Composable Formal Models for High-Assurance Fault Tolerant Networks

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People

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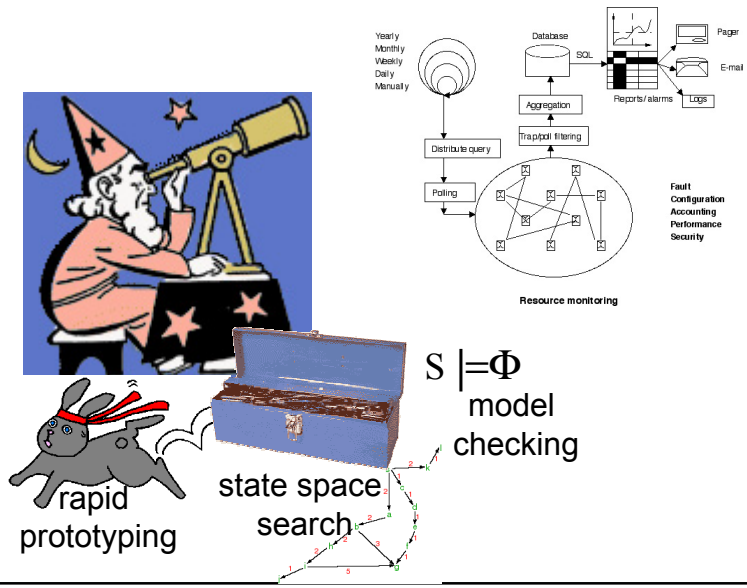
Composable Formal Models for High-Assurance Fault Tolerant Networks



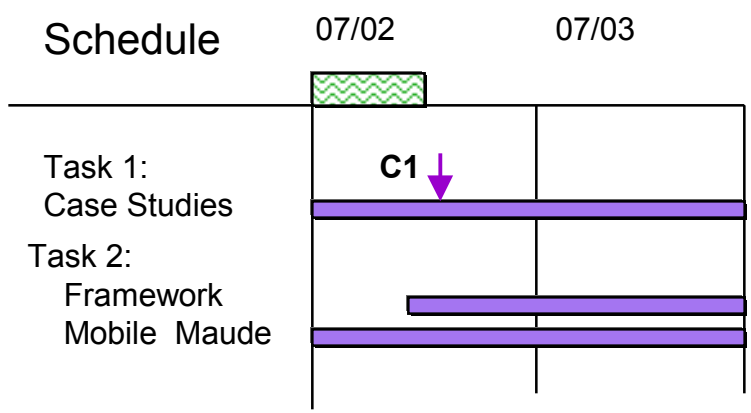
New Ideas

- Libraries of formal models of attacks
- Formal executable framework for reflective systems
- Formal test bed for design of network reconstitution and recovery services

Impact

- Sound principles for composition of network reconstitution and recovery services
- Higher assurance for FTN protocols and algorithms
- Compliment red team efforts to harden systems

Schedule



SRI International: Carolyn Talcott
University of Illinois Urbana-Champaign: José Meseguer

Some Possible Case Studies

- ♣ Proxy-based Distributed Systems
  - secure distribution of component based systems
- DDOS models
  - formal attack models, formal v&v?
- Secure Spread (Maude + uCAPSL)
  - is it secure?
  - is the group semantics preserved?
- TIARA project
  - intrusion tolerance for ad hoc networks
- Distributed/replicated databases
  - formal verification of core algorithms
  - reuse to verify DB specific optimizations

