Software Defined Cloud Security Architectures

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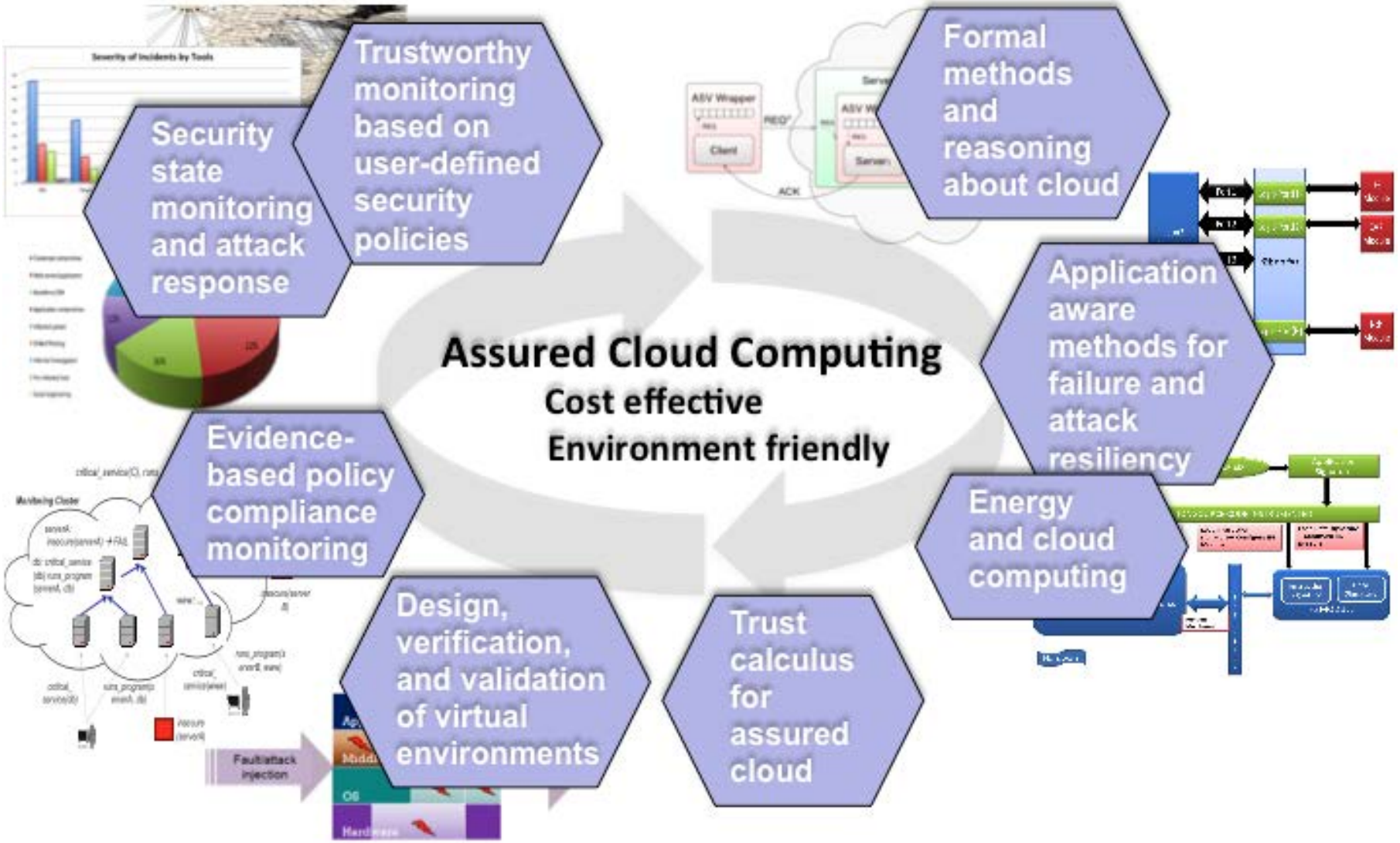
Towards Assured Clouds: Our Approach



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Concerns

- Software Defined Networks
- Virtual Machines and Virtualization
- Virtual Appliances. Component reuse.
- Software Defined Compute and Storage Engines
- Virtual Machine Introspection
- Digital Forensics
- Sensing and monitoring
- Integration of Techniques and Fusion of Sensing Information
- Trusted Bootstraps applied to distributed systems
- Transformational way of building security for Cloud Services.

