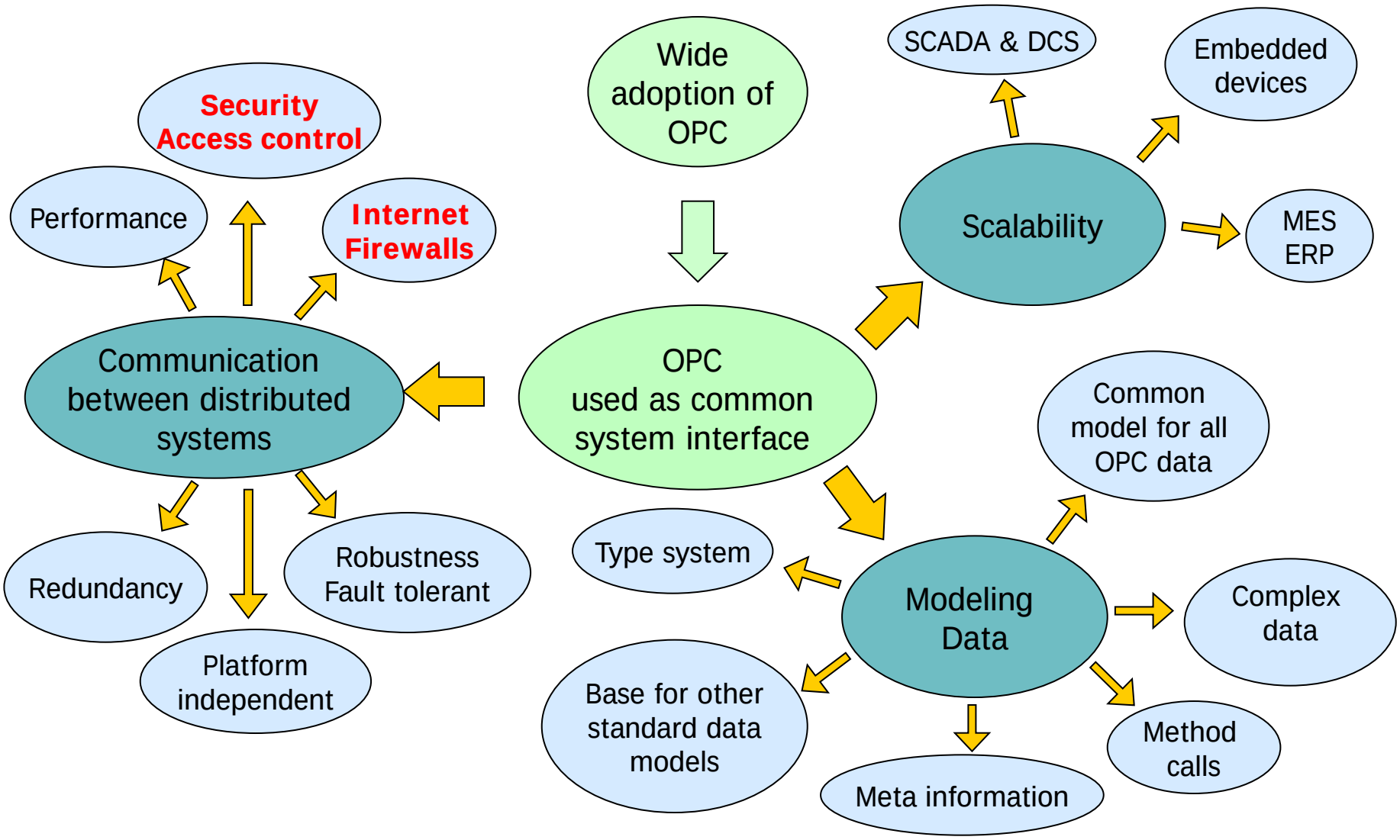
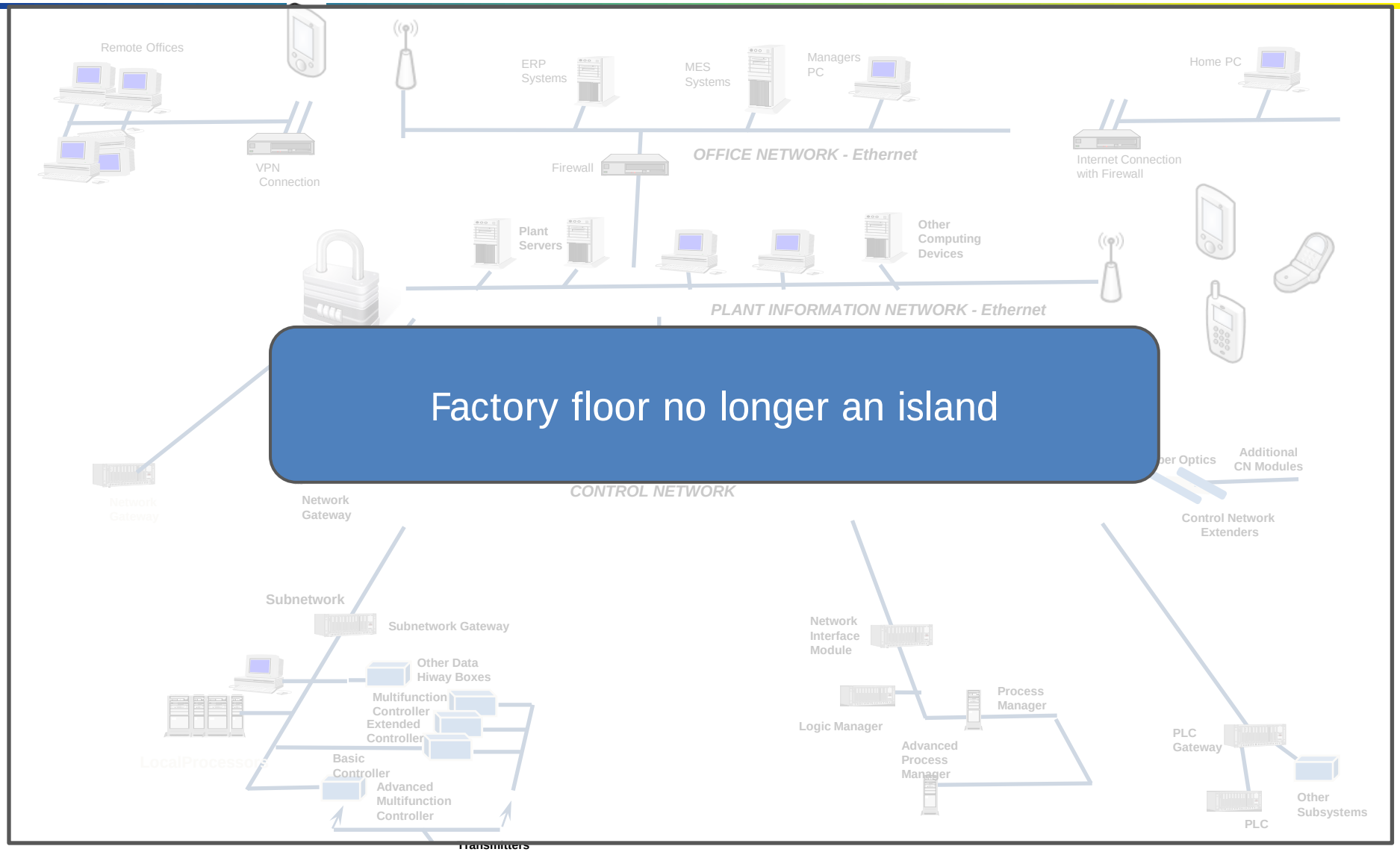
Security

