapping service

What do we do

- Make cloud/grid software more secure
- Make in-depth assessments more automated
- Teach tutorials for users, developers, admin, managers:
  - Security risks
  - Vulnerability assessment
  - Secure programming

Who we are

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