Secure Information Sharing for Cyber Response Teams

Cyber Incident Response

Models and Platforms for Information and Resource Sharing

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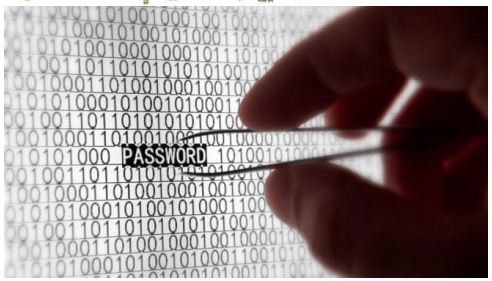
THANKS!

Cyber Incidents

- Recent incidents
  - JPMorgan Chase and 9 other financial institutions
    - >76M households compromised
  - Target, Home Depot, Michaels, Nieman Marcus



Cyber Incident Response

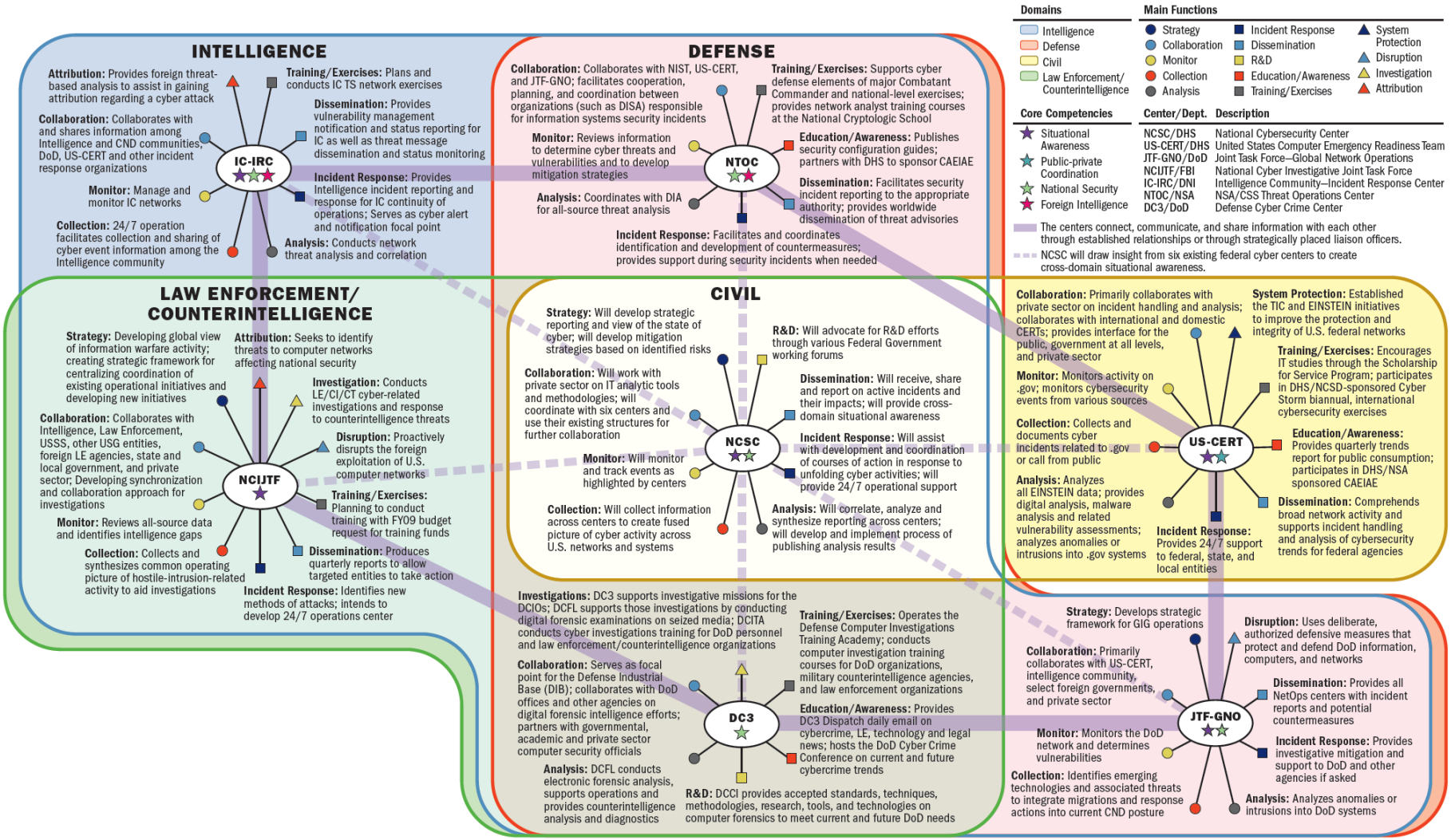
- Information sharing
- Two major challenges
  - Policy
  - Technology

National Information Sharing and Coordination Initiatives

- Inter-agency collaboration and coordination to enhance situational awareness
  - Share malicious activities on federal systems
  - Technologies, tools, procedures, analytics

Ref: http://www.whitehouse.gov/issues/foreign-policy/cybersecurity/national-initiative

National Cybersecurity Center



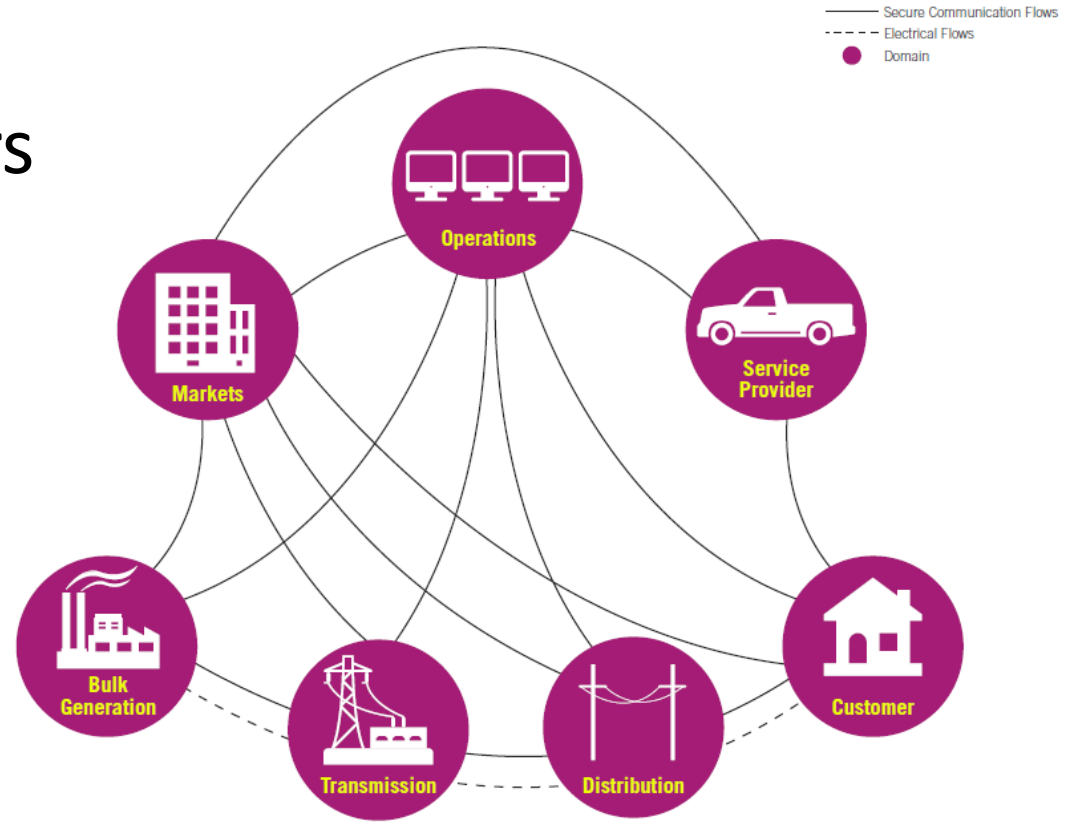
Ref: http://www.whitehouse.gov/files/documents/cyber/CybersecurityCentersGraphic.pdf