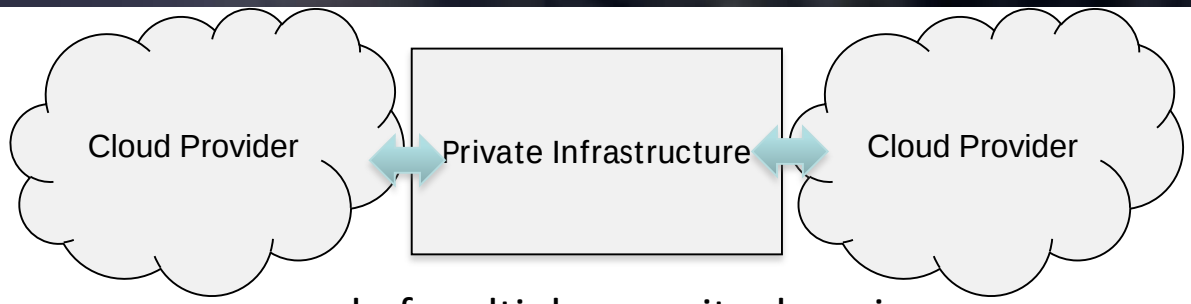
Defense in Depth-Network

- SDN
  - Toolbox for constructing security architecture for a network (FRESCO)
  - Separation of traffic, layering, secure, isolated data flows
  - Virtual network/flows associated with distributed architecture of virtual appliances (virtual cluster)
  - Modular applications in high-level languages written above controllers

ACC Results

- Distributed Monitoring (distributed policy, distributed checking, authenticated results)
- Trust Model for Clouds
- Virtual Appliances
- Virtual Machine Inspection within Clouds
- Remote Digital Forensics
- Integrating virtual networking with virtual appliances

Motivation: Multi-Domain Monitoring

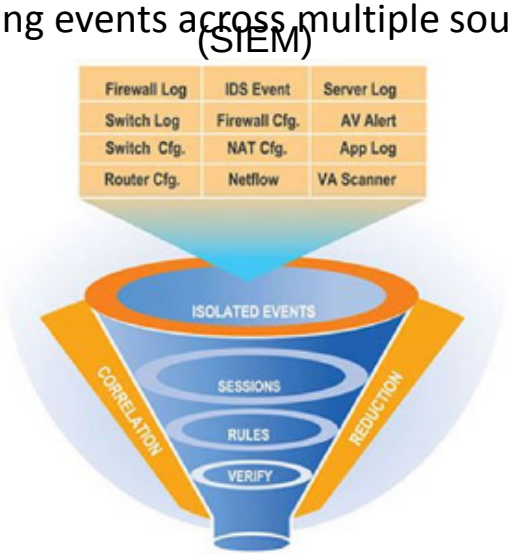


- Modern systems are composed of multiple security domains
  - Cloud Computing
  - Hybrid Clouds
  - Intercloud-Multi-cloud
  - Critical Infrastructure Systems
- Advantages
  - Economy of scale for cloud computing
  - Ability to select which services to use without binding to a single provider for multi-cloud/inter-cloud

EVENT TYPE	SOURCE	SECURITY DOMAIN	DESCRIPTION
runsCriticalService	Deployment software,SNMP agents	Cloud user	critical services run on a specific instances
instanceAssigned	Openstack	Cloud provider	instances are assigned to specific physical servers
badTraffic	IDS, Network monitoring	Cloud provider	malicious traffic detected from specific physical server

Sharing Only need-to-know Information

- How do we know that the system is working correctly as a whole?
- Integrating events across domains to detect complex security problems and attacks
  - Security Information and Event Management Systems (SIEM) are successful because they are capable of integrate monitoring events across multiple sources



- However, monitoring provides critical information about systems to external organizations which opens the system to attacks
  - *Network topology, network traffic, configurations, installed programs, vulnerable programs, user bahaviors, services, critical machines*

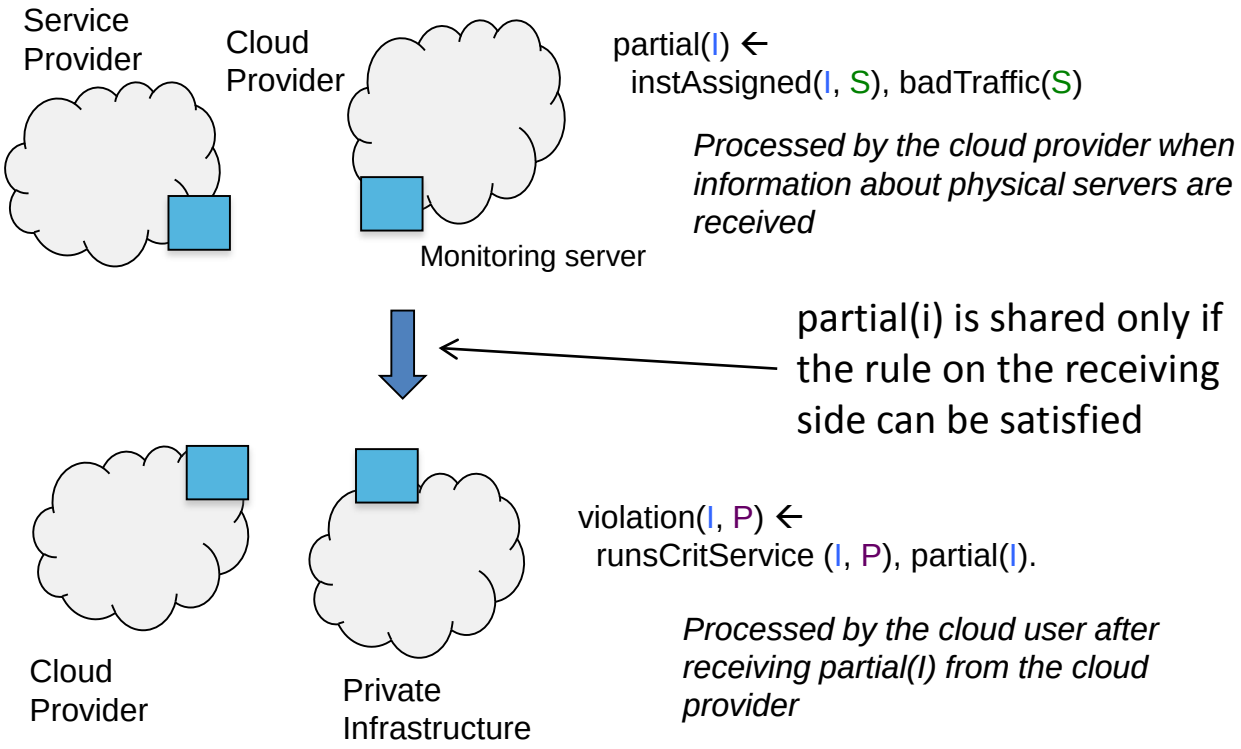
Goal: Share only *need-to-know* information across organizations to detect problems

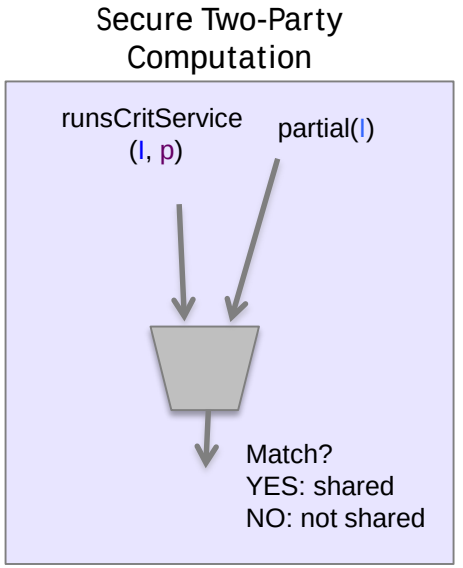
Policy-based Distributed Monitoring System

- Our Distributed Monitoring System
  - Policy-based
  - Detects violations of global policies while limiting event exposure
  - Identifies "need-to-know" events and shares only those

1. Policy rewritten to identify cross-domain sharing
2. Events shared only if they can create a violation

violation(I, P) ←
runsCritService (I, P), instAssigned(I, S), badTraffic(S)





Virtual Network/Virtual Appliances

- Science DMZ
- Secure End to End systems
- Overlay networks (research, academics, public)
- Monitoring of virtual appliances
- Introspection/forensics tools
- Policies for and monitoring of data flow between networks

SDN Facilities

- New Lab
- Latest wired and wireless switches/routers
- Integrated with experimental cloud
- Can simulate two campuses and multiple data centers
- Virtualization via Open Daylight Controller

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Matrix Integration Lab

Virtual Campus 1

- HP12900 VIRTUALIZED DC
- HP5900 DATA CENTER
- HP5406 CAMPUS SWITCH
- HP3800 * BLDG/CAMPUS
- HP2570

- HP560 AC AP

Virtual Campus 2

- HP12900 VIRTUALIZED DC
- HP5900 DATA CENTER
- HP5406 CAMPUS SWITCH
- HP3800 *BLDG/CAMPUS
- HP2570

- HP560 AC AP

OPEN DAYLIGHT CONTROLLERS

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12900 VIRTUALIZED DATA CENTER

High 10GbE, 40GbE and 100 GbE density across 36 Tb/s switch fabric

Defense in Depth-Virtualization

- Both metal and hypervisor based software stacks – appliances. Management of images (real or virtual)
- Separation of control (set up, configuration, security provisions) from function (processing, data)
- Introspection and monitoring of components.
- Secure slices of the Cloud representing different aspects of same application: auditing/introspection

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Cloud Security References

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