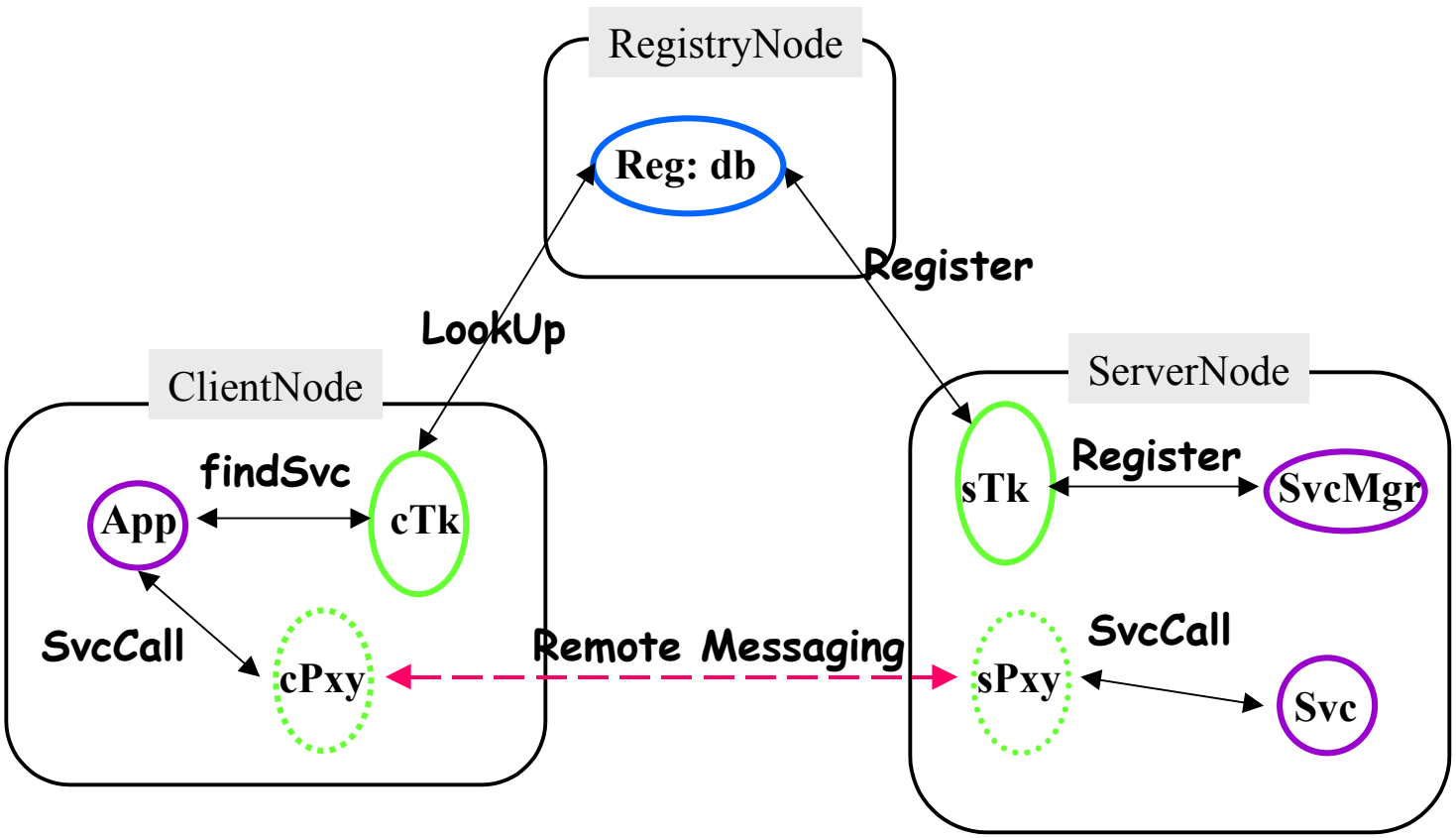
Analysis of Secure Proxy Toolkit

In collaboration with DC project

Securing Proxy-based Distributed Systems

John Mitchell, Ninghui Li, Derrick Tong
Stanford

Proxy based distributed service
End2end view



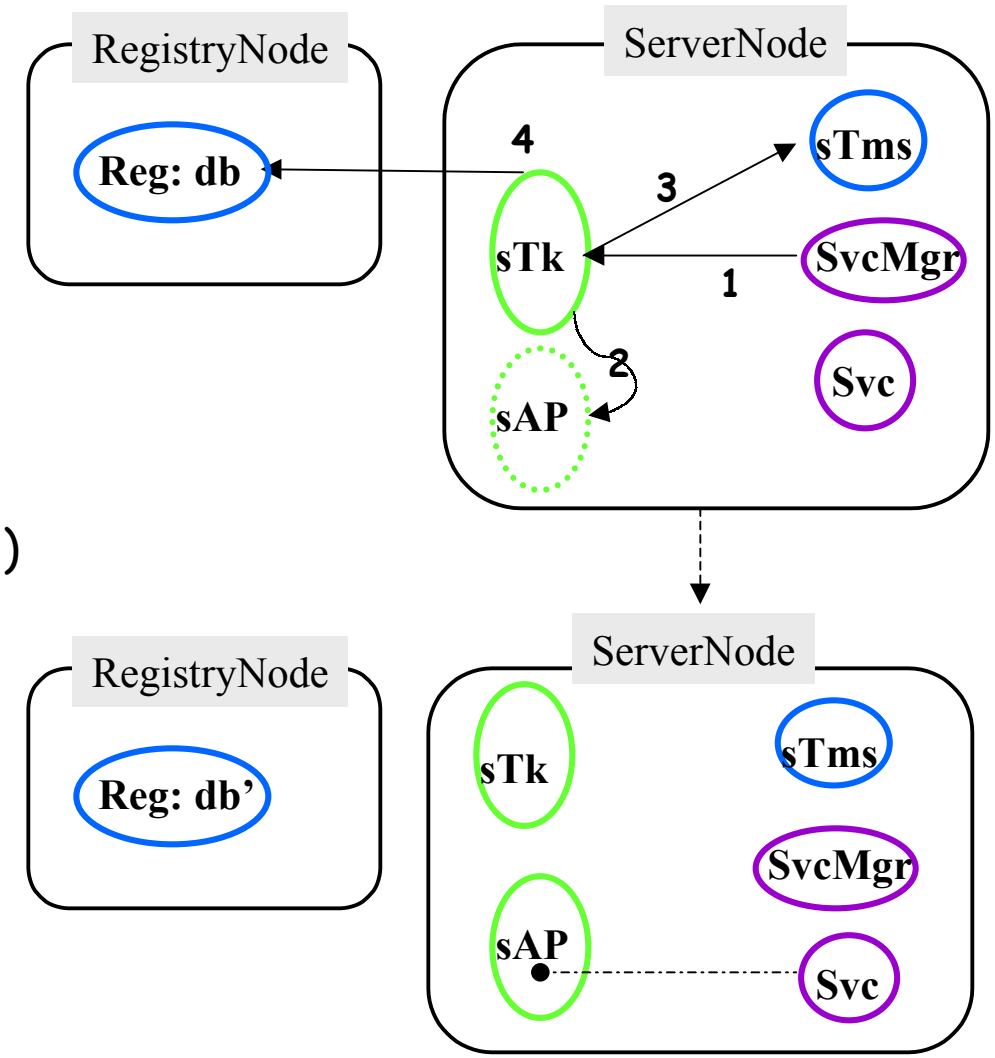
Security Goals

- Client VM protected from evil proxy
- Secure communication between client and server proxies
- Client should be able to authenticate service proxy
- Server should be able to authenticate client

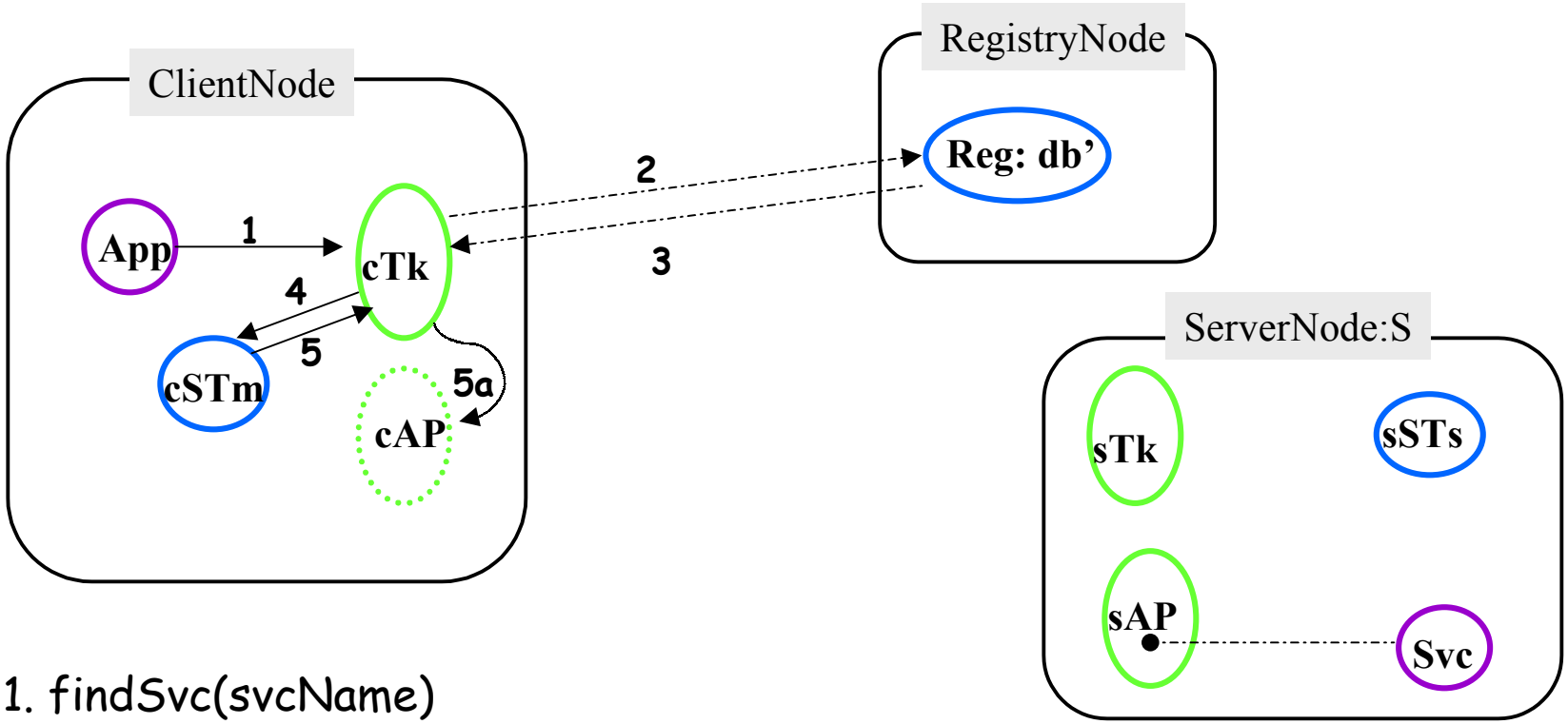
The Secure Proxy Toolkit in Pictures

Registering a signed secure proxy

1. RegReq(svcName,Svc)
2. create(sAP)
3. sign(cAPd)
4. register(svcName,signedcAPd)



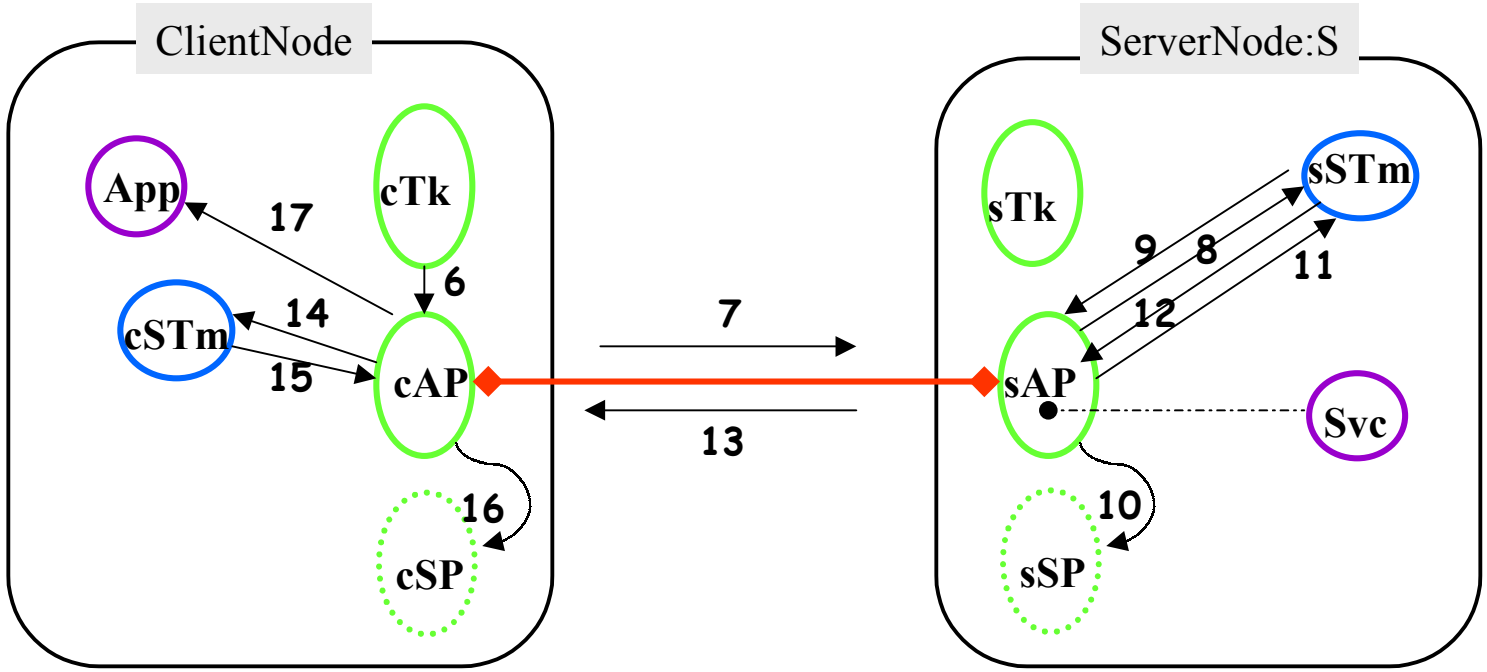
Getting an authentication proxy



1. findSvc(svcName)
2. lookup(svcName)
3. reply(signedcAPd)
4. verify(signedcAPd,tsK)
5. ok(apxd)
5a. install(apxd)

♦ must check description!