Project Scope

- Focus on technical challenges
- Sharing amongst a set of organizations
  - Information, infrastructure, tools, analytics, etc.
  - May want to share malicious or infected code/systems (e.g. virus, worms, etc.)
  - Sensitive
  - Often ad hoc
- What are the effective ways to facilitate sharing in such circumstances?
  - Information sharing models
  - Infrastructure, technologies, platforms

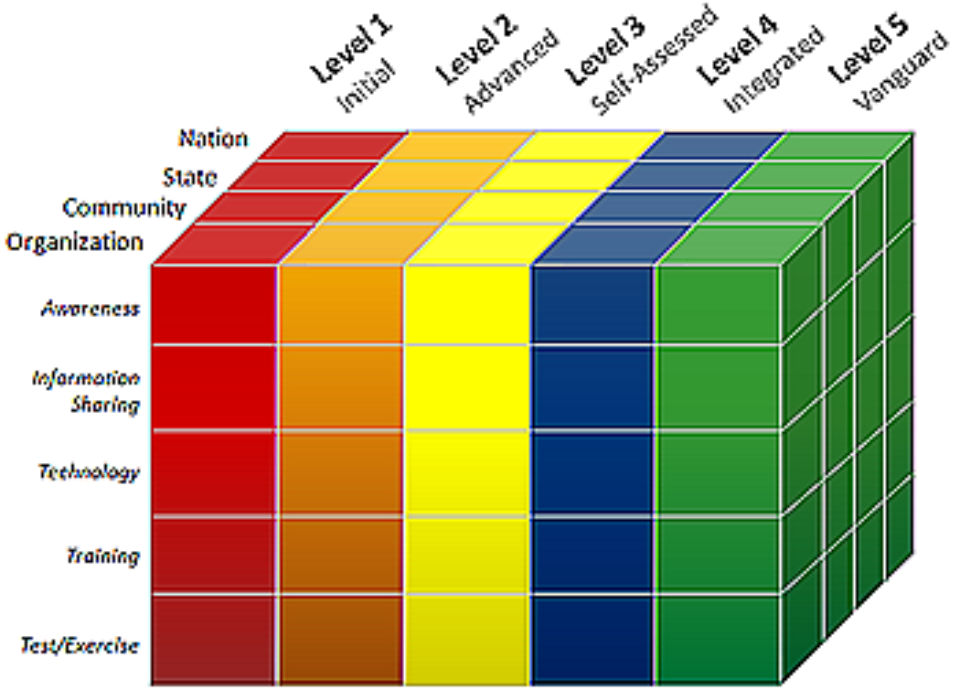
Electric Grid Scenario

- Cyber incidents in electricity providers
  - Local utilities, regional, state, national operators
- Need a standing platform that facilitates sharing
  - Controlled access



Community Scenario

- Cyber incidents across critical infrastructure providers in a community
  - Emergency response, healthcare, banks, utility
- Need a community information sharing platform
  - Controlled access



Community Cyber Security Maturity Model
"Yardstick" to determine current cyber security posture

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Data Exfiltration Scenario

- Unusual file transfers from IP addresses within an org to an external IP address
- Similar activities observed in partner orgs
- Need to find if these events are connected
  - Any correlation between those files?
- Share resources for analysis+collaboration

Key Requirements for Information Sharing

- Cyber infrastructure
- Light-weight and agile
- Rapid deployment and configuration
- Secure isolated environment

Cyber Infrastructure for Sharing

- Traditional platforms
  - Shared storage
    - SharePoint, Dropbox, Google Drive, etc.
  - Shared infrastructure
    - Grid computing
- Modern platform
  - Cloud

Cloud Service Models

Software as a Service (SaaS)

Network accessible software

Platform as a Service (PaaS)

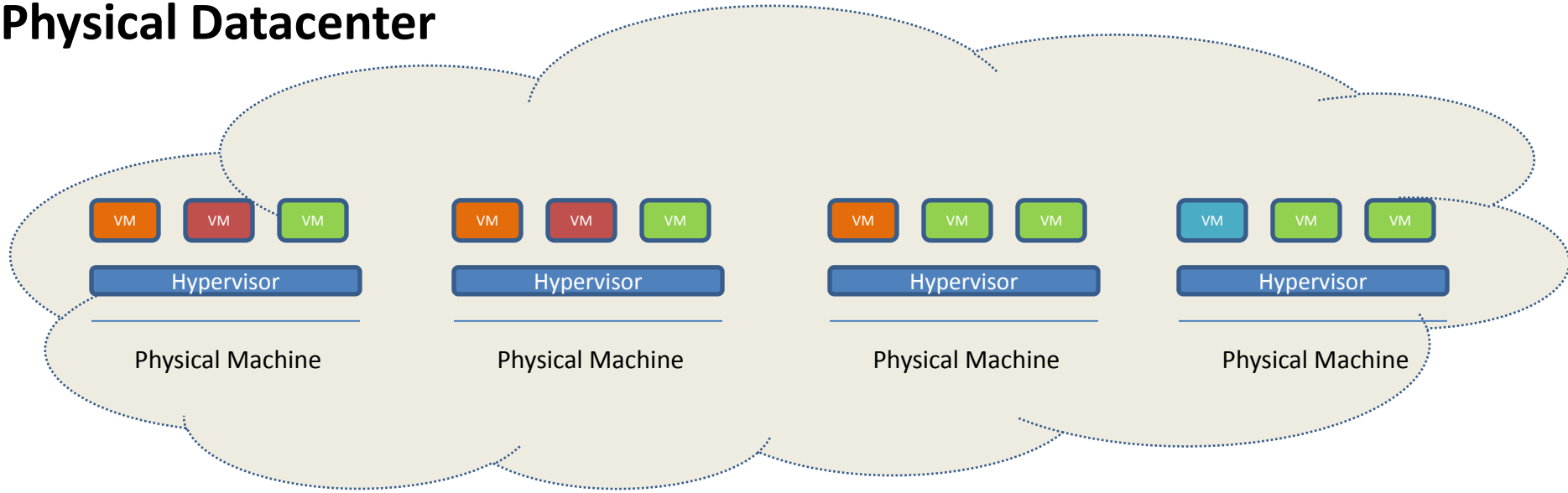
App dev environment with cloud characteristics