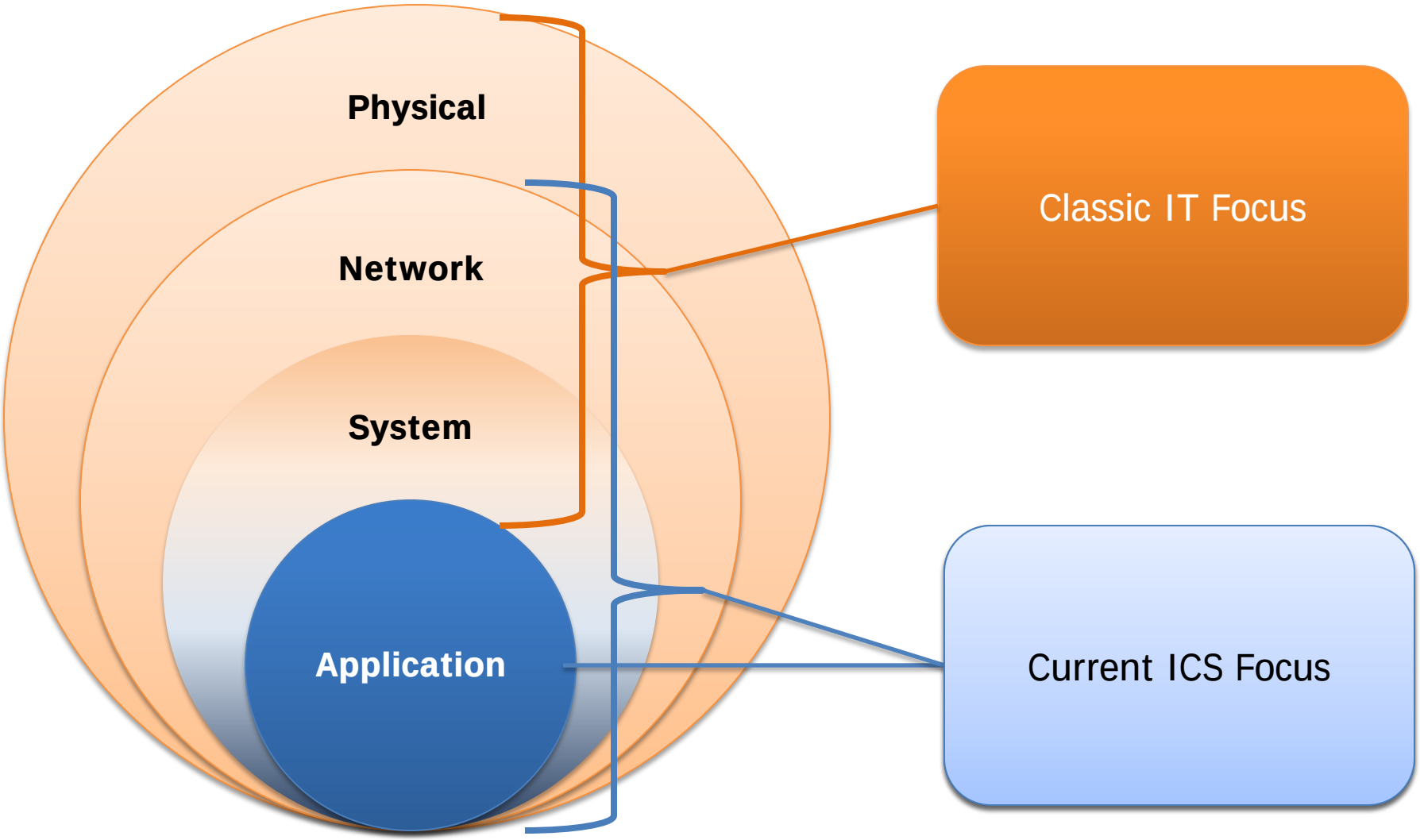
OPC UA - Security



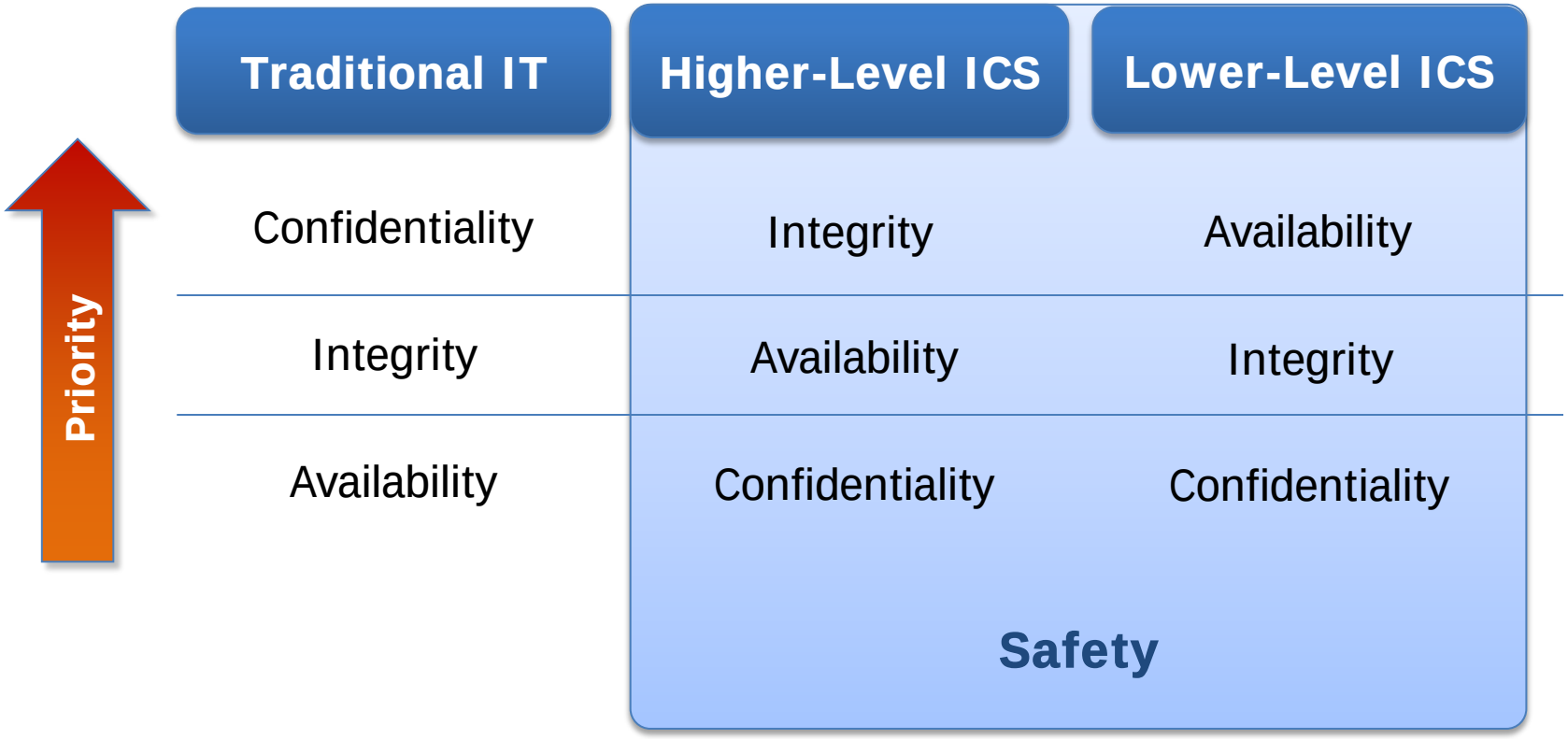
Security Yesterday and Today



Cyber Security – Multiple Aspects

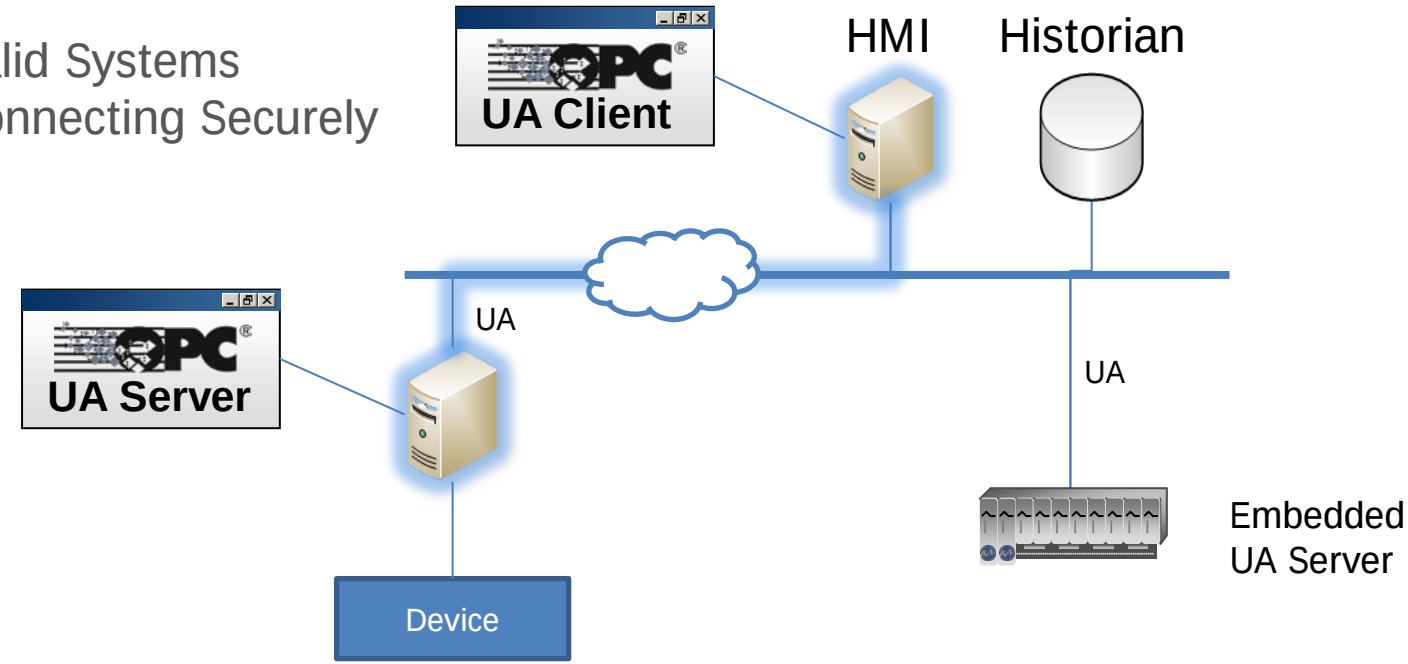


Implications: ICS meets IT



OPC UA Goal: Secure Data Connectivity

Valid Systems
Connecting Securely



Authorized Users
Gaining Access

Challenge: How To Keep It Secure

Must uphold:

How?

- Build standard with security in mind
- Use industry accepted standards & best practices (Ex. WS-*,NERC, ISA99, NIST…)
- Keep it flexible: Account for evolution

Key Security Factors

1. Should the Client and Server trust each other?
2. Should the Server trust the current user of a trusted application (Client)?
3. How can the data be protected?
4. Is there a trace of what happened?

Secure Communications

Backgrounder

Security Backgrounder

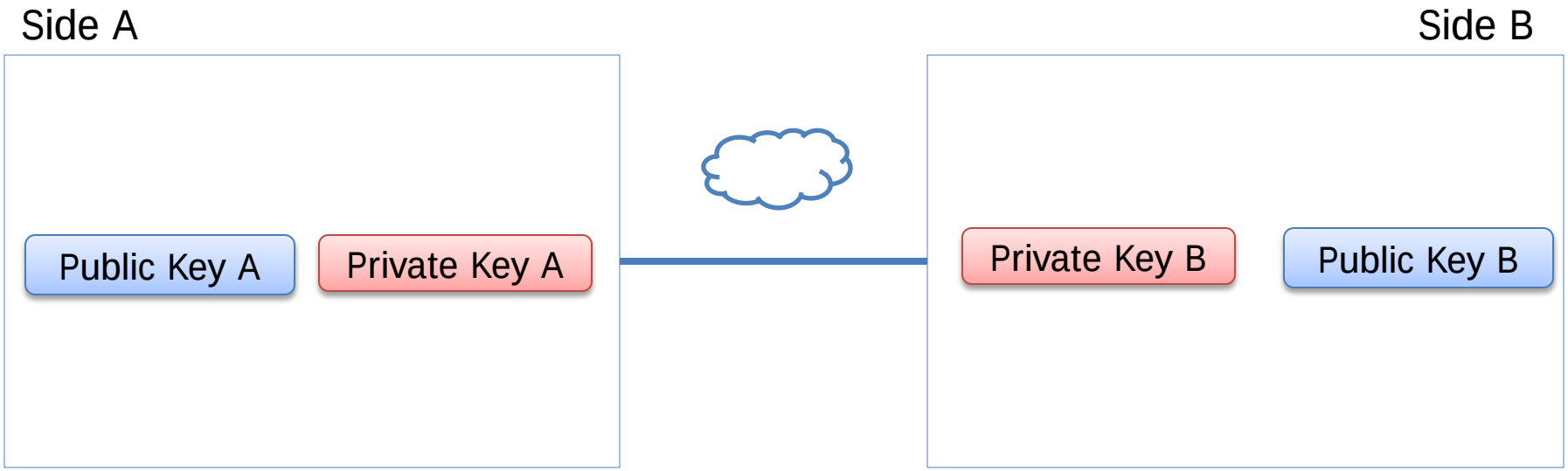
Physical Security

Digital Security

Physical Security	Digital Security
Physical Keys & Locks	Cryptographic Keys & Algorithms
Keys - Physical Locks - Physical	Keys - Large Prime numbers (hard to guess) Locks - Cryptographic Algorithms
Lock & Unlock	Encrypt & Decrypt
Block Access, protect contents	Block Access, protect contents, prove identity

Topic 1: Establish Secure Communication

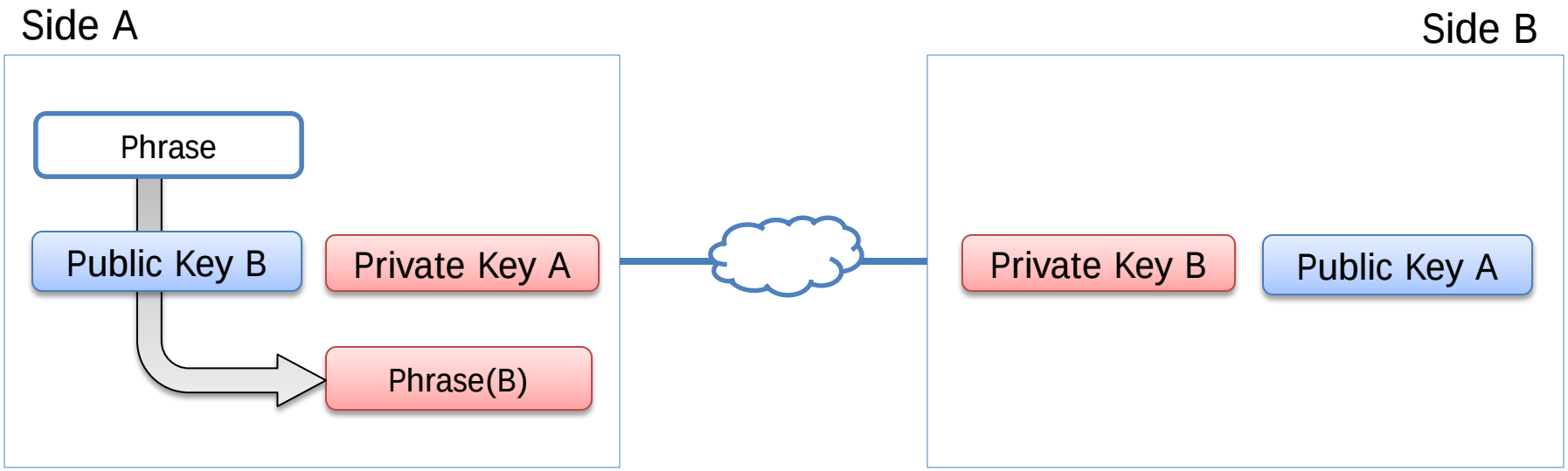
Focus: Mechanics



Sides A & B: Exchange Public Keys

Topic 1: Establish Secure Communication

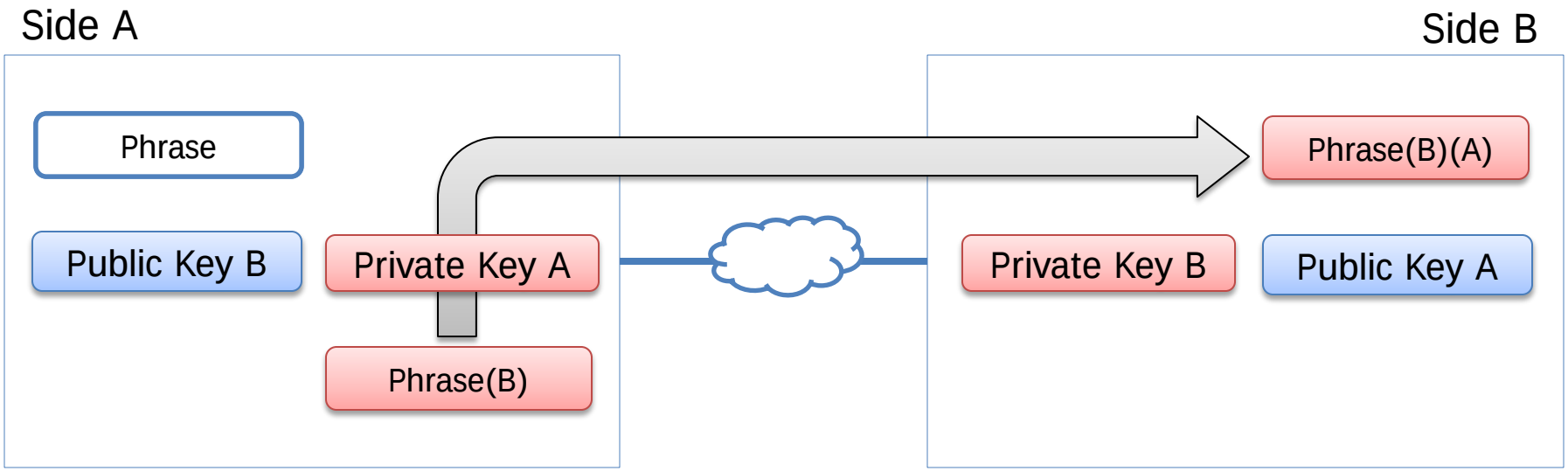
Focus: Mechanics



Side A: Encrypt “Test Phrase” with Public Key B

Topic 1: Establish Secure Communication

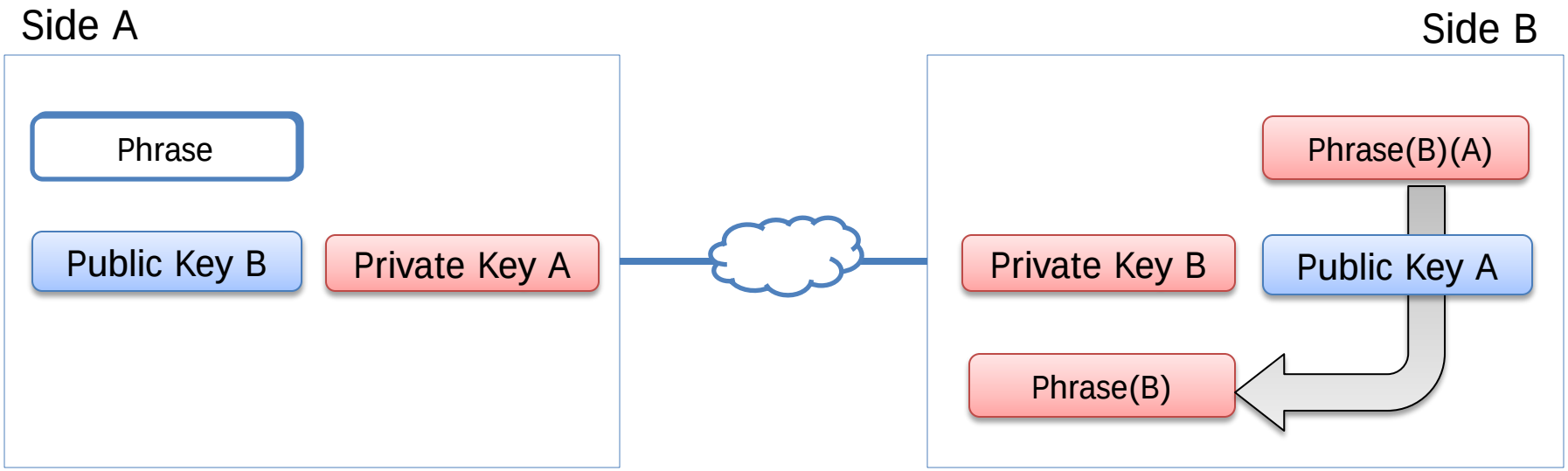
Focus: Mechanics



Side A: Sign “Test Phrase” with Private Key A, send to B

Topic 1: Establish Secure Communication

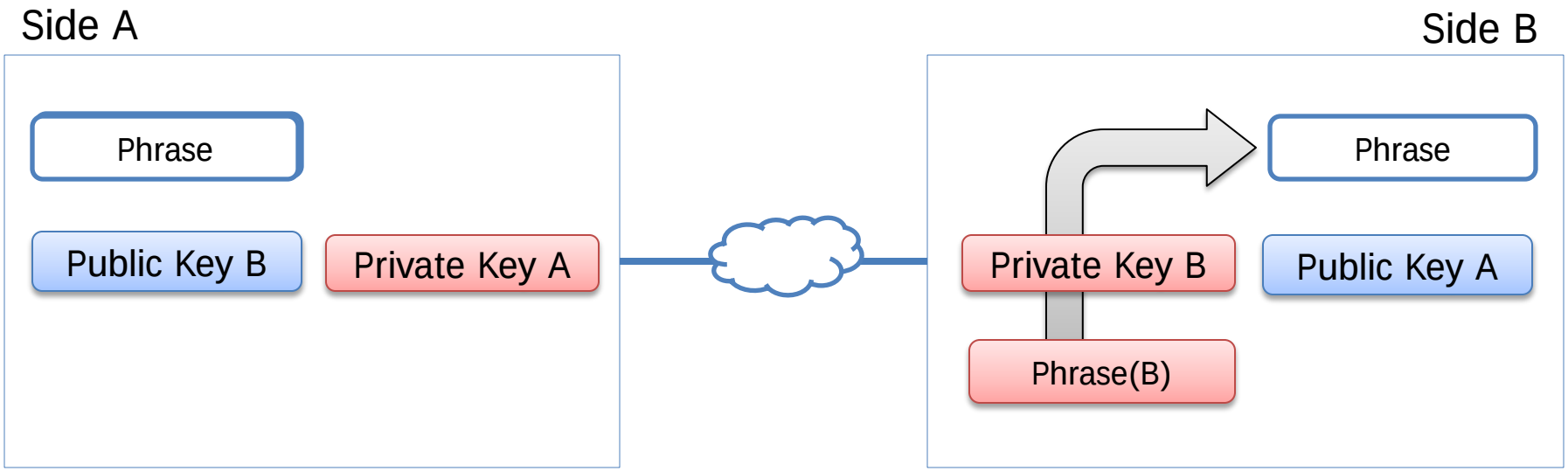
Focus: Mechanics



Side B: Verify signature of “Test Phrase” with Public Key A

Topic 1: Establish Secure Communication

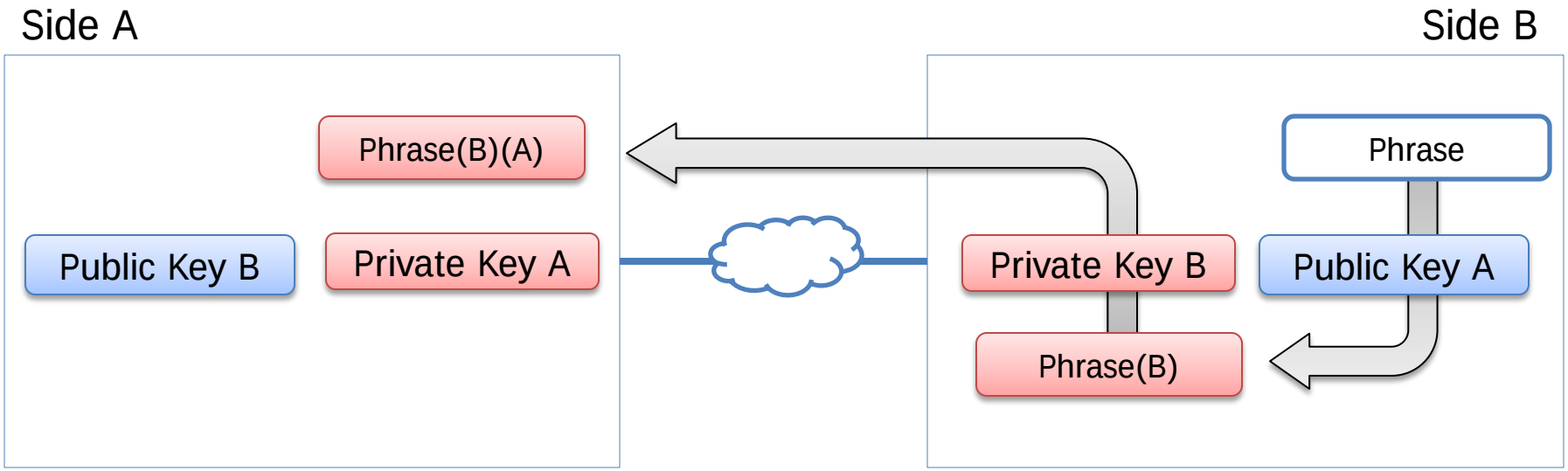
Focus: Mechanics



Side B: Decrypt “Test Phrase” with Private Key B,
Message content confirm and confirmed that received from A

Topic 1: Establish Secure Communication

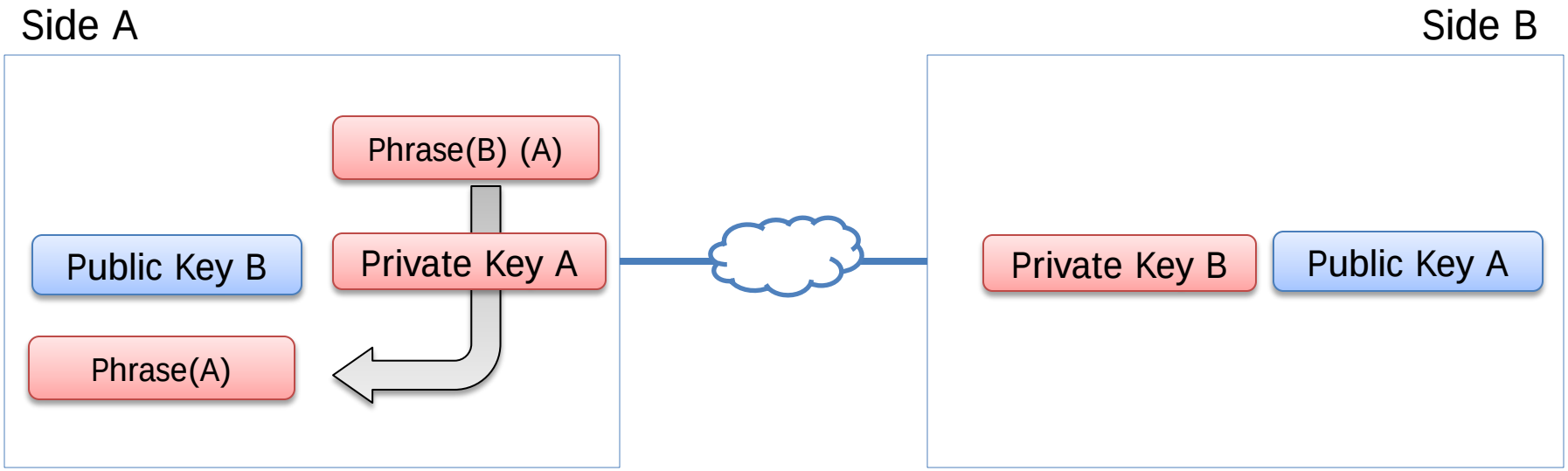
Focus: Mechanics



Side B:Encrypt with Public Key A, Sign with Private Key B, Send to A

Topic 1: Establish Secure Communication

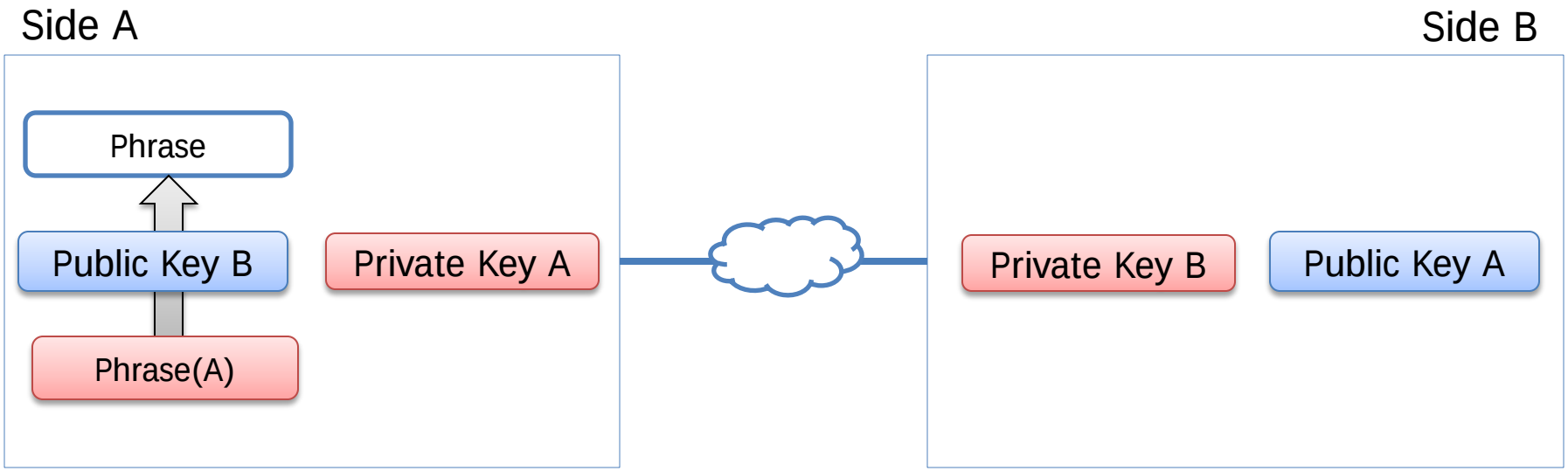
Focus: Mechanics



Side B: Decrypt with Private Key A, then Encrypt with Public Key A, send to A

Topic 1: Establish Secure Communication

Focus: Mechanics



Side A: Decrypt with Private Key A – ensure both sides can process message

Asymmetric Encryption: Each side uses different key to encrypt messages.

Symmetric Encryption: Both sides use agreed to key for encrypt/decrypt

Topic 1: Establish Secure Communication

Focus: Signing vs. Encryption

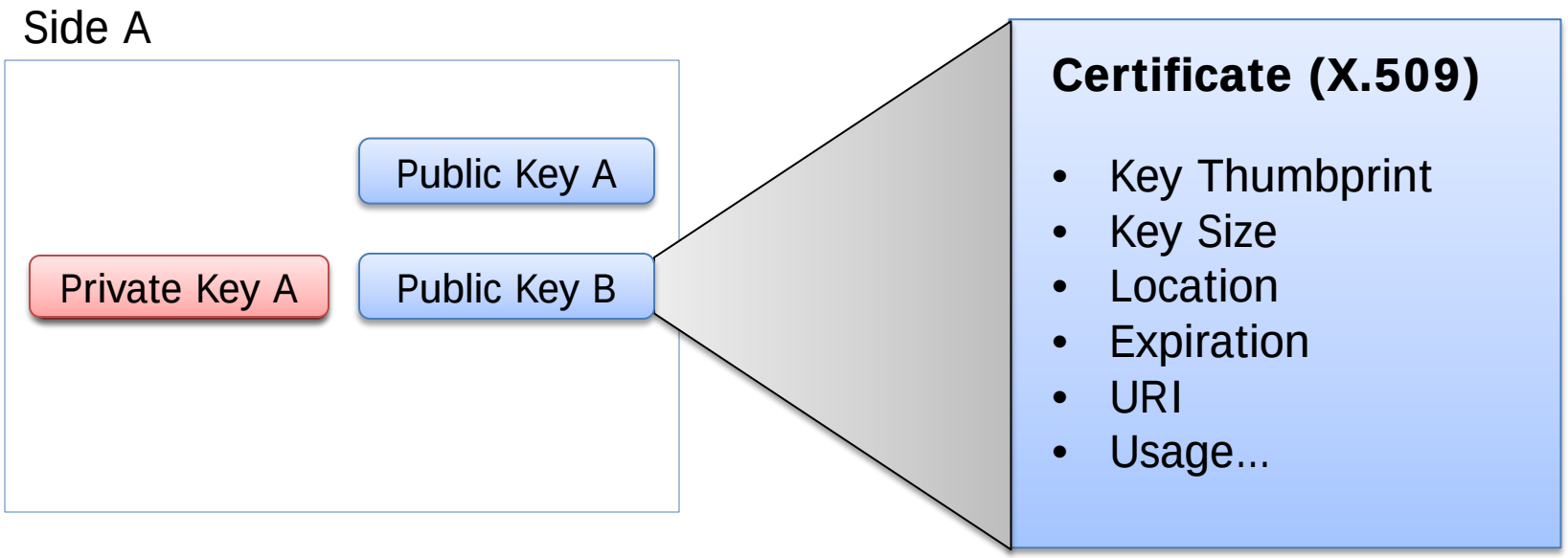
Private and public keys can be used for both functions:

- **Signing:** Proving you are who you say you are
- **Encrypting:** Protecting the data being sent so only receiver can read

Operation	What's Generated	Generated Using	Consumed Using
Signing	CRC / Hash	Sender's Private Key	Sender's Public Key
Encrypting	Scrambled Message	Receiver's Public Key	Receiver's Private Key

Topic 2: Certificates

Focus: What is a Certificate

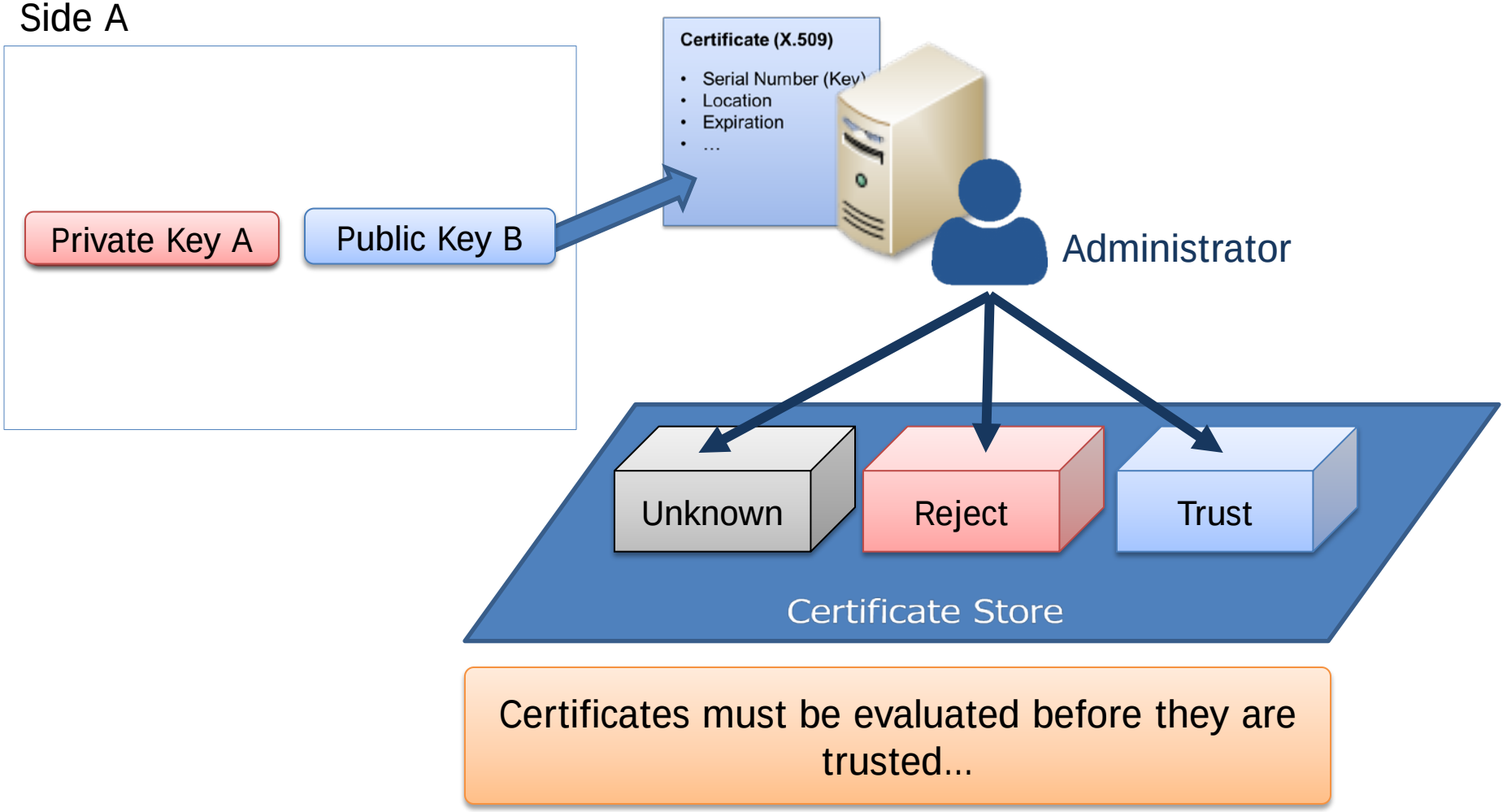


Certificates provide:
1. standardized key encoding format
2. additional context (expiry date)

Topic 2: Certificates

Focus: Trusting Certificates

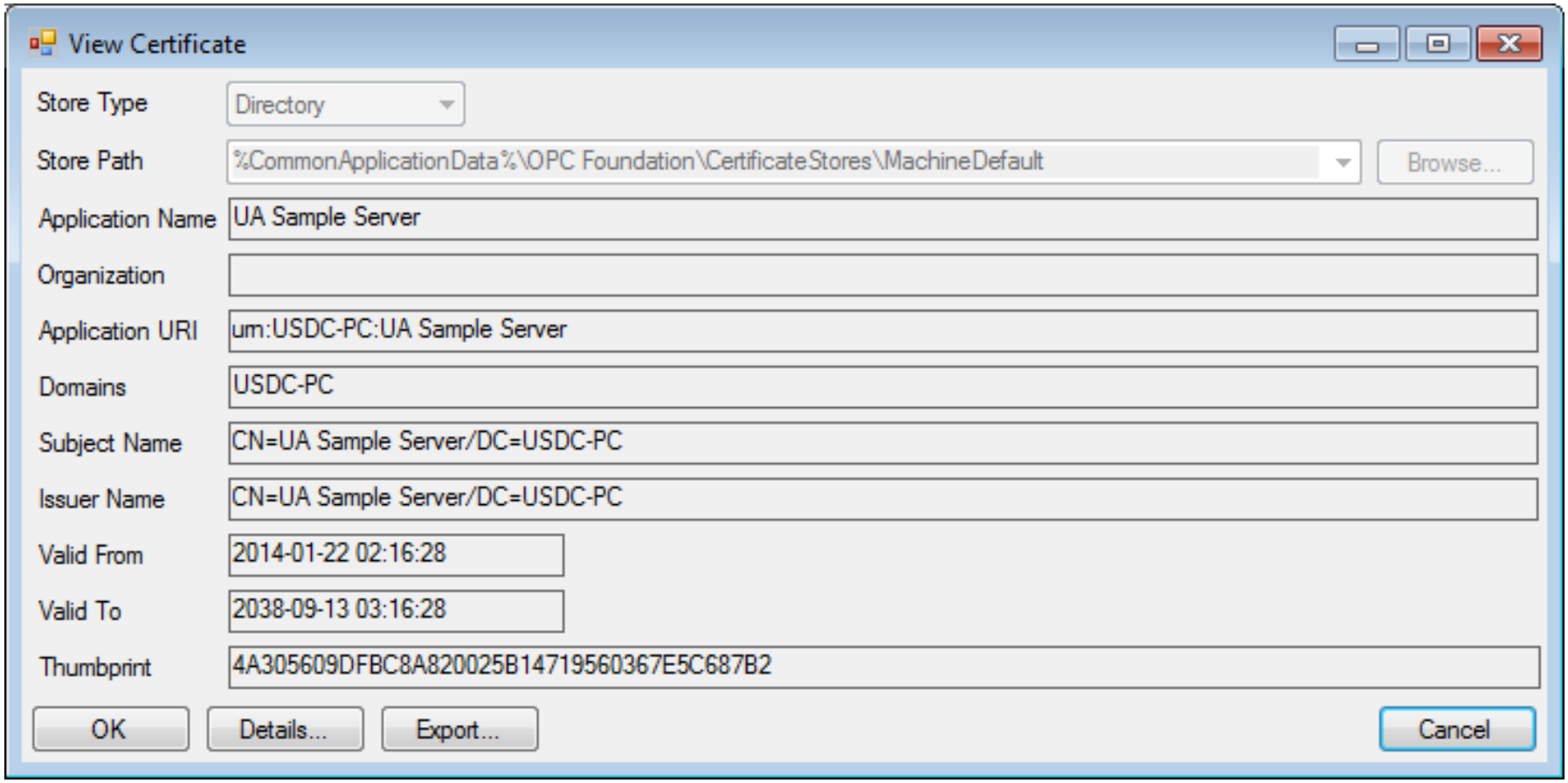
Side A



Certificates must be evaluated before they are trusted...

Topic 2: Certificates

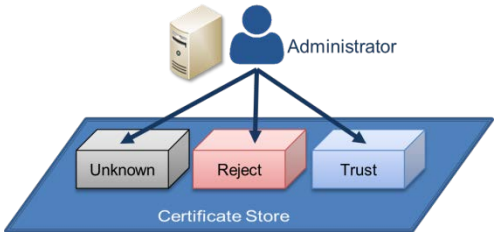
- Example: Certificate



Topic 2: Certificates

Focus: Certificate Management

- Public Key Infrastructure (PKI)
  - System for managing certificates
  - Management options:



Self-Signed (Manual Process)

Pro:
- Low infrastructure cost

Con:
- work intensive
- does not scale well

Local Certificate Authority (CA)

Pro:
- Medium/Large installations
- Local trust
- Chaining

Con:
- Medium cost

External Certificate Authority (CA)

Pro:
- Large installations
- Multiple CA's

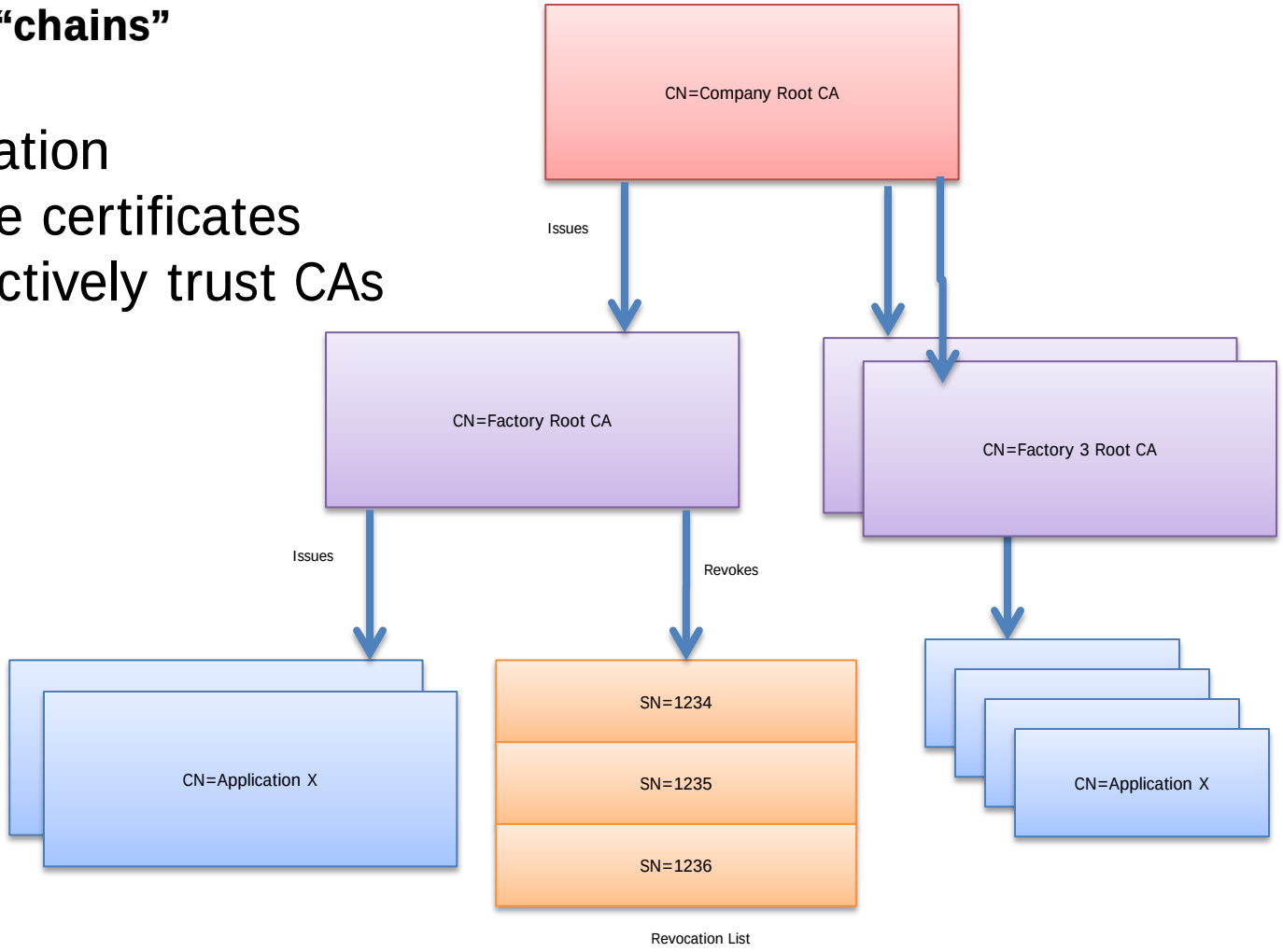
Con:
- Medium/high cost
- 3rd Party trust

Topic 2: Certificates

Focus: Scalable Certificate Management

Certificate Authority "chains"

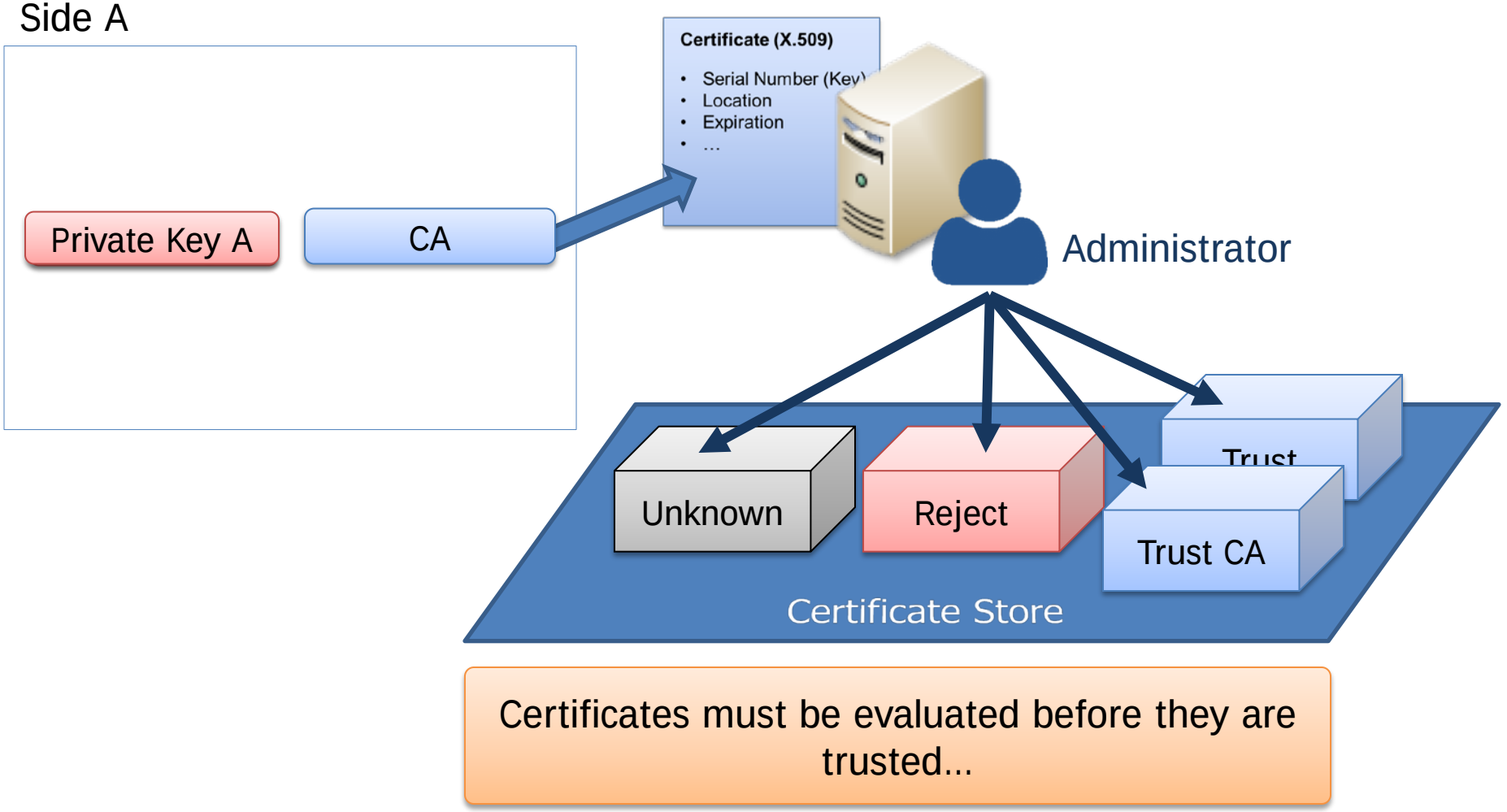
- Create hierarchy
- Improve organization
- CAs issue/revoke certificates
- Applications selectively trust CAs



Topic 2: Certificates

Focus: Trusting Certificates

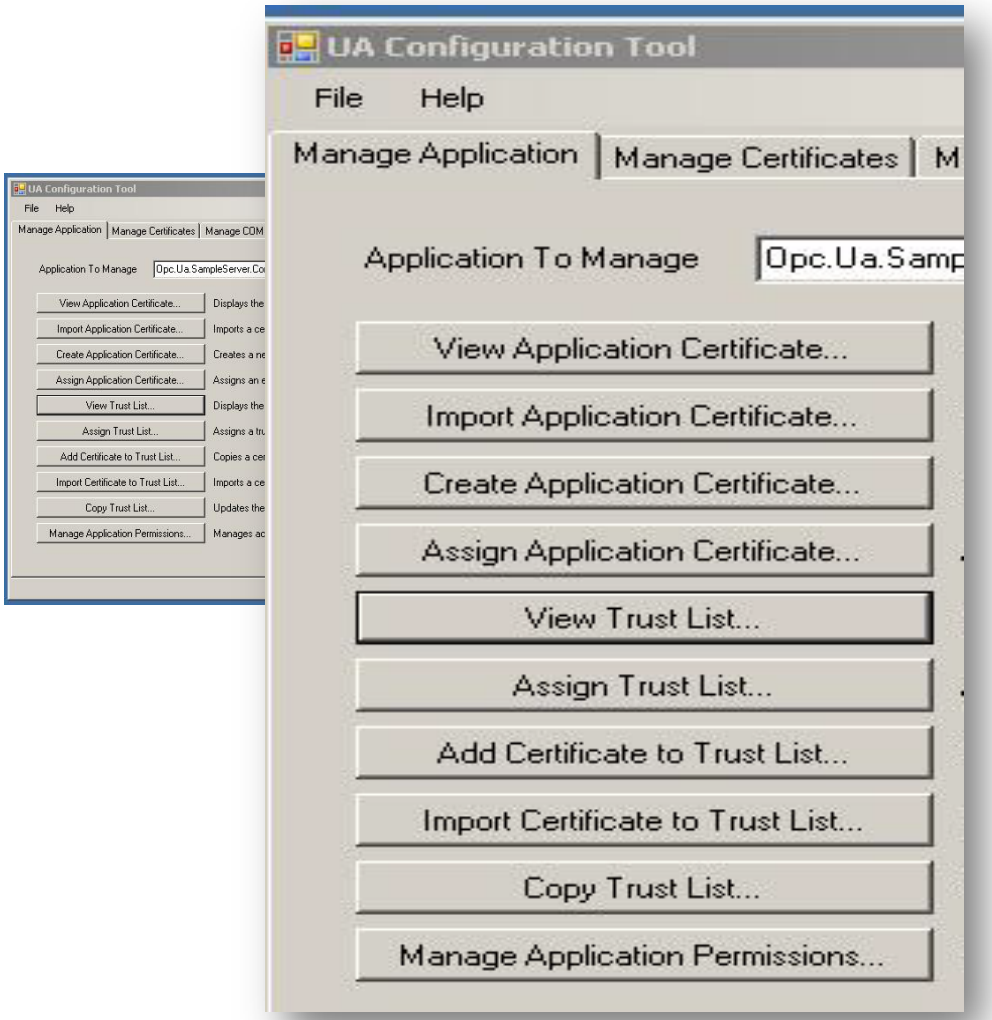
Side A



Certificates must be evaluated before they are trusted...

Topic 2: Certificates

Focus: Example Certificate Management Utility (OPC Foundation)



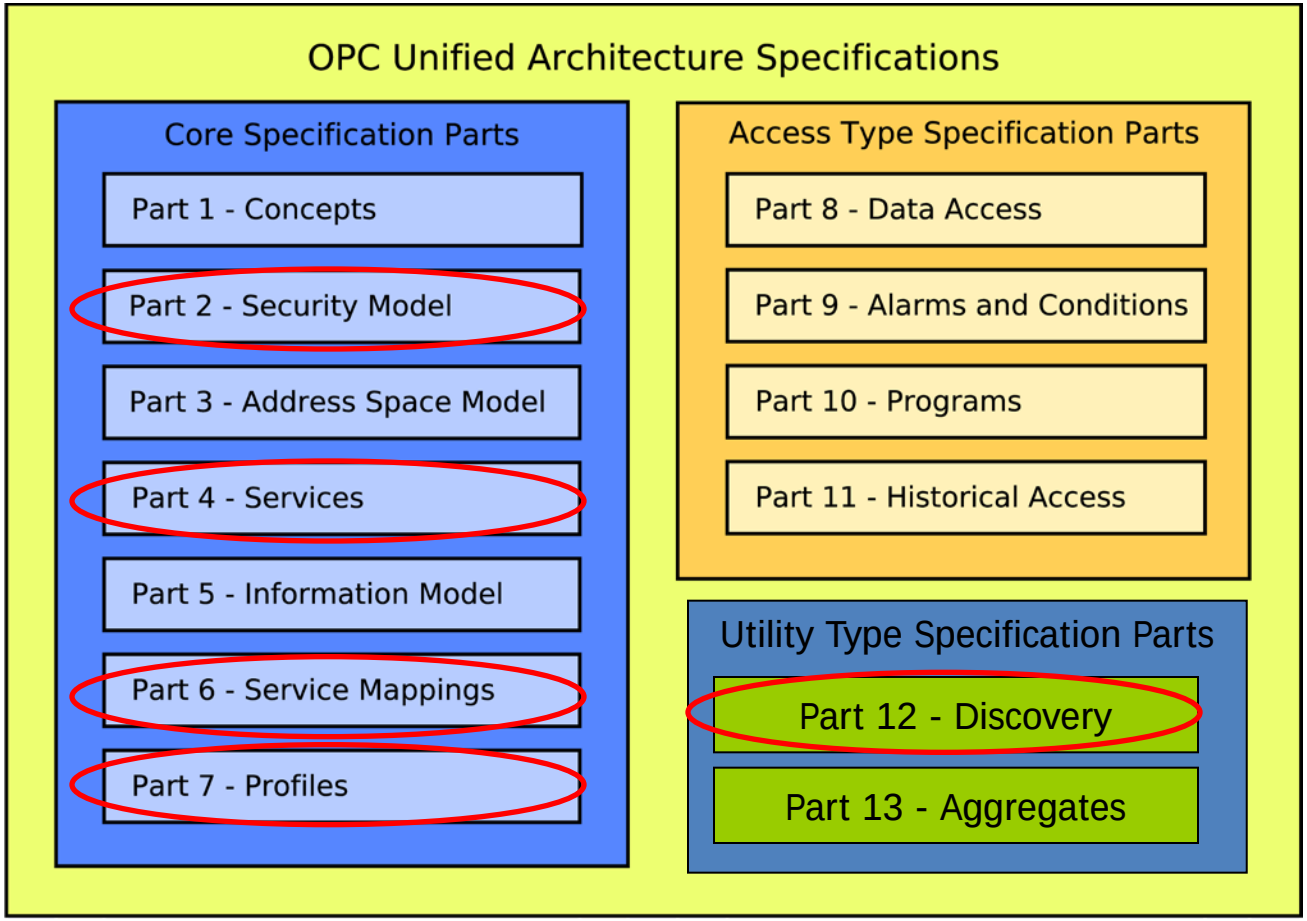
Available for OPC Foundation members

OPC UA Security

High Level Overview

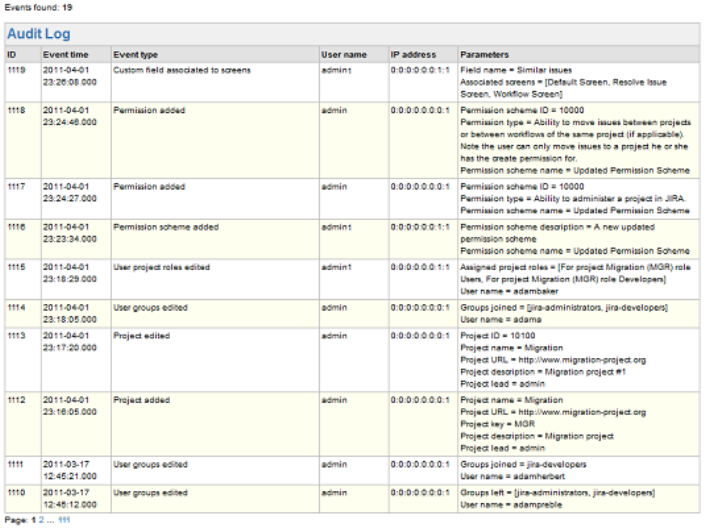
OPC UA Security: Overview

Security built into specification from ground up.



OPC UA Security: Auditing

- Log all actions
- Audit review as required
- Act on suspicious activity
- Integrate with IDS/IPS



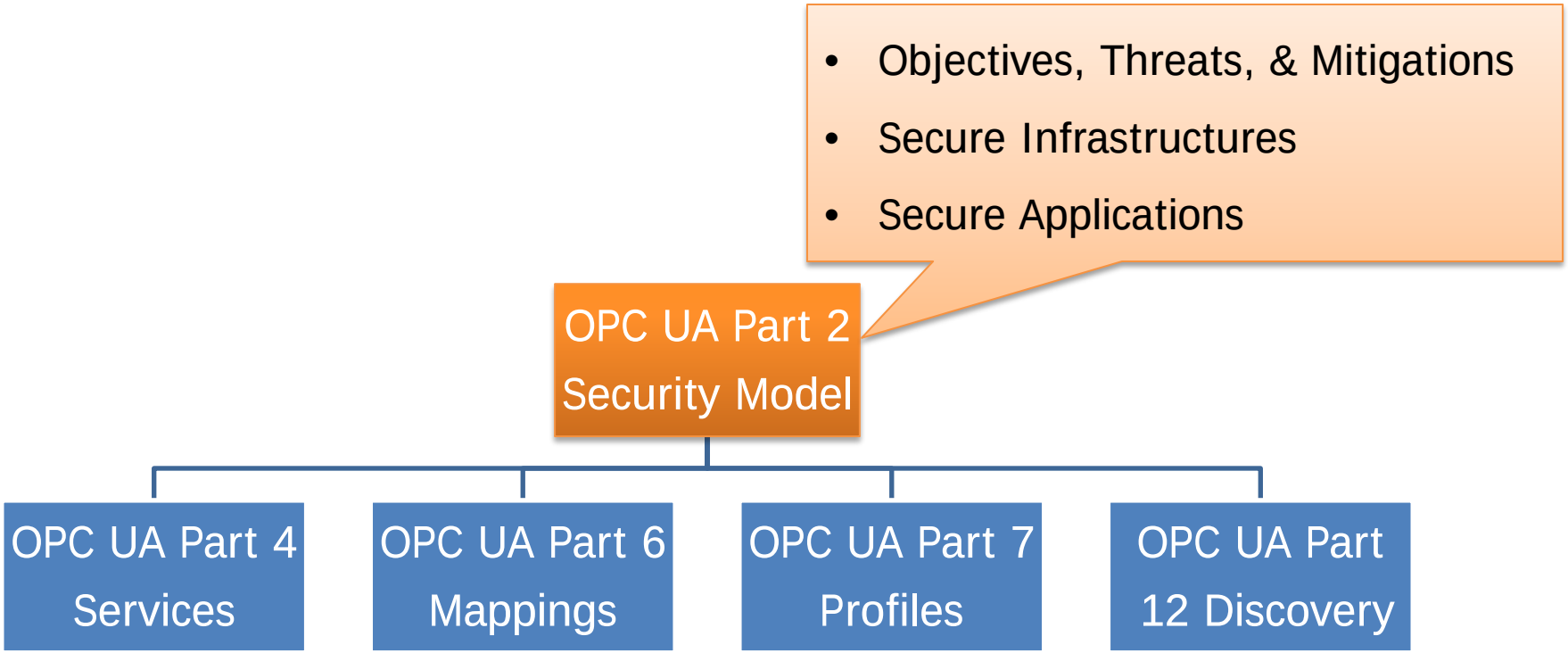
Events found: 19

Audit Log

ID	Event time	Event type	User name	IP address	Parameters
1119	2011-04-01 23:26:08.000	Custom field associated to screens	admin1	0:0:0:0:0:0:1:1	Field name = Similar issues Associated screens = [Default Screen, Resolve Issue Screen, Workflow Screen]
1118	2011-04-01 23:24:48.000	Permission added	admin	0:0:0:0:0:0:0:1	Permission scheme ID = 10000 Permission type = Ability to move issues between projects or between workflows of the same project (if applicable). Note the user can only move issues to a project he or she has the create permission for. Permission scheme name = Updated Permission Scheme
1117	2011-04-01 23:24:27.000	Permission added	admin	0:0:0:0:0:0:0:1	Permission scheme ID = 10000 Permission type = Ability to administer a project in JIRA. Permission scheme name = Updated Permission Scheme
1116	2011-04-01 23:23:34.000	Permission scheme added	admin1	0:0:0:0:0:0:1:1	Permission scheme description = A new updated permission scheme Permission scheme name = Updated Permission Scheme
1115	2011-04-01 23:18:29.000	User project roles edited	admin1	0:0:0:0:0:0:1:1	Assigned project roles = [For project Migration (MGR) role Users, For project Migration (MGR) role Developers] User name = adambaker
1114	2011-04-01 23:18:05.000	User groups edited	admin	0:0:0:0:0:0:0:1	Groups joined = [jira-administrators, jira-developers] User name = adams
1113	2011-04-01 23:17:20.000	Project edited	admin	0:0:0:0:0:0:0:1	Project ID = 10100 Project name = Migration Project URL = http://www.migration-project.org Project description = Migration project #1 Project lead = admin
1112	2011-04-01 23:16:05.000	Project added	admin	0:0:0:0:0:0:0:1	Project name = Migration Project URL = http://www.migration-project.org Project key = MGR Project description = Migration project Project lead = admin
1111	2011-03-17 12:45:21.000	User groups edited	admin	0:0:0:0:0:0:0:1	Groups joined = jira-developers User name = adamherbert
1110	2011-03-17 12:45:12.000	User groups edited	admin	0:0:0:0:0:0:0:1	Groups left = [jira-administrators, jira-developers] User name = adampreble

Page: 1 2 ... 111

OPC UA Security: Highlights

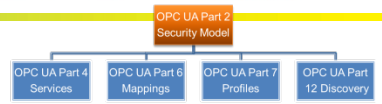


OPC UA Security: Objectives

- **Application Authentication**
  - All application must have a unique Application instance Certificate
  - URI should identify the instance, vendor and product
- **User Authentication**
  - Username / password, WS-Security Token or X.509
  - Fits into existing infrastructures like Active Directory

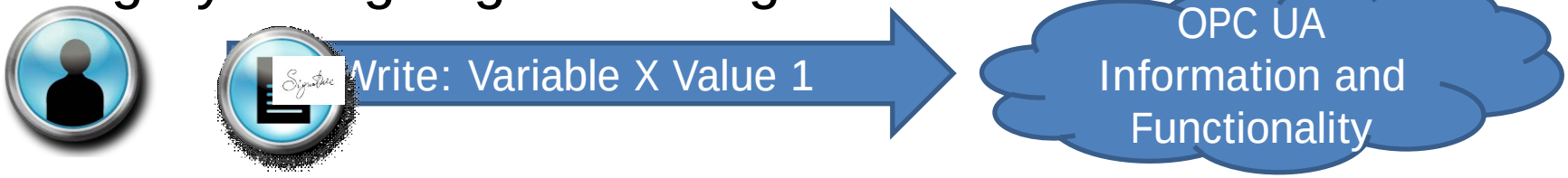
- **User Authorization**
  - Granular control over user actions: read, write, browse, execute
- **Server Availability**
  - Minimum processing before authentication
    - Restricting message size
    - No security related error codes returned
    - ...
- **System Auditability**
  - Generating audit events for security related operations

OPC UA Security: Objectives

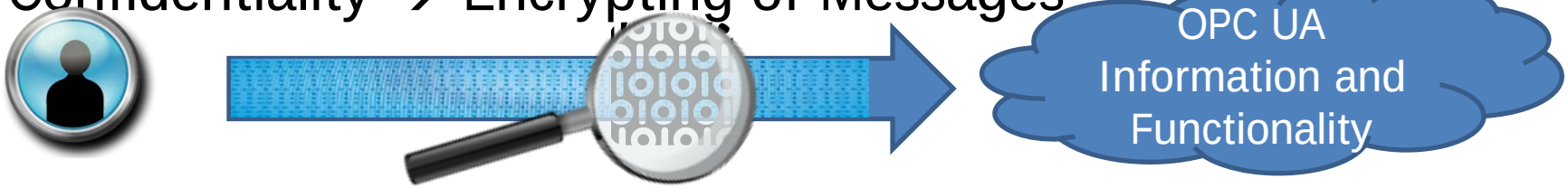


- Availability → Fast & Efficient Authentication

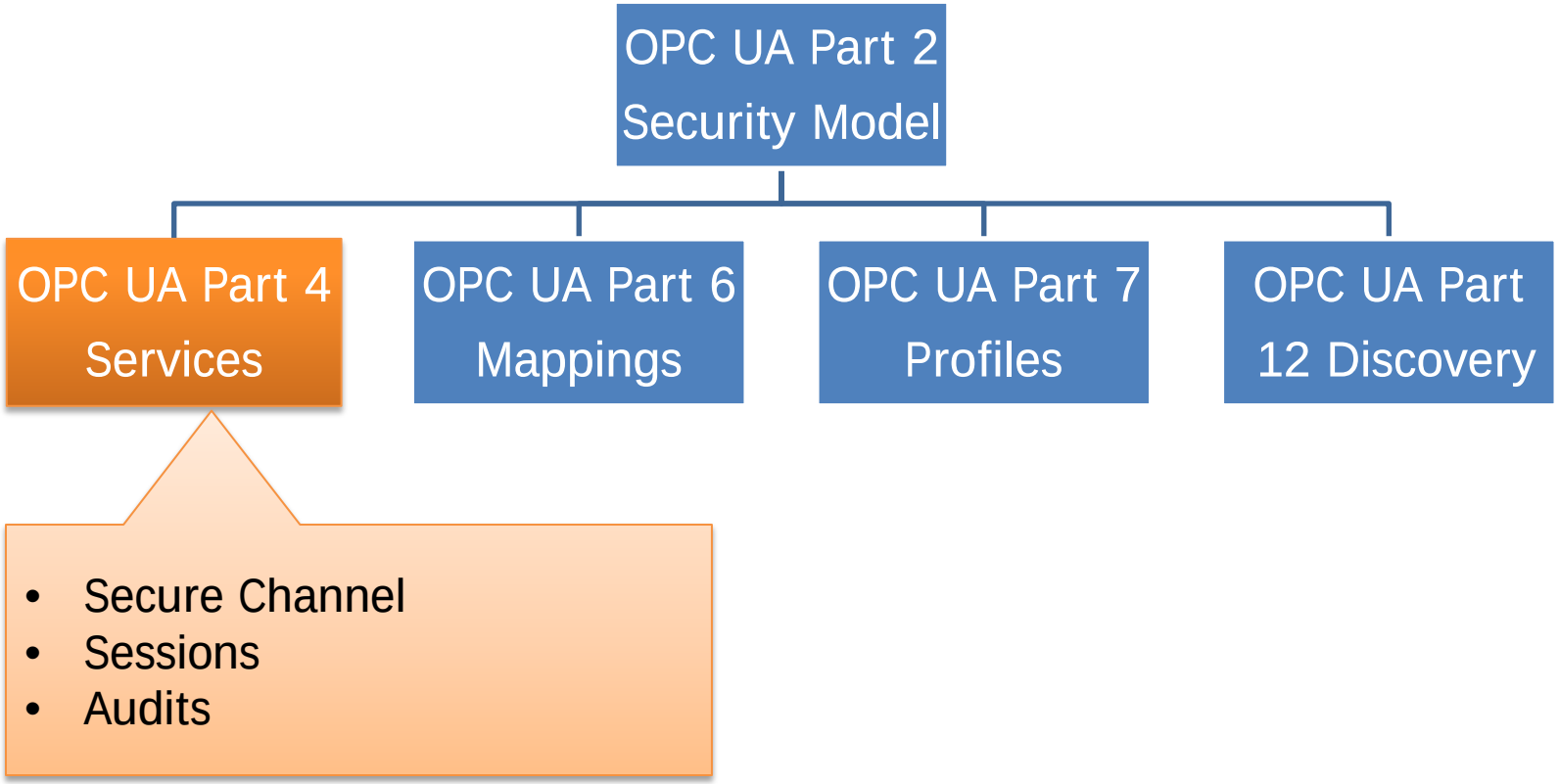
- Integrity → Signing of Messages



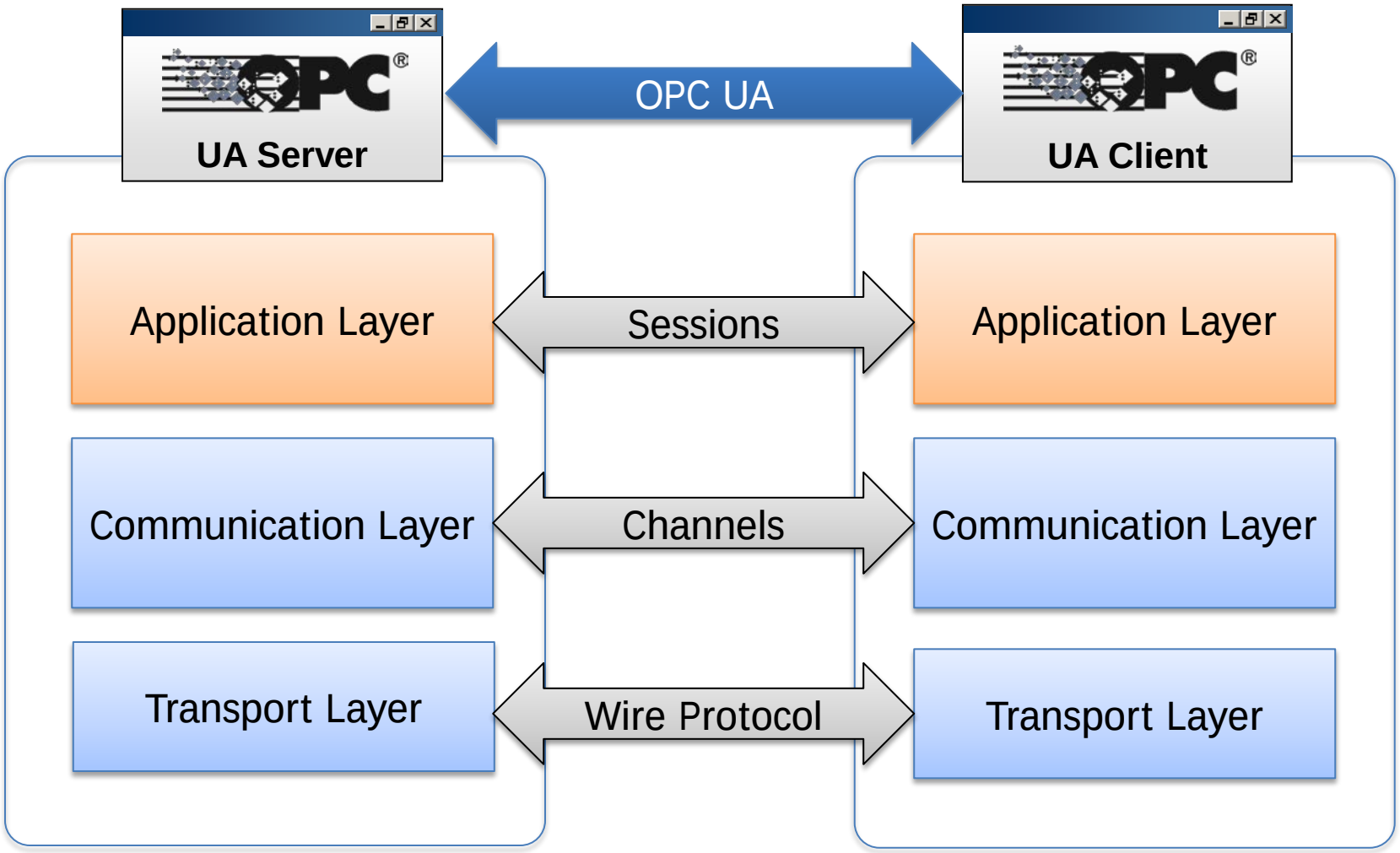
- Confidentiality → Encrypting of Messages



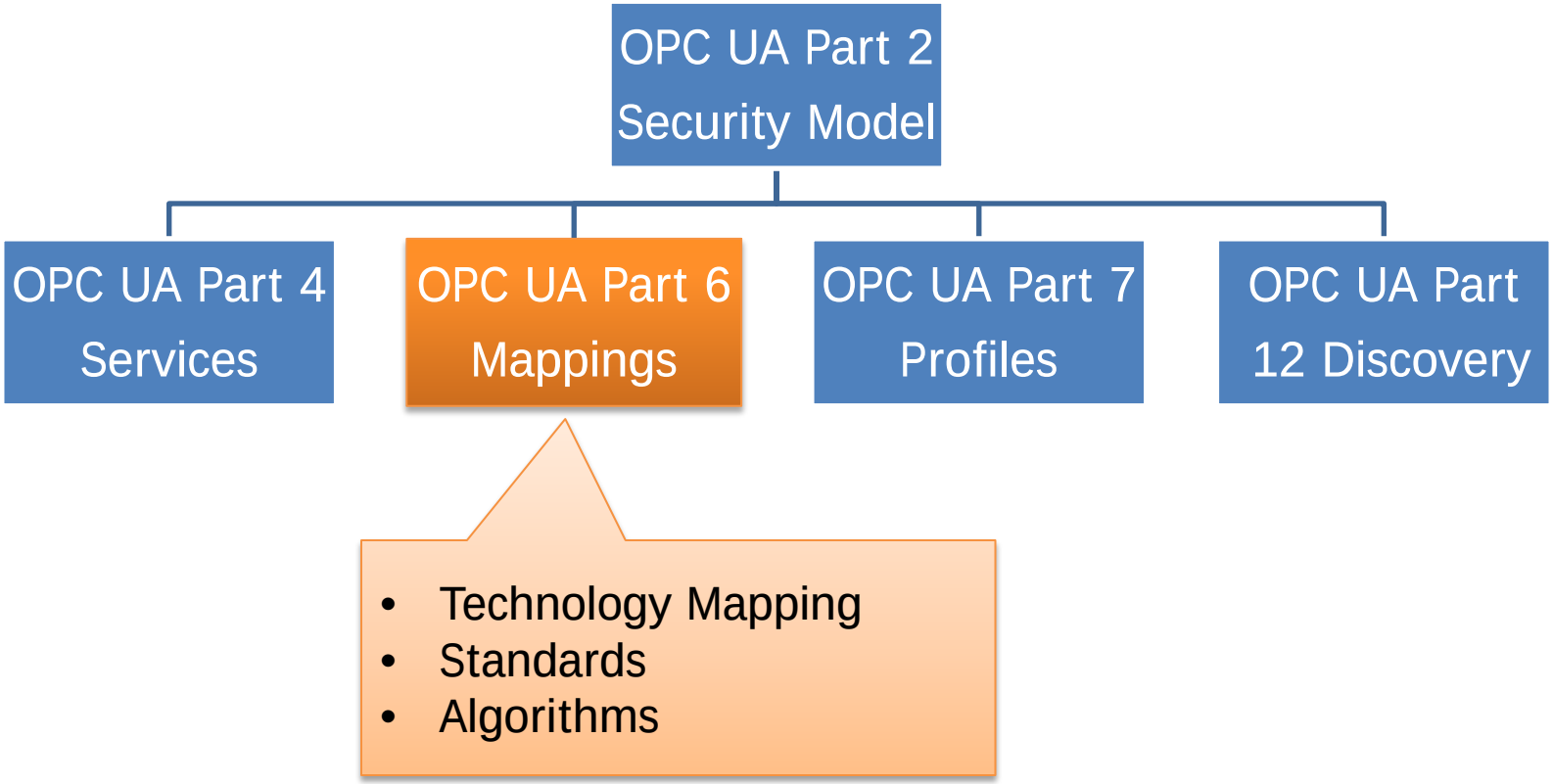
OPC UA Security: Services



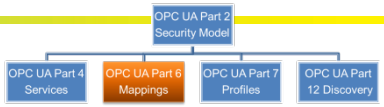
OPC UA Security: Services



OPC UA Security: Services

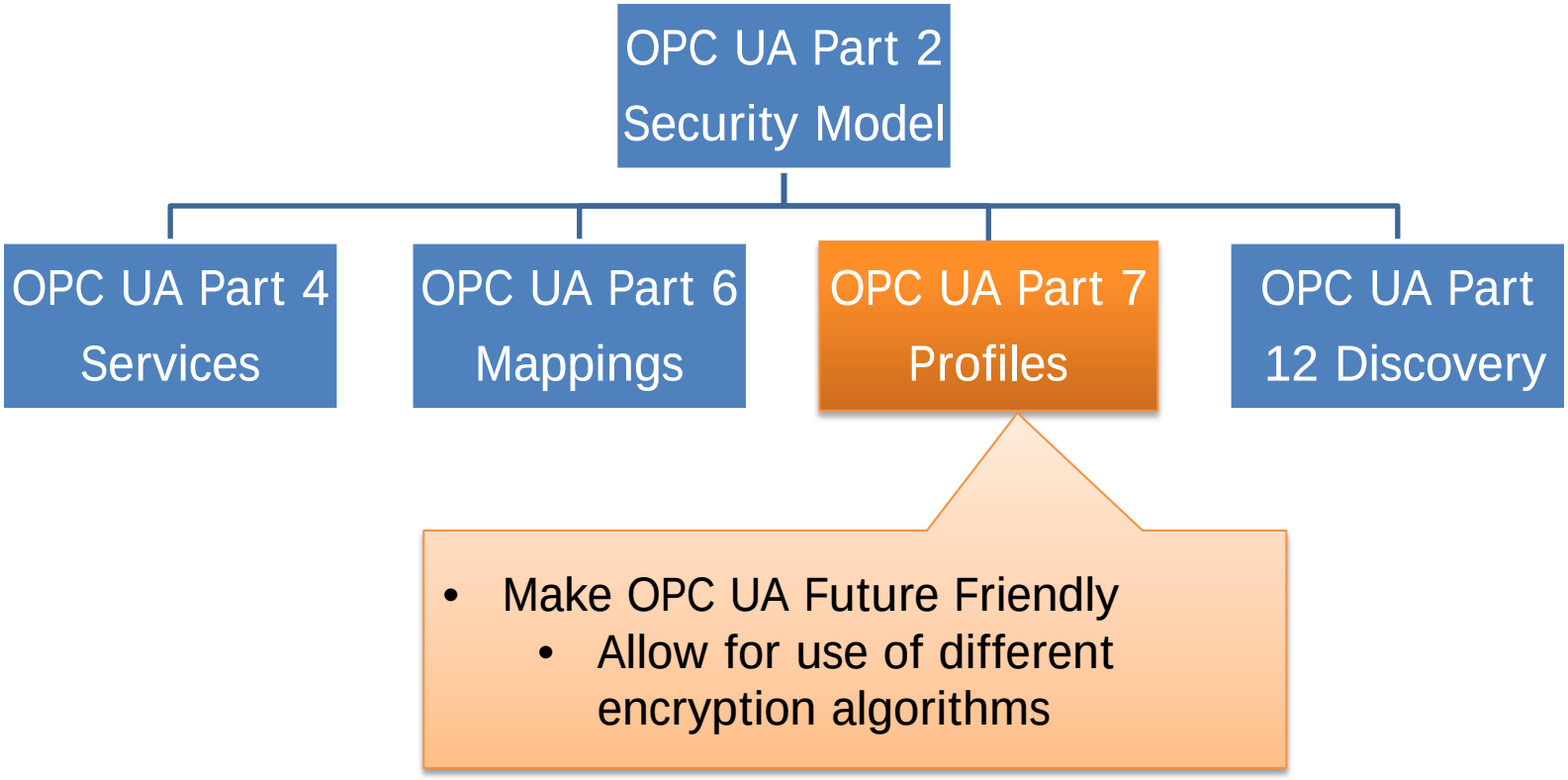


OPC UA Security: Standards Based

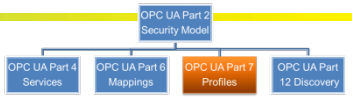


- OPC UA relies upon approved security standards
  - WS-Security
  - WS-Trust
  - WS-Secure Conversation
  - Public Key Cryptography Standards (PKCS)
  - Digital Signature Standard (DSS)
  - Advanced Encryption Standard (AES)

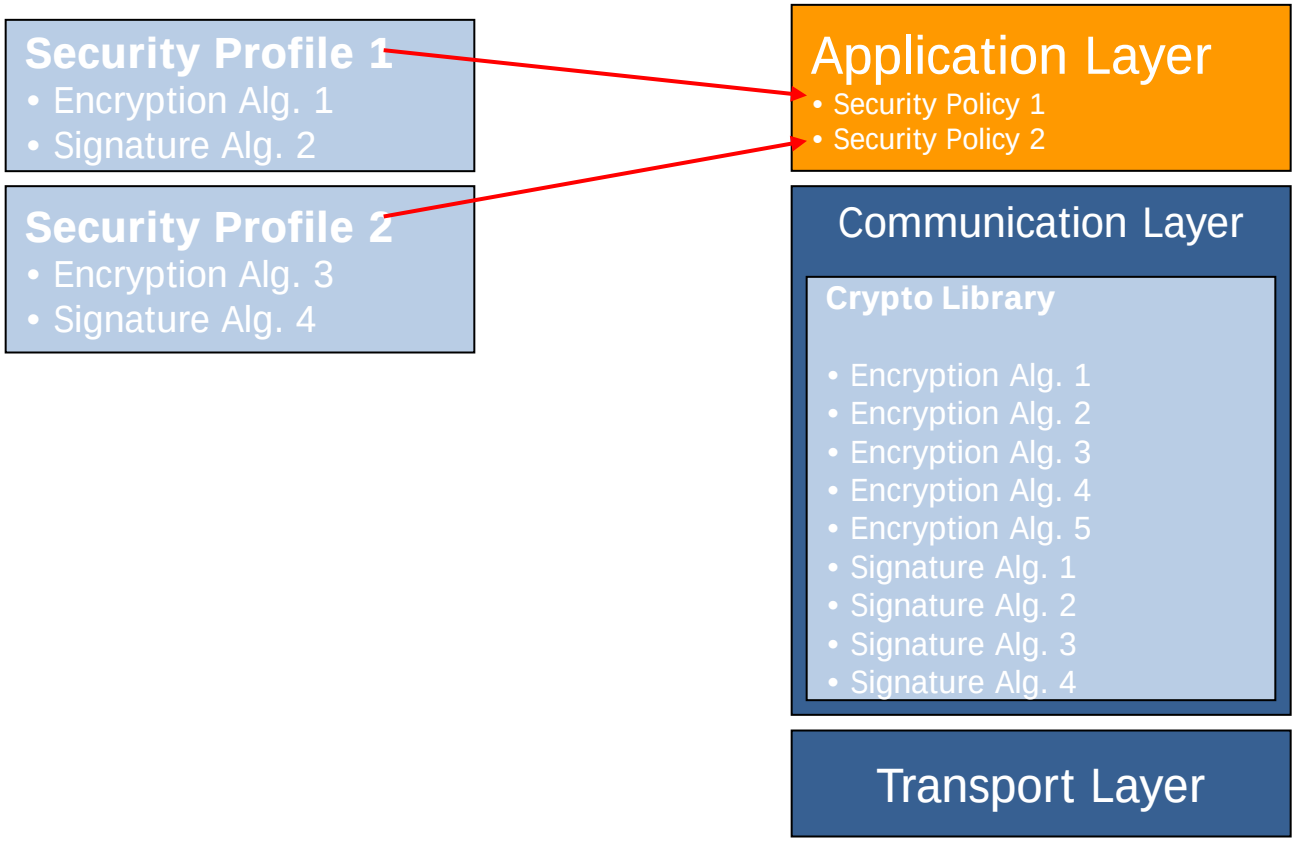
OPC UA Security: Services



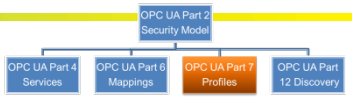
OPC UA Security: Flexibility



- Flexibility and Extensibility
  - Profiles and Policies
    - Profiles list various functionalities of UA applications



OPC UA Security: Flexibility



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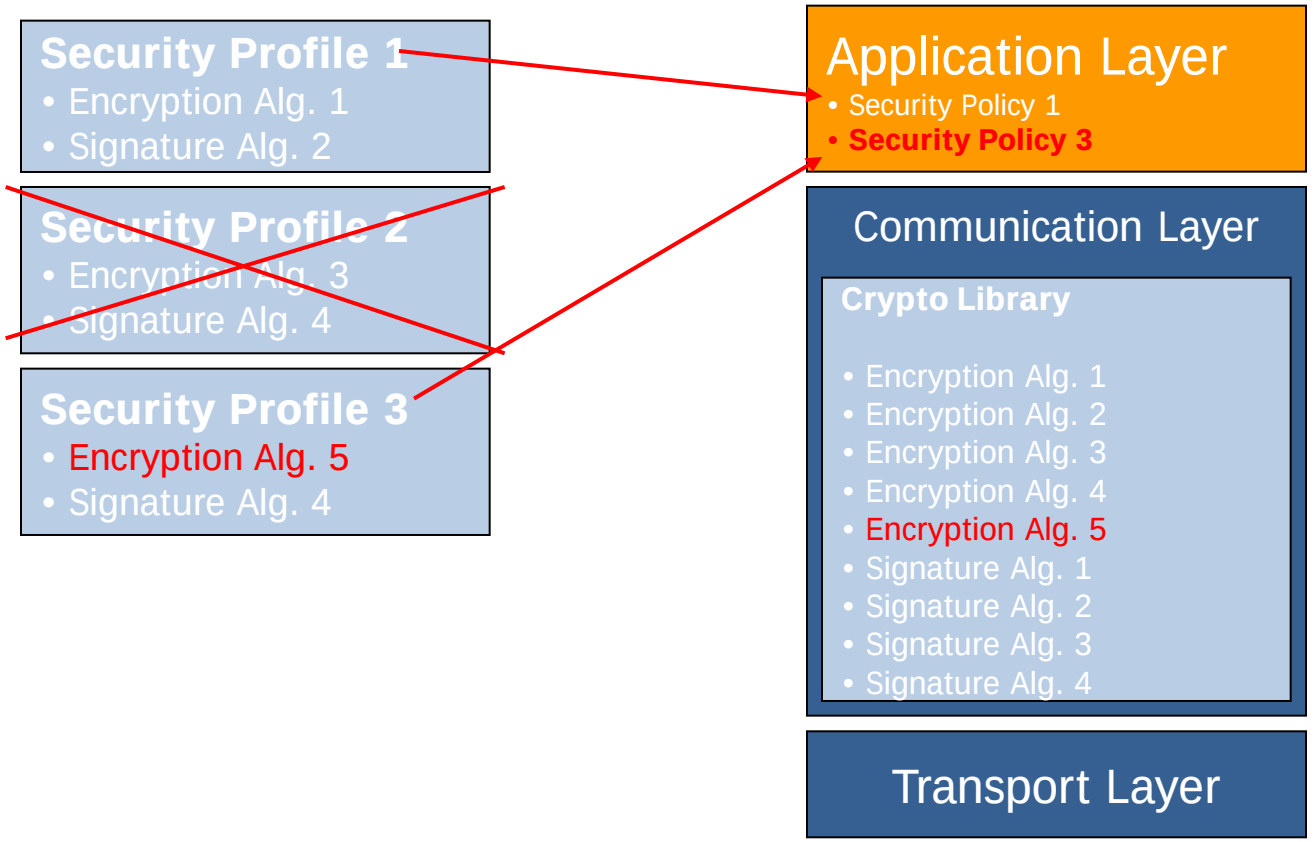
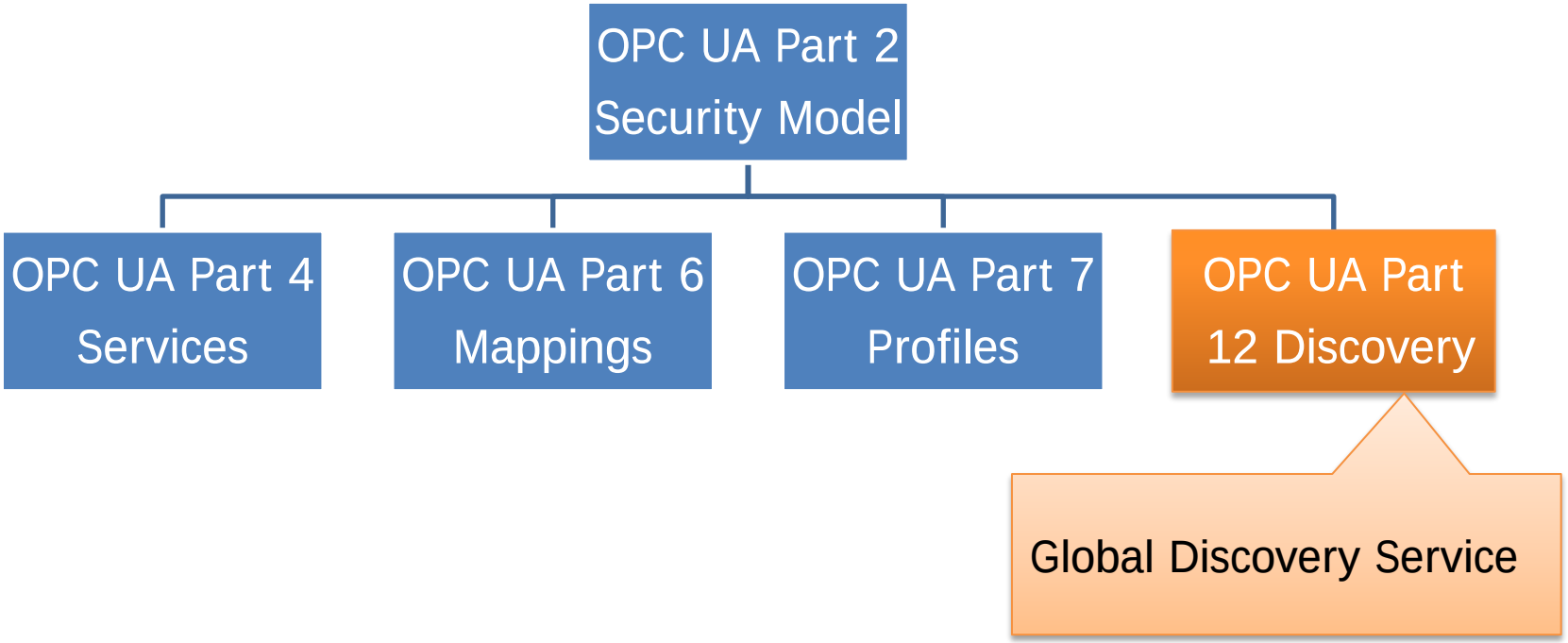
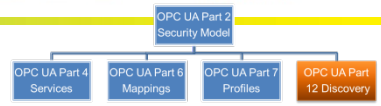


OPC UA Security: Configuration



Global Directory Service (GDS)



OPC UA Client | OPC UA Client | OPC UA Client

NEW

GDS Features:

- Certificate creation / management
- Certificate Authority (CA)
- Management of Certificate Revocation Lists (CRL)
- Push / Pull of Certificates / CRL
- Network wide server registry

- Security Config
- Find Servers

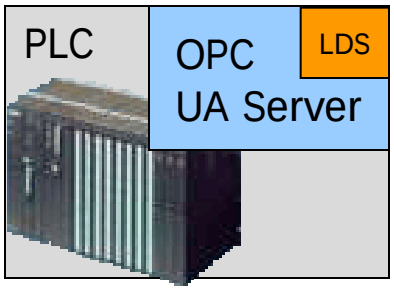
- