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Dependable Virtual Appliances

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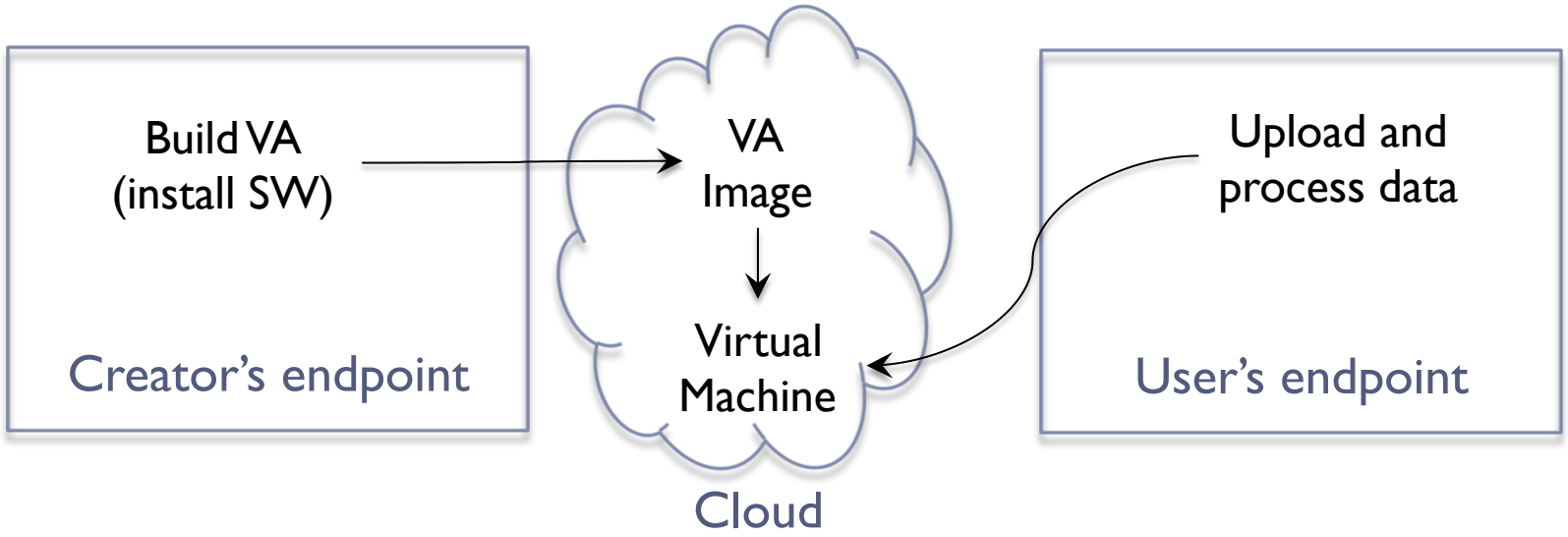
Virtual Appliance: Cloud's *de facto* executable

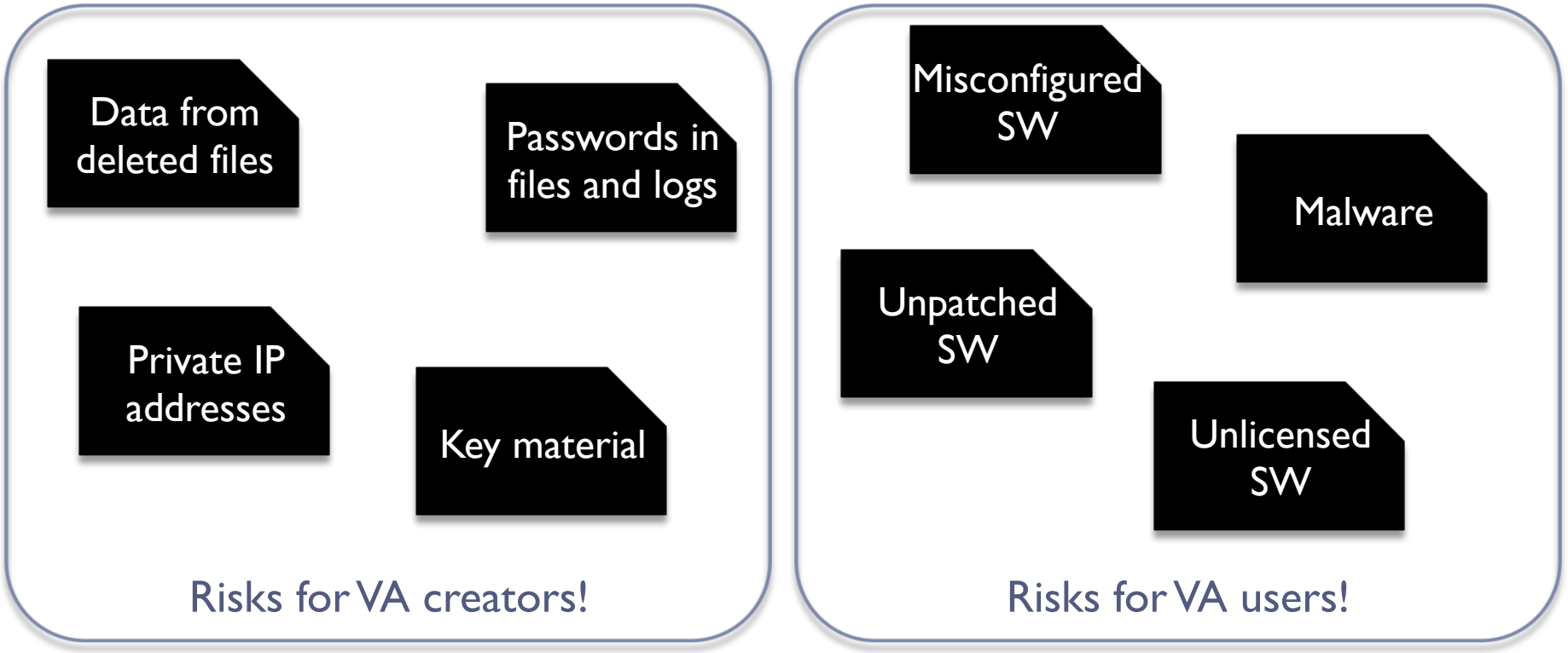
- Virtual Appliance: pre-configured virtual machine image
  - Provides, e.g., LAMP web server, mail server, database server…



- Today, 1000s of VAs available online, e.g., through Amazon EC2

But beware of risks!

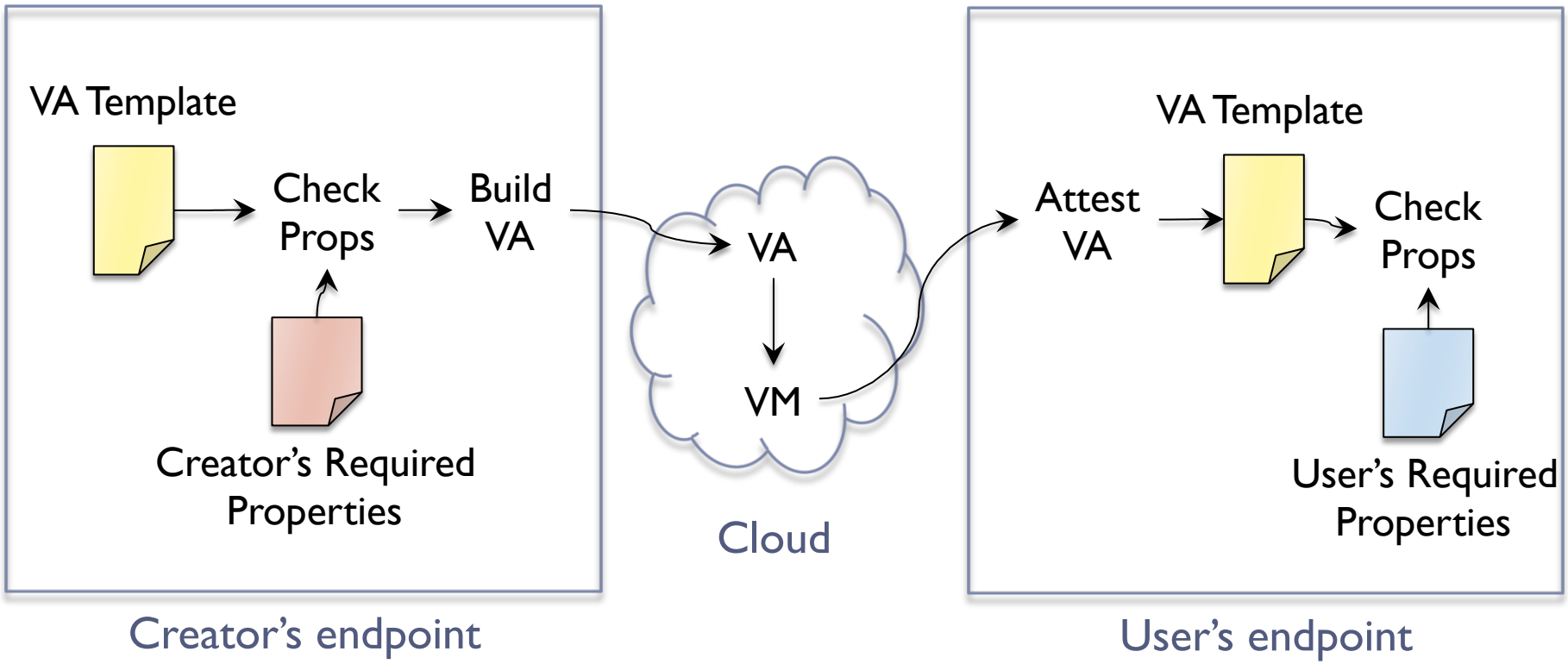
- Researchers looked at 100s of public VAs [Bugiel11,Huh13]



- Lack defenses. How can we mitigate these risks?

Our Vision: Dependable Virtual Appliances

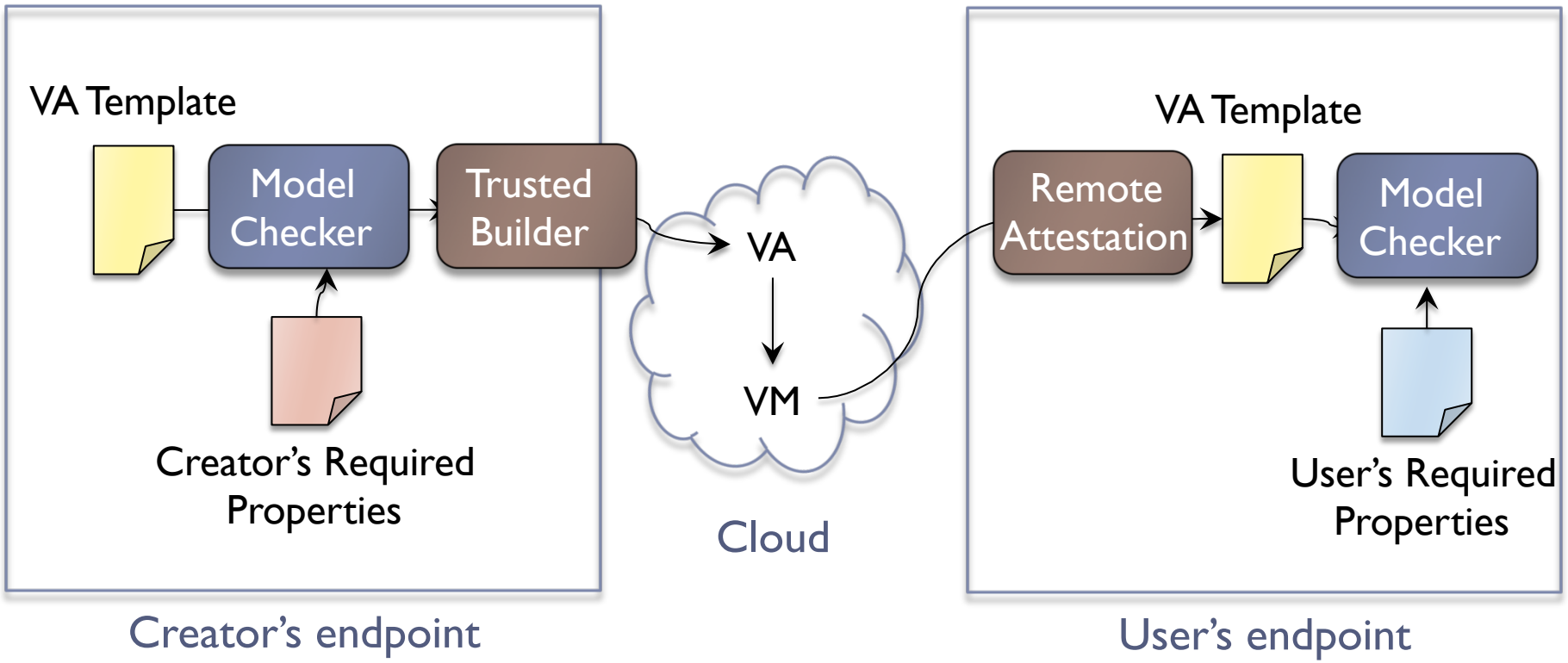
- We call them *depliances*
  - Creators / users can verify config properties before shipment / usage



Key Techniques for Building Depliances

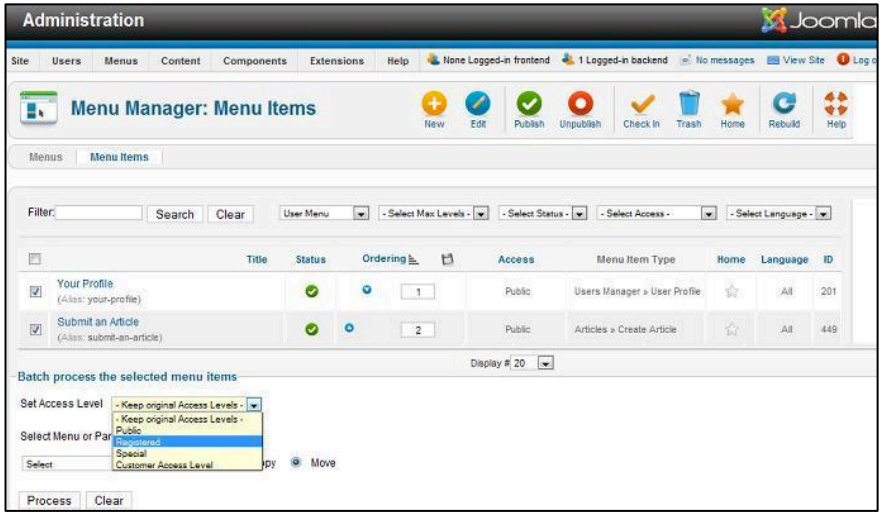
Model Checking
To verify properties of VA model

Trusted Computing
To build and attest VAs

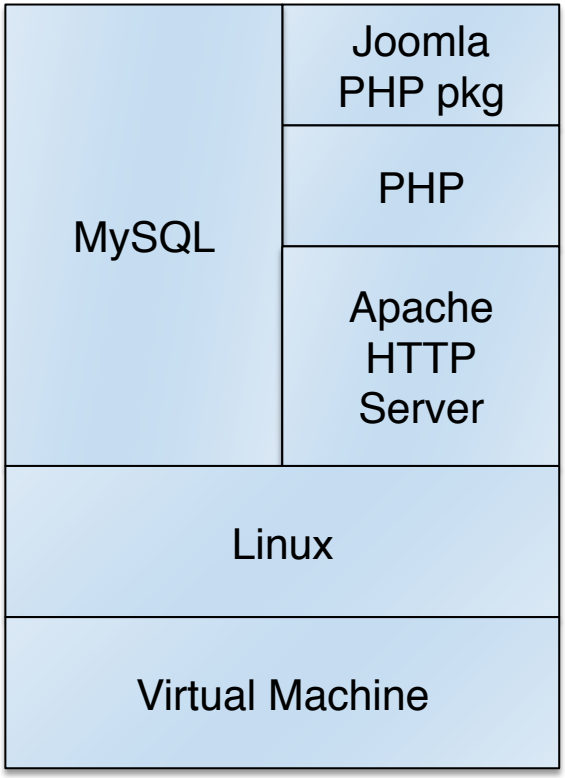


Example: Joomla Depliance

- What is Joomla?
  - Content management system
  - Written in PHP
  - For publishing web content

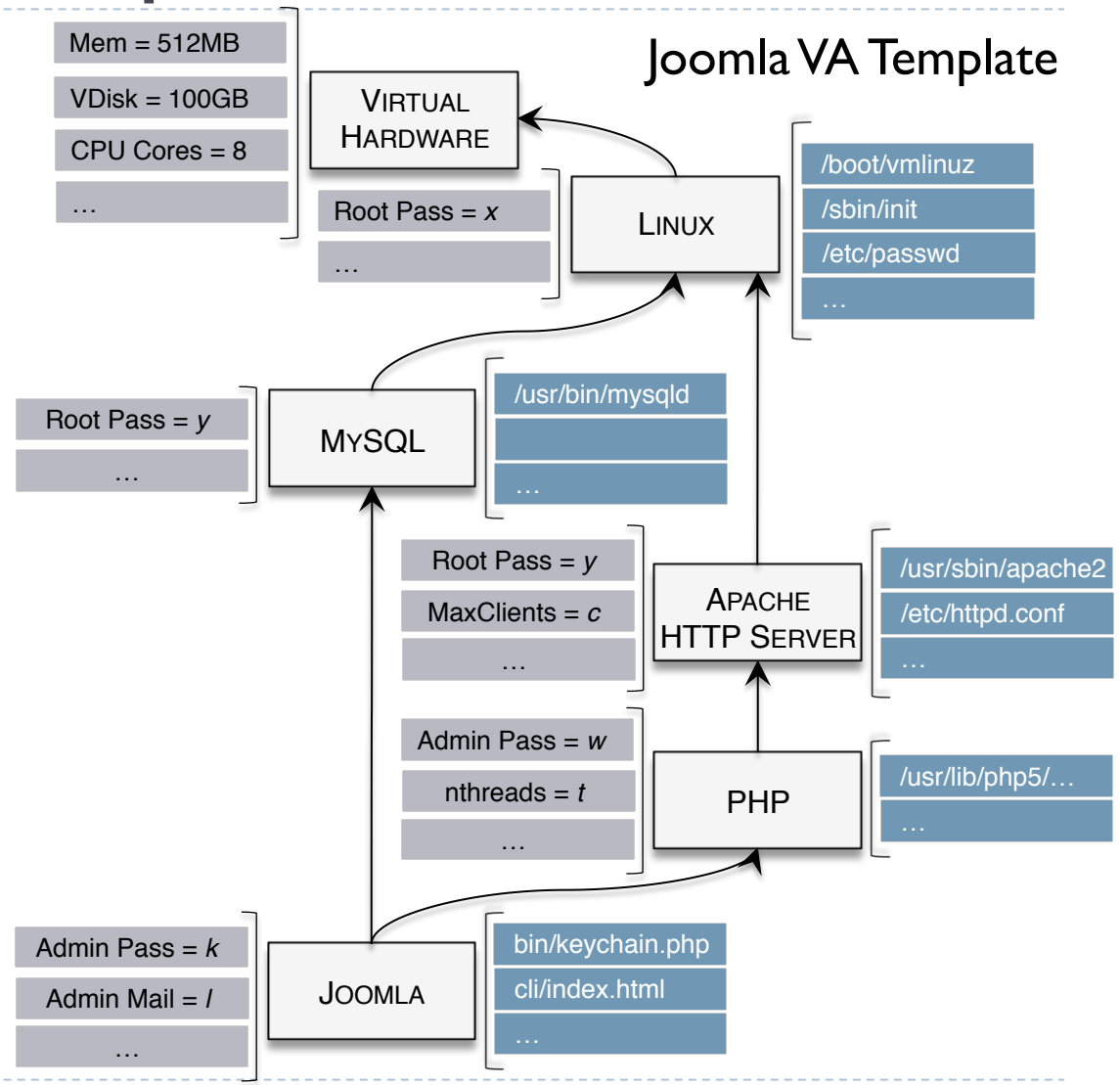


- How to set it up?
  - Configure the following SW



Step 1. VA Template Specification

- Specify modules and inter-dependencies
  - E.g., Linux, MySQL…
- Specify config attributes
  - E.g., "Root Pass"
- Specify files
  - E.g., /usr/mysql/my.cnf



Step 2. Property Specification and Verification

Examples of properties to verify

- *Efficiency*:

  "check number of concurrent threads for Apache and PHP based on memory and CPU cores"

- *Confidentiality*:

  "check passwords of Apache, MySQL, and PHP admin not default nor private identities"

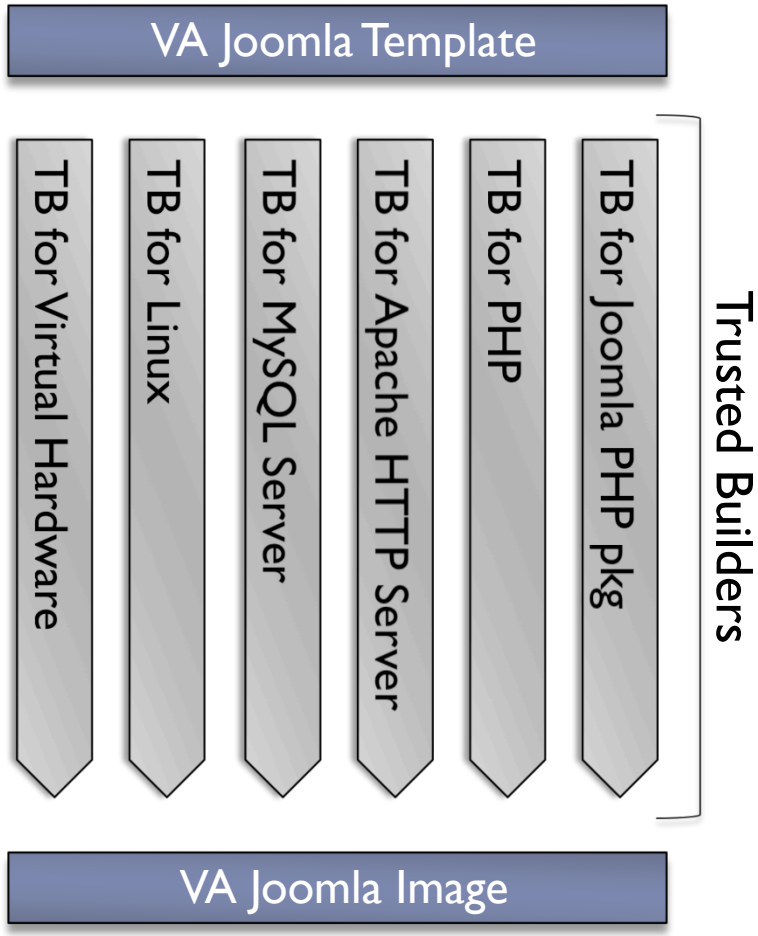
- *Integrity*:

  "check versions of SW and missed patches"

- Describe modules' behavior as state machines
  - Config and file attributes as inputs
- Specify properties as logic conditions
  - Over config and file attributes
- Model checker to verify properties
  - E.g., PRISM, SPIN

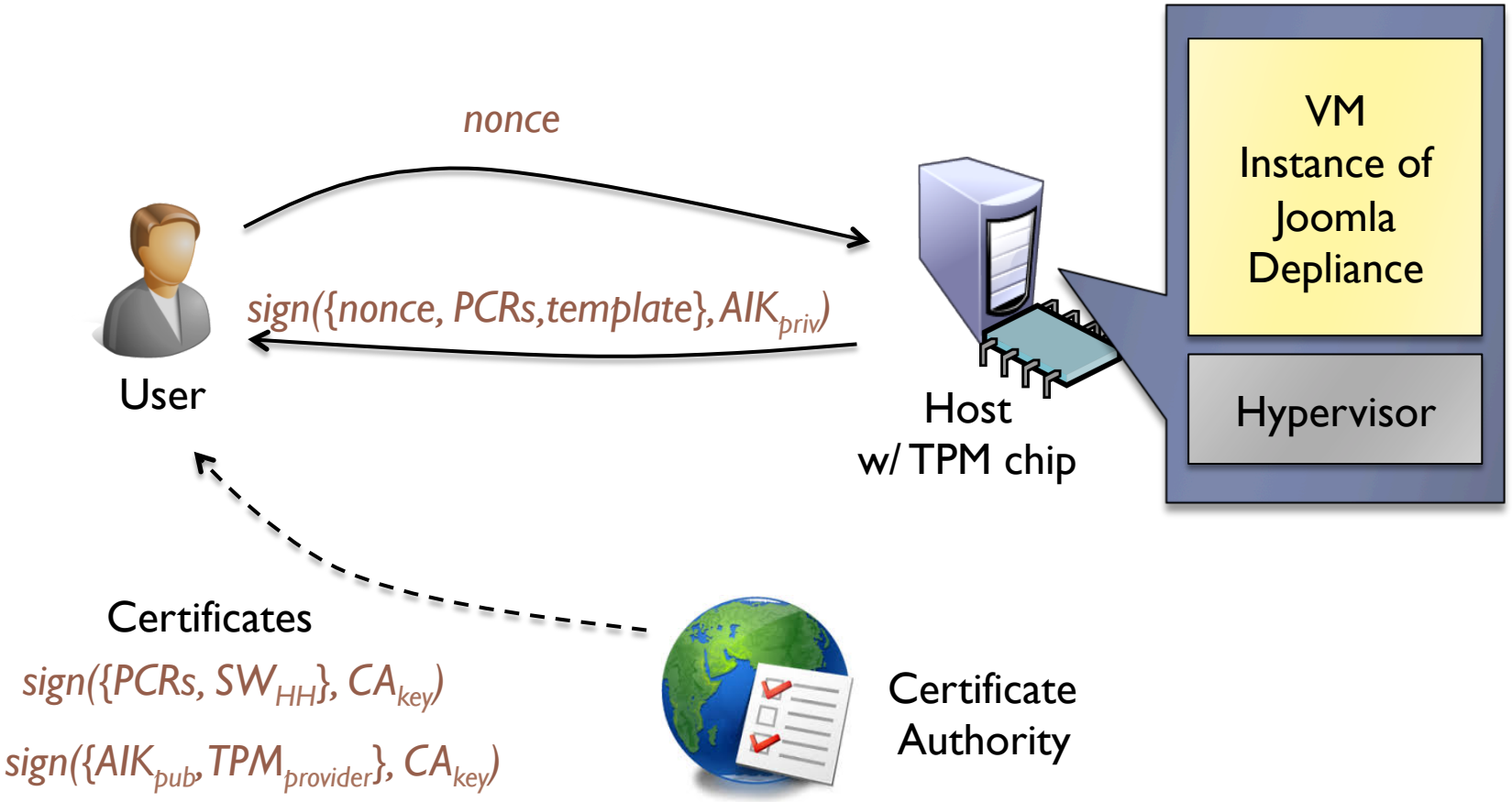
Step 3. VA Image Generation

- Through dedicated programs: trusted builders
- Input: verified VA template
- For each module:
  - Resolve dependencies
  - Run trusted builder to install and configure files of module
- Output: VA image



Step 4. VA Instantiation and Attestation

- Remote attestation protocol yields original VA template



Usage Scenarios

- Condition: VA image must be built by trusted party

Case I

VA built by creator
Cloud only stores VA

↗ Fits today's model
↘ Must trust the creator

Case II

VA built by cloud
Creator shares VA template

↗ No trust needed in creator
↘ Requires compute time in cloud

Case III

VA built by user
Creator shares VA template

↗ No trust needed in creator nor cloud
↘ Requires compute time locally

Open Challenges and Future Work

- Thousands of SW config attributes is overwhelming
  - Idea: decouple DSL abstractions from SW config attributes
- Different properties require different verification approaches
  - Idea: study best encoding logic and verification tools
- Enable (partial) offload of VA generation to untrusted party
  - Idea: generate trustworthy log of untrusted party operations

Conclusions

- Virtual appliances popular, but creators and users incur risks
  - Misconfigurations, security threats, privacy breaches, etc.
- We propose depliance model to build dependable VAs
  - Creators / users verify properties of VA before publication / usage
- Depliance model enabled by two techniques:
  - Model checking and trusted computing
- Many open challenges to be addressed in the future
  - Find right level of DSL abstractions, efficient way of verifying properties

Thanks!
Questions?

http://www.gsd.inesc-id.pt/~nsantos/