Infrastructure as a Service (IaaS)

Virtualized hardware infrastructure

IaaS Cloud

Physical Datacenter



Tenant 1: Need 3 VMs

Tenant 2: Need 3 VMs

Tenant 3: Need 2 VMs

Tenant 2: Need 3 VMs

Tenant 4: Need 1 VM

Each tenant sees a virtual private datacenter

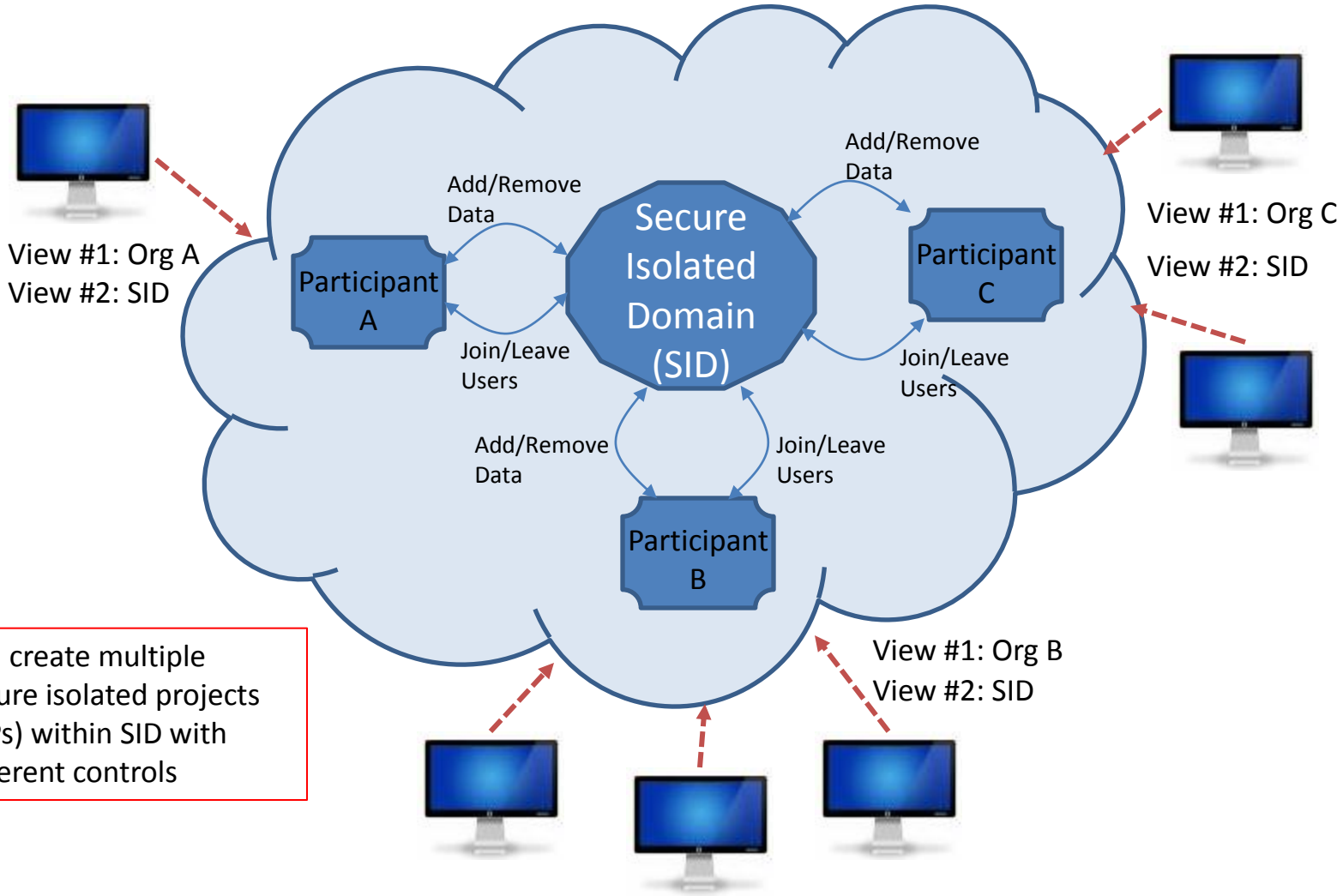
Cloud IaaS Advantages for Cyber Incident Sharing

- Virtualized resources
  - Theoretically, one can take a snapshot and mobilize
- Operational efficiency
  - Light-weight and agile
  - Rapid deployment and configuration
  - Dynamic scaling
  - Self-service