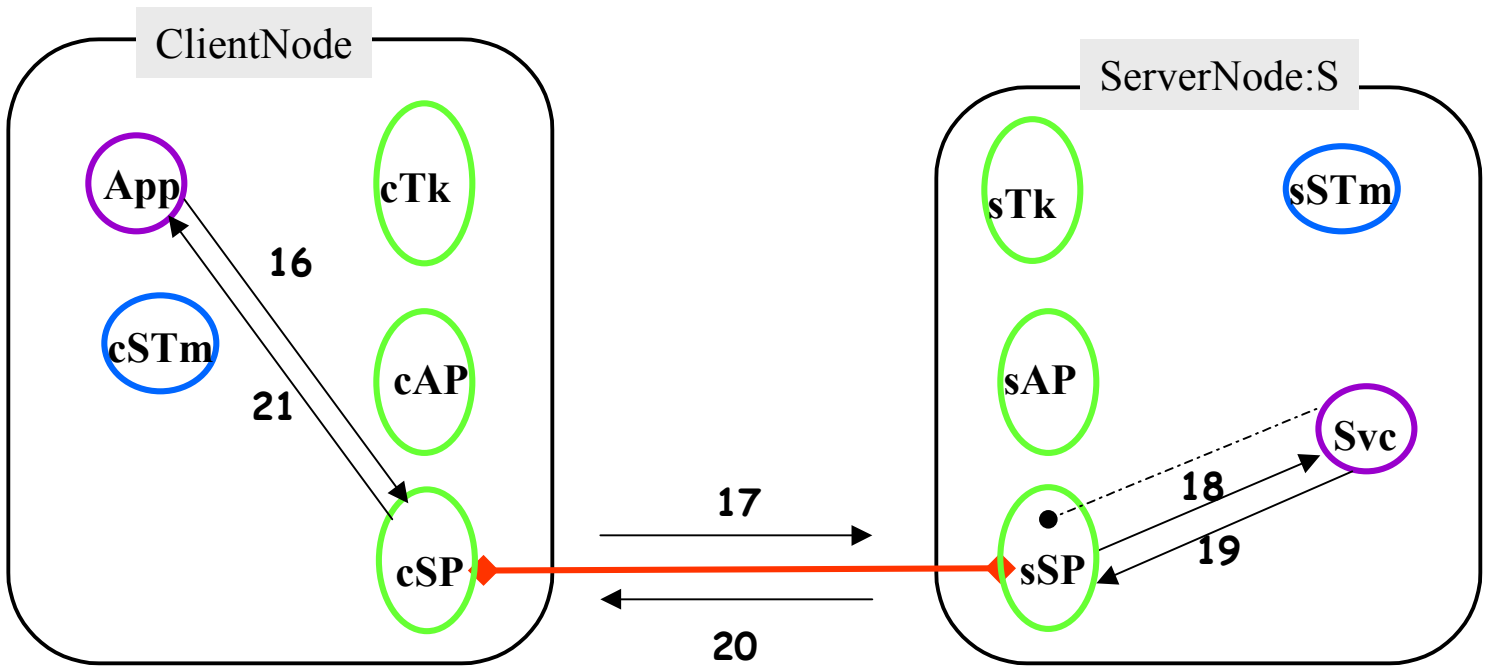
Setting up a secure session



6. authenticate(ccred)
6a. setup secure cnx ---
7. authenticate(ccred)
8. checkClient(ccred,svcName)
9. clientOk(perms)
10. install(sspd)

11. encryptReq(csspd,ccred)
12. encrypted(csspd,ccred)
13. encrypted(csspd,ccred)
14. decrypt(encrypted(csspd,ccred))
15. ok(csspd)
16. install(csspd)
17. findSvcReply(cSP)

Accessing the service



16. serviceCall(args)
17. serviceCall(args)
18a. check(args,per)
18. serviceCall(args,cId)

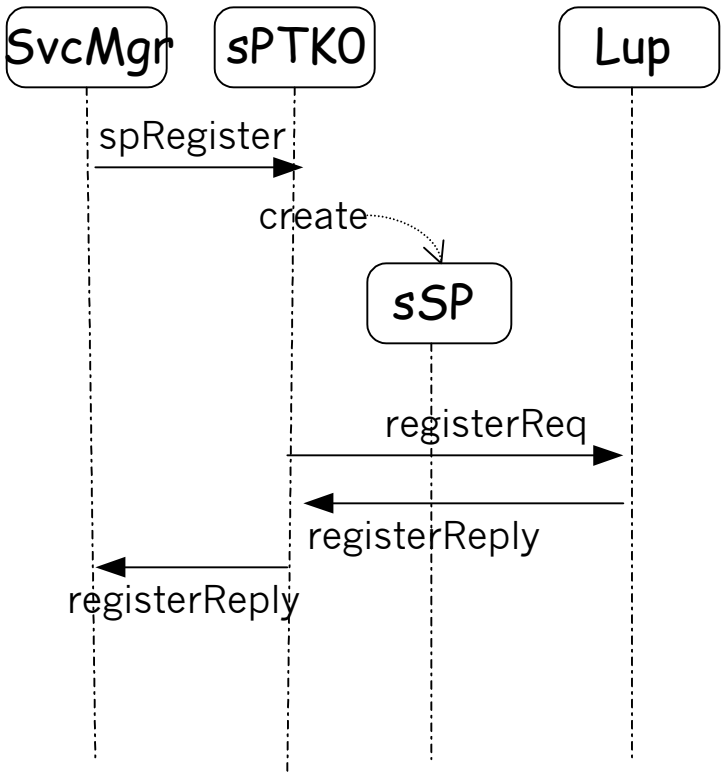
19. serviceReply(result)
20. serviceReply(result)
21. serviceReply(result)

Proxy Toolkit Models
4 levels of security

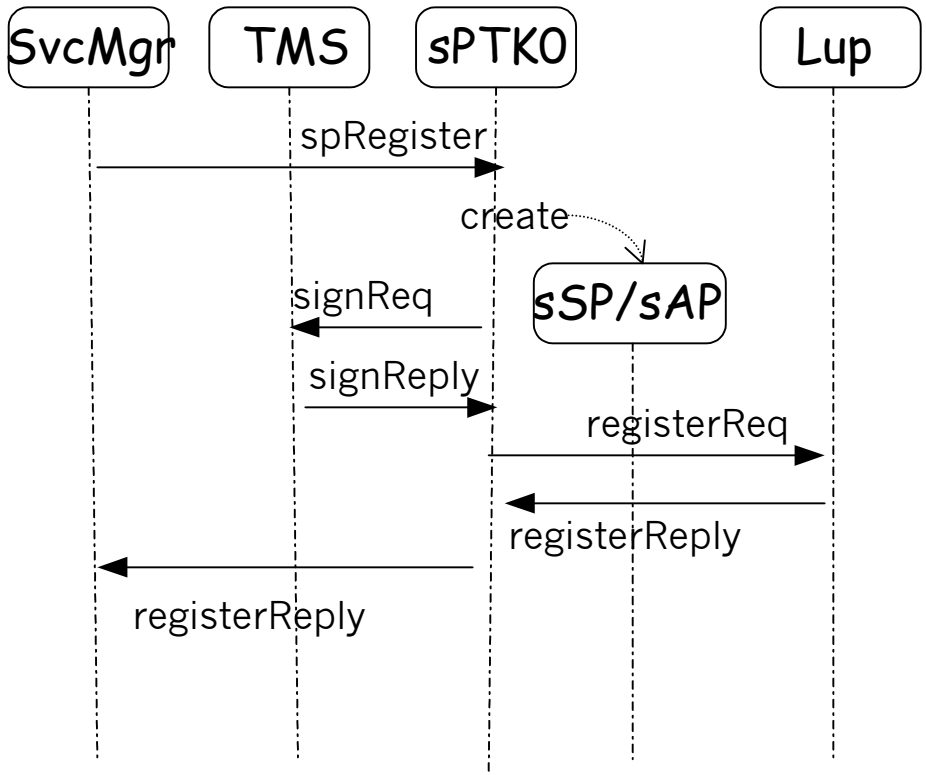
- Level 0 -- naive proxy (just does rmi)
- Level 1. naive proxy enhanced with secure communication
- Level 2[t,f]. signed proxy
  - [with,without] checking proxy service name
- Level 3. signed proxy with authentication
  (and secure session)

Registering a service

Levels 0,1

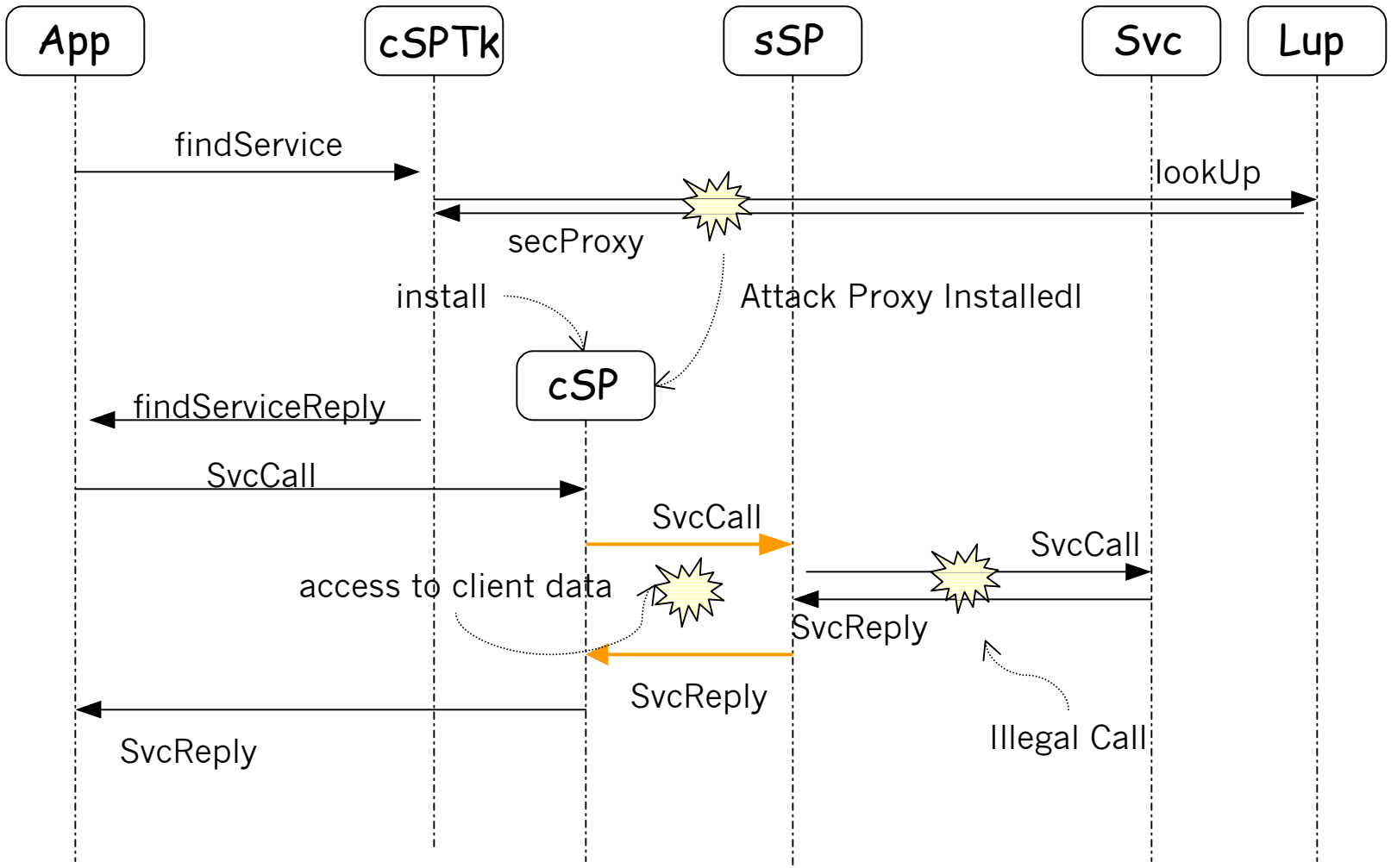


Levels 2,3



Levels differ in choice of proxy behavior

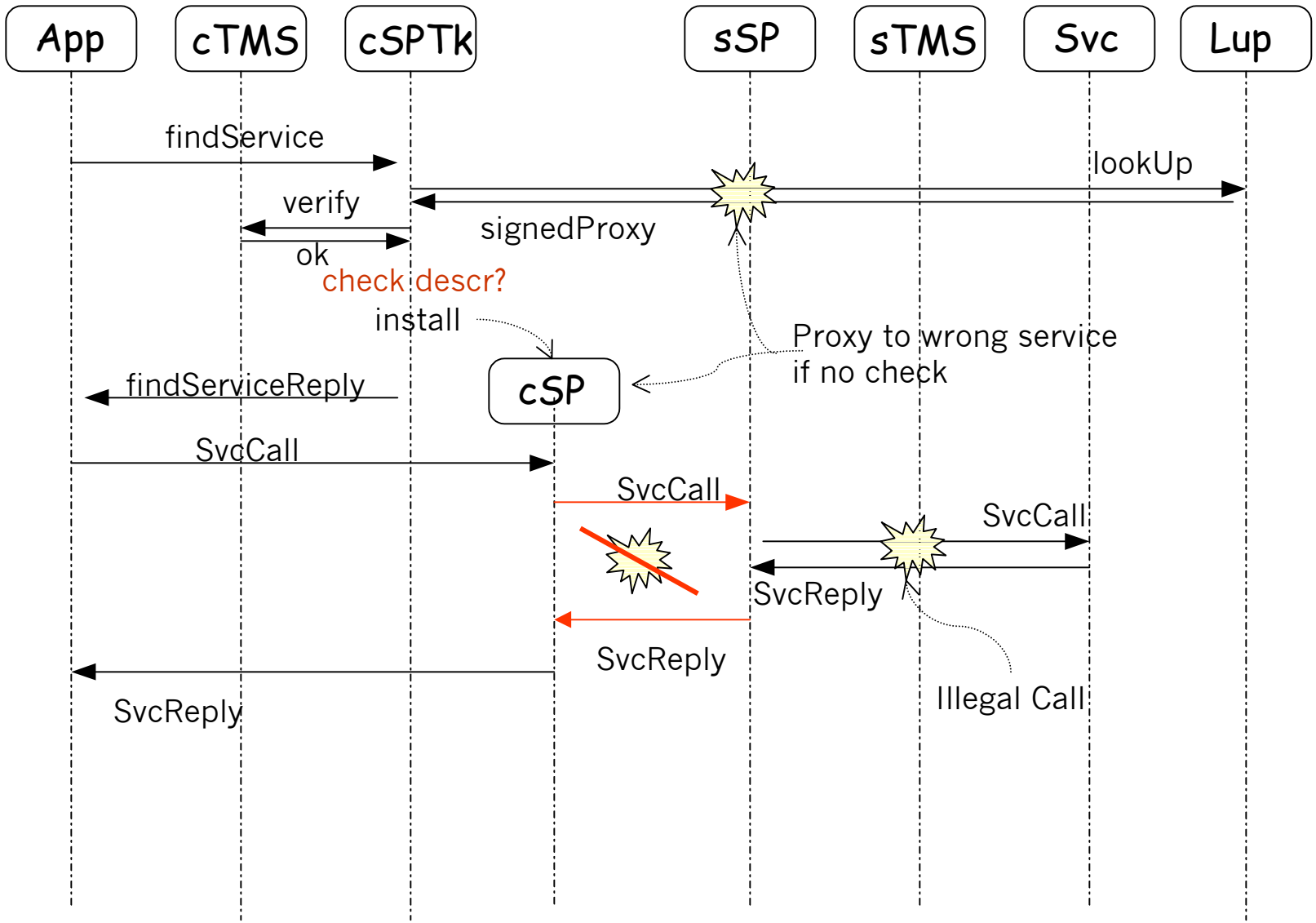
Scenario -- finding and using a service via Level 0,1 PTK



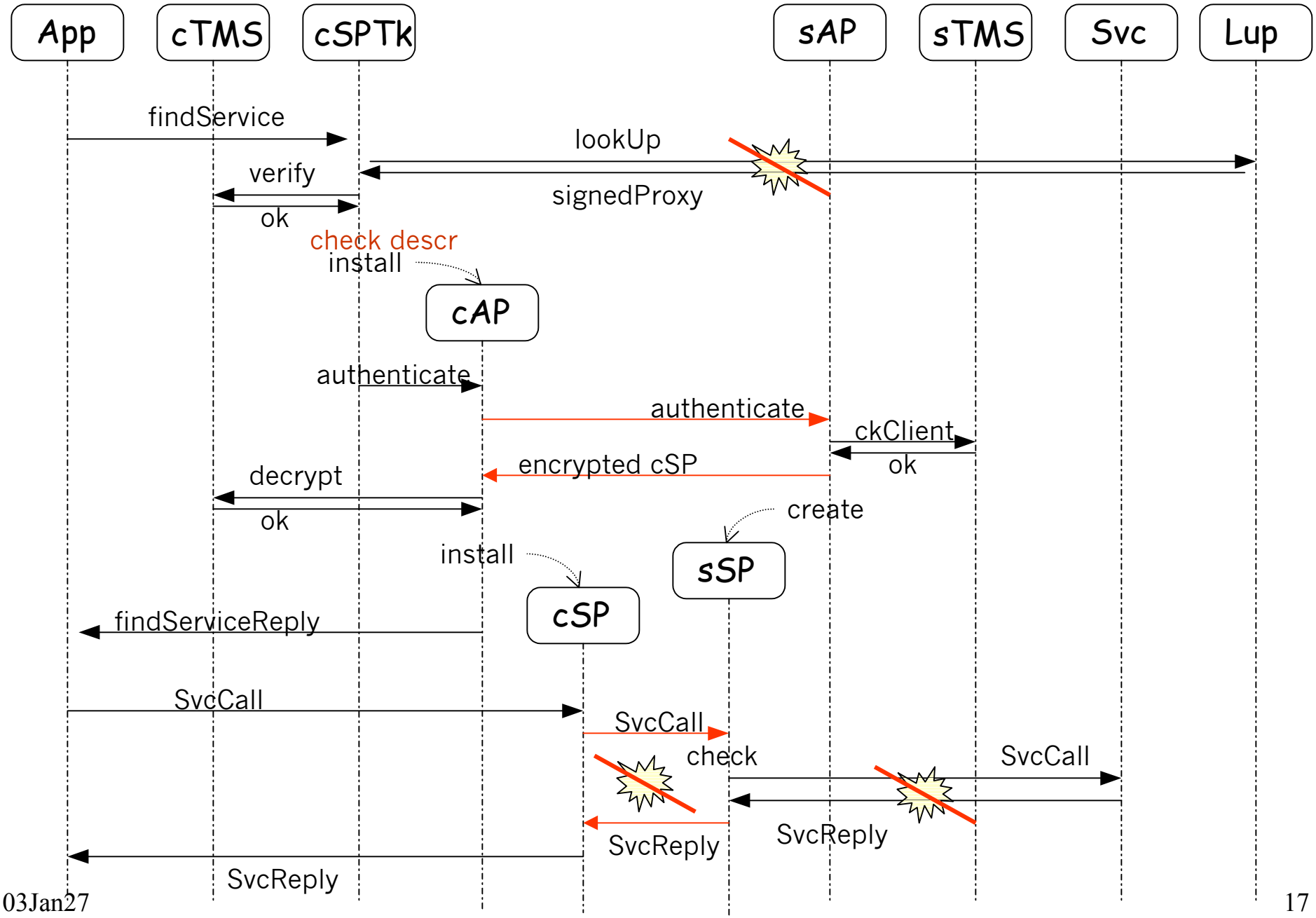
clear in level 0, secure in level 1

point of attack

Scenario -- finding and using a service via Level 2 PTK



Scenario -- finding and using a service via Level 3 PTK



Attack Model I

1. Attacker in the ether + independent imposter

Properties checked:

- 1.1 attacker see/modify client data
  - sent as service arguments or received as reply
- 1.2 attacker replace registered proxy
- 1.3 illegal or unauthorized service call
- 1.4 client imposter succeeds

Summary of analyses attacker in net

Property:	1.1 msg attack	1.2 replace proxy	1.3 illegal call	1.4 imposter succeeds
Level 0	yes	yes	yes	yes
Level 1	no	yes	yes	yes
Level 2f	no	yes	yes	yes
Level 2t	no	no	yes	yes
Level 3	no	no	no	no

yes/no Property holds/not

Attack Model II

2. Attacker controls Lookup node

Properties checked:

- 2.1 client app can get proxy to requested/registered service (sanity check)
- 2.2 client app accepts proxy to attacker service
- 2.3 client app accepts wrong proxy
- 2.4 service integrity violated

Summary of analyses
compromised registry

Property:	2.1 sanity check	2.2 bad proxy	2.3 wrong proxy	2.4 impersonate
Level 0	yes	yes	yes	yes
Level 1	yes	yes	yes	yes
Level 2f	yes	no	yes	yes
Level 2t	yes	no	no	yes
Level 3	yes	no	no	no

yes/no Property holds/not

What Next

- TIARA intrusion tolerance for ad hoc networks
  - abstract router and network model
  - composing - router, TIARA, TCP/IP layer

- DDOS models (JHU/APL)
  - attacks with classification mitigagtion technology
  - TCP SYN flood attack / Synkill active monitoring

- Secure Spread (Maude + uCAPSL)
  - abstract spread network model
  - compose with Cliques model