Cloud IaaS Challenges for Cyber Incident Sharing

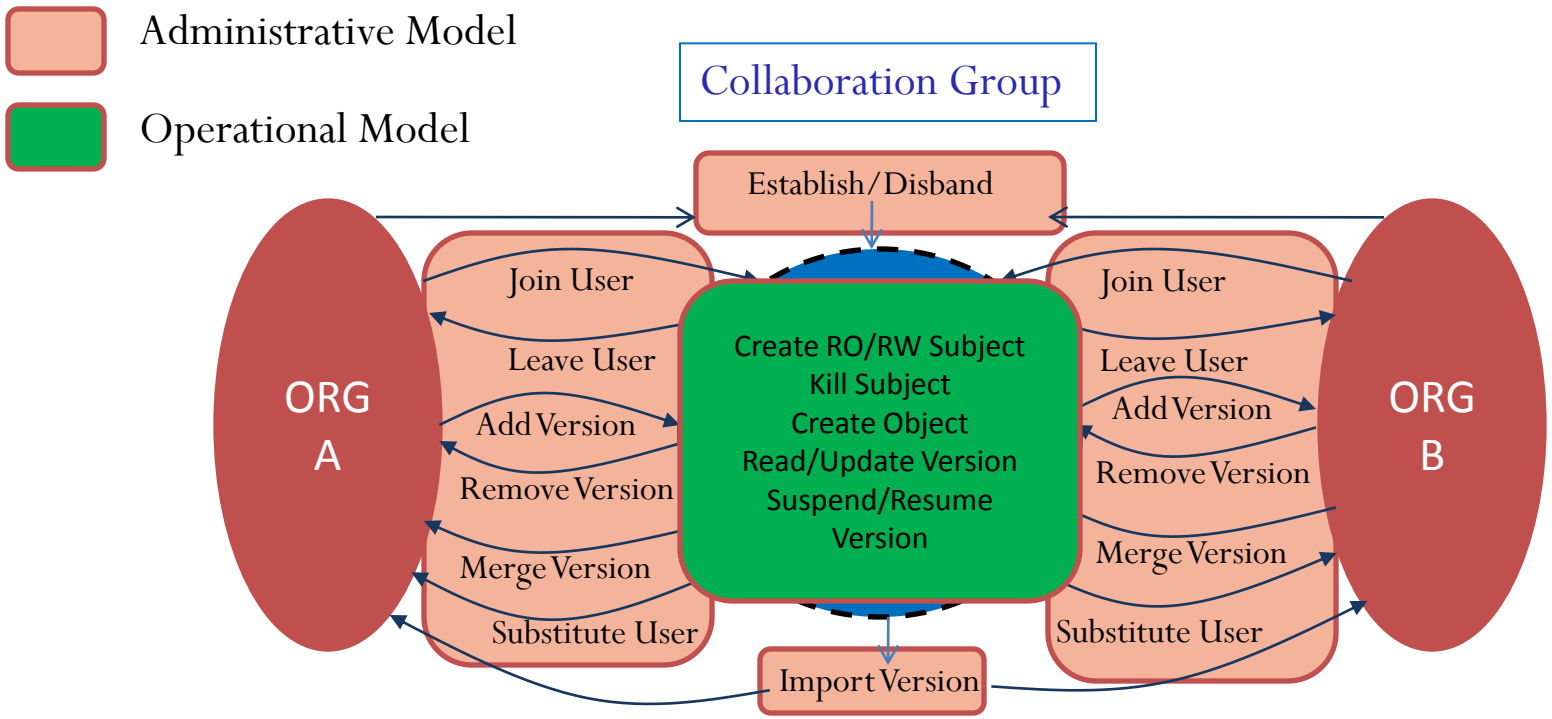
- Tenants are strongly isolated
- IaaS clouds lack secure sharing models
  - Storage
  - Compute
  - Networks
- Need ability to snapshot tenant infrastructure, share, and control who can access
  - Share by copy

Sharing Model in Cloud IaaS

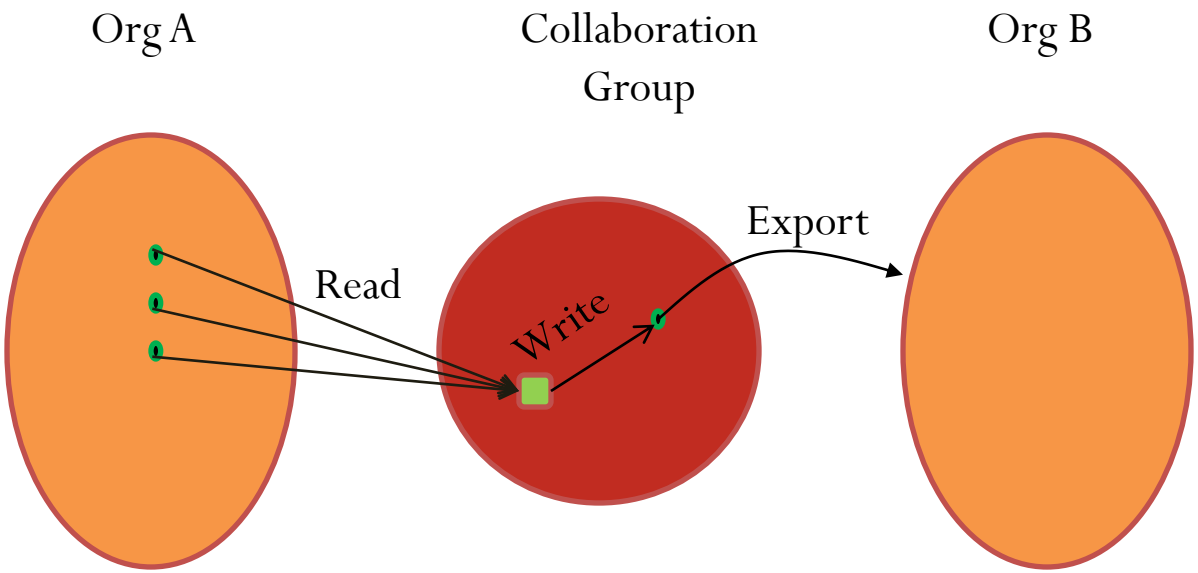


Can create multiple secure isolated projects (SIPs) within SID with different controls

Conceptual Model



Read-only Vs Read-Write Subjects

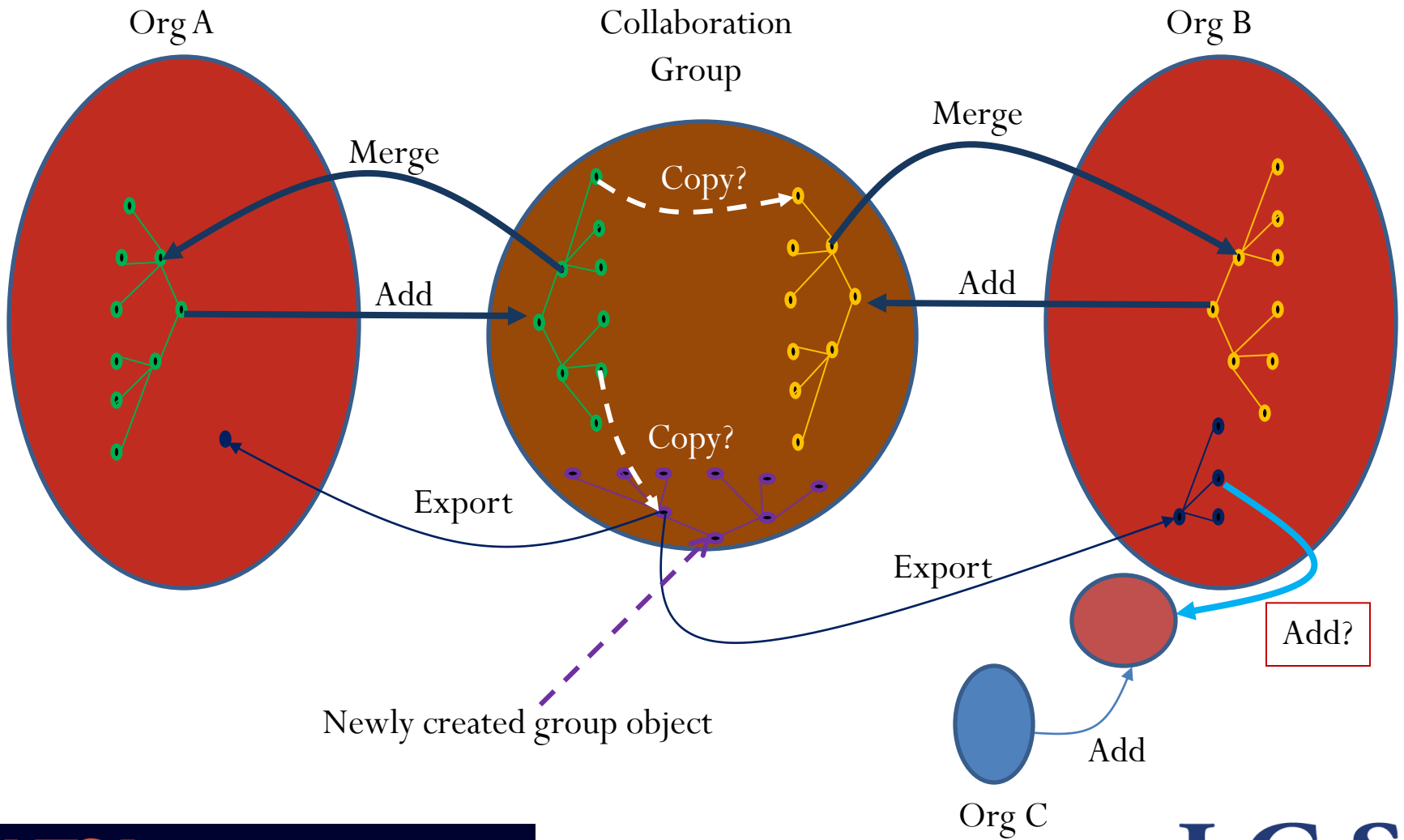


- Read Only subjects can read from multiple groups/entities
- Read-Write subjects restricted to one group

Malicious Group Subject

Object

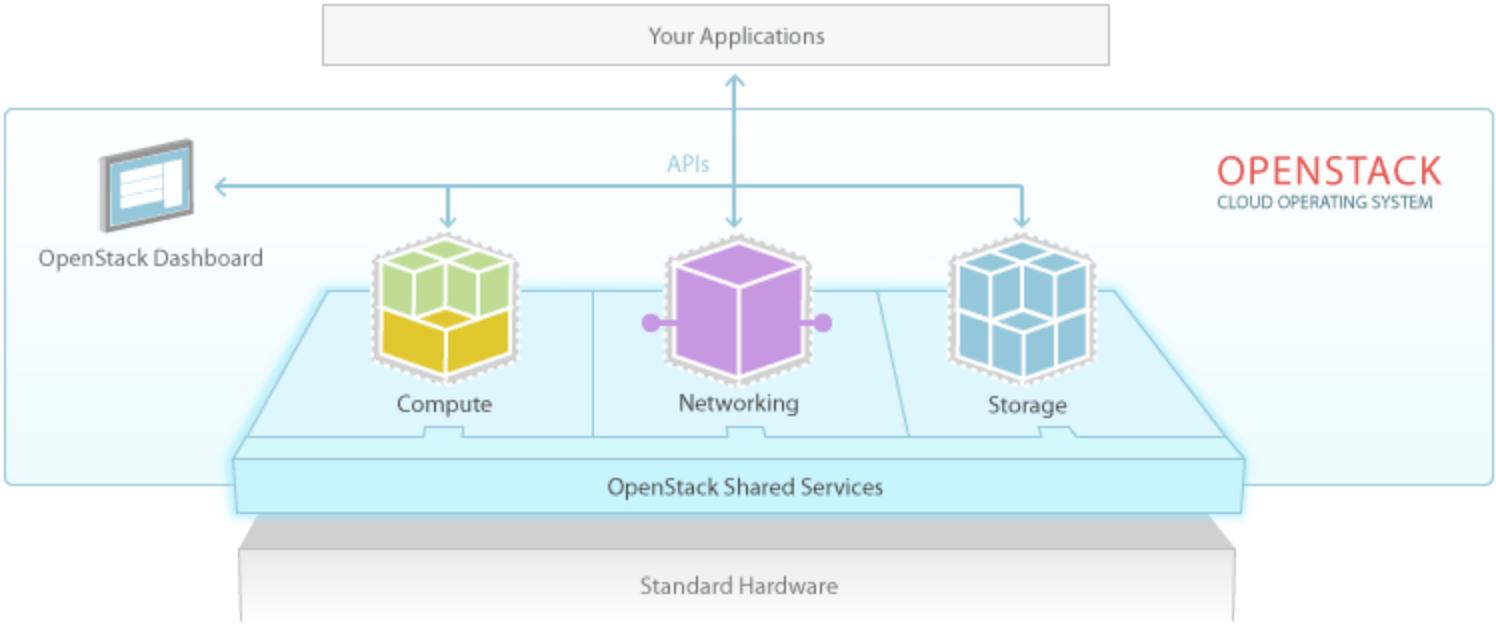
Merge Vs Export of Objects



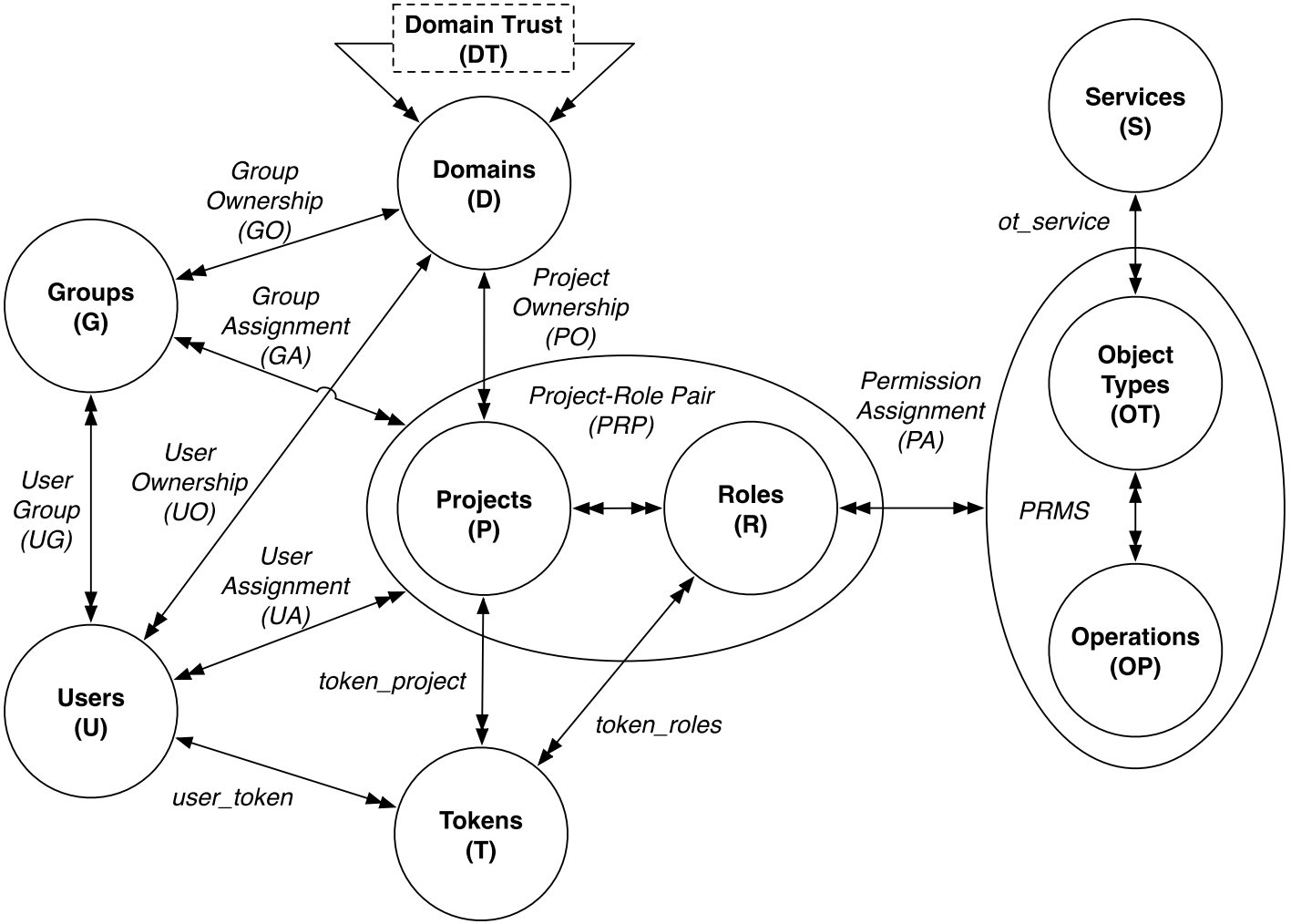
OpenStack

- OpenStack
  - Dominant open-source cloud IaaS software

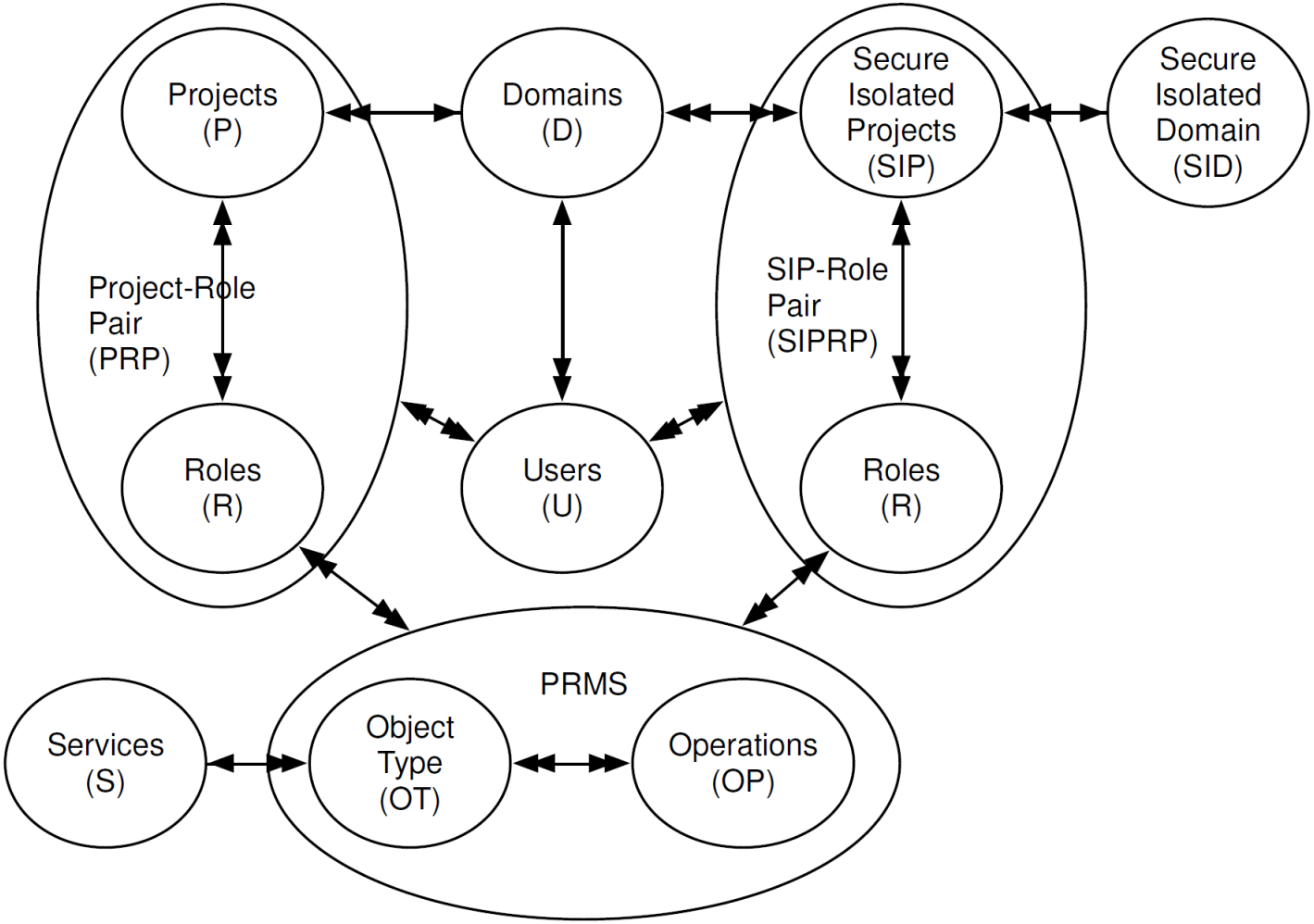
- > 200 companies
- ~14000 developers
- >130 countries



OpenStack Access Control (OSAC)



OSAC-SID


Projects
(P)
Domains
(D)
Secure
Isolated
Projects
(SIP)
Secure
Isolated
Domain
(SID)
Project-Role
Pair
(PRP)
SIP-Role
Pair
(SIPRP)
Roles
(R)
Users
(U)
Roles
(R)
PRMS
Services
(S)
Object
Type
(OT)
Operations
(OP)

OSAC-SID Administrative Model

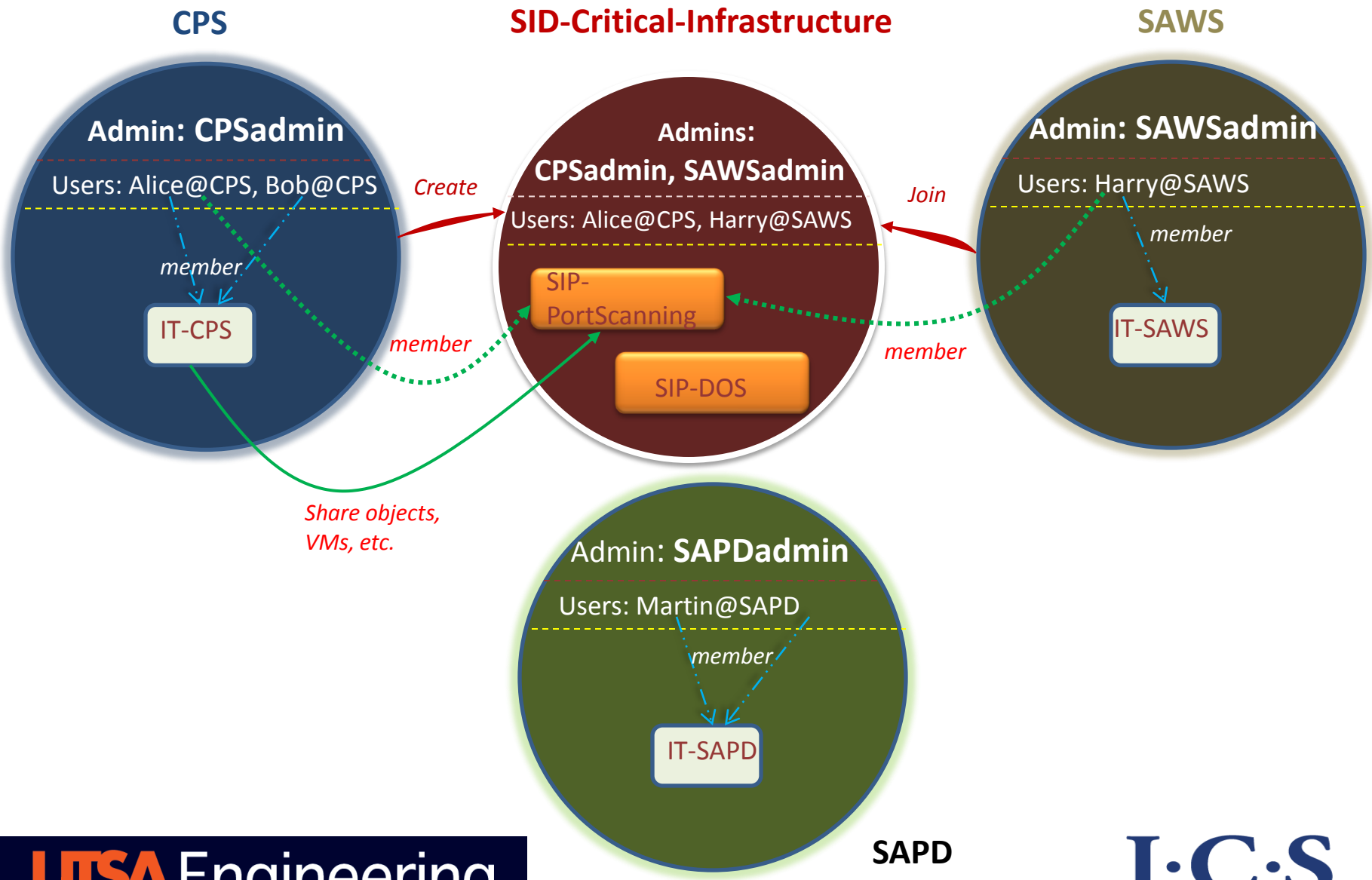
Operation	Authorization Requirement	Update
SipCreate(uSet, sip) */* a set of domain admin users together create a sip */*	∀ u1, u2 ∈ uSet.((DA(u1)=True ∧ DA(u2)=True ∧ u1 ≠ u2 ∧ UO(u1) ≠ UO(u2))) sip ∈ (UNIV_SIP - SIP)	SIPO(sip) = $\bigcup_{\forall u \in uSet}$ UO(u) SIPU(sip) = uSet ∀ u ∈ uSet.SIPA(u) = SIPA(u) ∪ {sip} SIP' = SIP ∪ {sip}
SipDelete(uSet, sip) */* delete the sip*/*	∀ u ∈ uSet.((DA(u)=True ∧ sip ∈ SIPA(u))) ∧ SIPO(sip) = $\bigcup_{\forall u \in uSet}$ UO(u) sip ∈ SIP	SIPO(sip) = NULL SIPU(sip) = NULL ∀ u ∈ uSet.SIPA(u) = SIPA(u) - {sip} SIP' = SIP - {sip}
SidCreate(uSet, sid) */* a set of domain admin users together create a sid */*	∀ u1, u2 ∈ uSet.((DA(u1)=True ∧ DA(u2)=True ∧ u1 ≠ u2 ∧ UO(u1) ≠ UO(u2))) sid ∈ (UNIV_SID - SID)	SIDO(sid) = $\bigcup_{\forall u \in uSet}$ UO(u) SID' = SID ∪ {sid}
SidDelete(uSet, sid) */* delete the sid*/*	∀ u ∈ uSet.((DA(u)=True ∧ sid ∈ SIDA(u))) ∧ SIDO(sid) = $\bigcup_{\forall u \in uSet}$ UO(u) sid ∈ SID	SIDO(sid) = NULL SID' = SID - {sid}
UserAdd(admin, r, u, sip) */* sip admin add a normal user to a sip*/*	sip ∈ SIPA(admin) ∧ DA(admin)=True ∧ UO(admin) ∈ SIDO(sid) ∧ sip ∈ sid ∧ UO(u) = UO(admin) ∧ r ∈ R ∧ sip ∈ SIP ∧ u ∈ U	(u, (sip, r)) ∈ SIPUA ∧ SIPU'(sip) = SIPU(u) ∪ {u}
UserRemove(admin, r, u, sip) */* sip admin remove a normal user from a sip*/*	sip ∈ SIPA(admin) ∧ DA(admin)=True ∧ UO(admin) ∈ SIDO(sid) ∧ sip ∈ sid ∧ UO(u) = UO(admin) ∧ r ∈ R ∧ sip ∈ SIP ∧ u ∈ U ∧ (u, (sip, r)) ∈ SIPUA	(u, (sip, r)) = NULL ∧ SIPU'(sip) = SIPU(u) - {u}
CopyObject(u, so1, c1, p, d, so2, c2, sip, sid)	so1 ∈ SO ∧ c1 ∈ C ∧ p ∈ P ∪ SIP ∧ d ∈ D ∪ SID ∧ so2 ∈ (UNIV_SO - SO) ∧ c2 ∈ C ∧ sip ∈ P ∪ SIP ∧ sid ∈ D ∪ SID ∧ (so1, c1) ∈ SOO ∧ (c1, p) ∈ CO ∧ (p, d) ∈ PO ∪ SIPO ∧ (c2, sip) ∈ CO ∧ (sip, sid) ∈ PO ∪ SIPO ∧ u ∈ U ∧ (u, (p, r)) ∈ UA ∧ (u, (sip, r)) ∈ SIPUA)	SO' = SO ∪ {so2} SOO' = SOO ∪ {(so2, c2)}

† uSet: a set of domain admin users.

OSAC-SID Operational Model

Operation	Authorization Requirement	Update
Nova:		
CreateVM(vm, sip, u)	vm ∈ (UNIV_VM - VM) ∧ sip ∈ SIP ∧ u ∈ U ∧ ∃ (perms, r) ∈ PA.(perms = (vm, create) ∧ (u, (sip, r)) ∈ SIPUA)	VM' = VM ∪ {vm} VMO' = VMO ∪ {(vm, p)}
DeleteVM(vm, sip, u)	vm ∈ VM ∧ sip ∈ SIP ∧ u ∈ U ∧ ∃ (perms, r) ∈ PA.(perms = (vm, delete) ∧ (u, (sip, r)) ∈ SIPUA)	VM' = VM - {vm} VMO' = VMO - {(vm, p)} vm = NULL
Swift:		
CreateContainer(c, sip, u)	c ∈ (UNIV_C - C) ∧ sip ∈ SIP ∧ u ∈ U ∧ (u, (sip, r)) ∈ SIPUA)	C' = C ∪ {c} CO' = CO ∪ {(c, p)}
DeleteContainer(c, sip, u)	c ∈ C ∧ sip ∈ SIP ∧ u ∈ U ∧ (u, (sip, r)) ∈ SIPUA)	C' = C - {c} CO' = CO - {(c, p)} c = NULL
UploadObject(so, c, sip, u)	so ∈ UNIV_SO ∧ c ∈ C ∧ sip ∈ SIP ∧ u ∈ U ∧ (u, (sip, r)) ∈ SIPUA) if ∃ so' ∈ SO. (so = so'), then so' = so	SO' = SO ∪ {so} SOO' = SOO ∪ {(so, c)}
DownloadObject(so, c, u, p)	so ∈ SO ∧ c ∈ C ∧ sip ∈ SIP ∧ u ∈ U ∧ (u, (sip, r)) ∈ SIPUA)	
DeleteObject(so, c, sip, u)	so ∈ SO ∧ c ∈ C ∧ sip ∈ SIP ∧ u ∈ U ∧ (u, (sip, r)) ∈ SIPUA)	SO' = SO - {so} SOO' = SOO - {(so, c)} so = NULL

SID and SIP in OpenStack



Key Accomplishments (1)

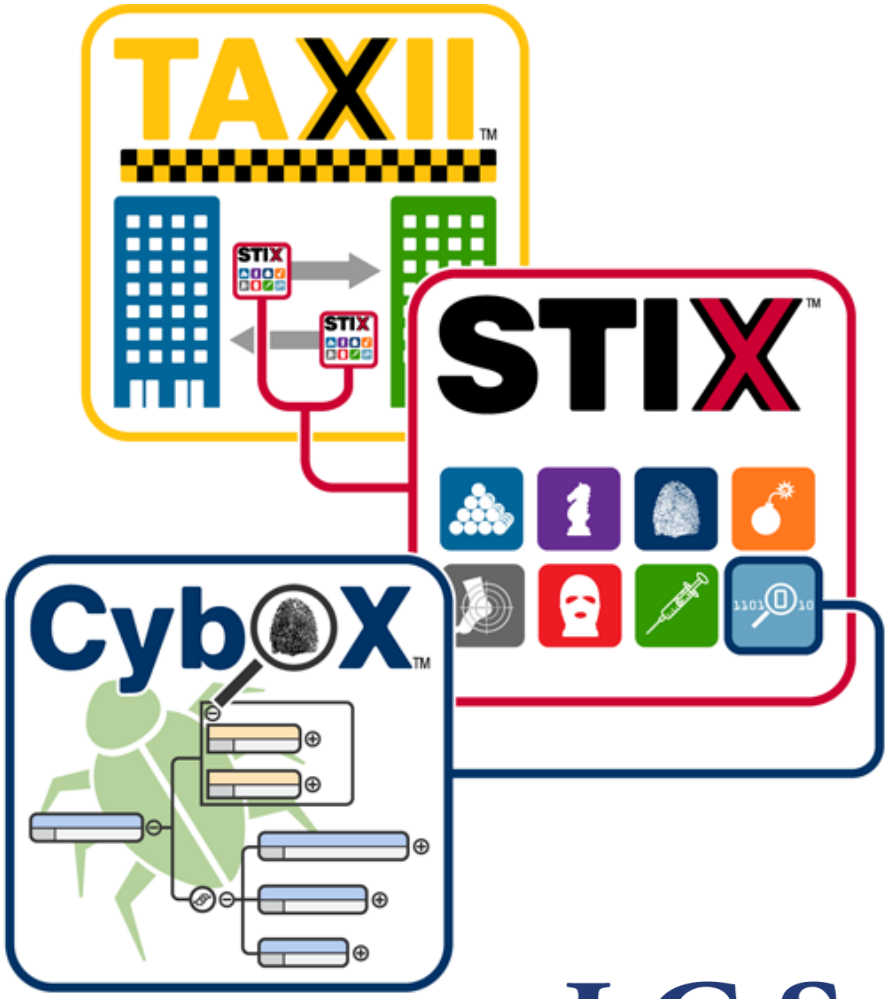
- Developed sharing models
  - Formal specification
  - Cloud-based instantiation
- Enhanced OpenStack with SID/SIP capabilities
  - Cyber incident response capabilities out of the box
    - Self-service
    - SID/SIP specific security
    - Share data, tools, etc. in an isolated environment
    - Ability to execute and analyze malicious code in an isolated environment
  - Practitioners can deploy a “cyber incident response” cloud
  - Potential blueprint for official OpenStack adoption

Key Accomplishments (2)

- Initial work published in Association for Computing Machinery (ACM) Workshop on Information Sharing and Collaborative Security (WISCS '14)
  - To be presented on November 3, 2014 in Scottsdale, AZ
  - Potential dissertation topic for Amy Zhang, PhD Candidate

Next Steps (1)

- Integrate STIX-TAXII in SID
  - Information Sharing Specifications for Cybersecurity
- Trusted Automated eXchange of Indicator Information (TAXII)
- Structured Threat Information eXpression (STIX)
- Cyber Observable eXpression (CybOX)



Next Steps (2)

- Fine-grained and expressive access control
- Hardened SID/SIP
- User-friendly interface for management
- Develop cyber incident response lifecycle management in cloud
  - Prepare, share, detect & analyze, contain/eradicate, post-incident activity, etc.

Thanks

- Comments, Q&A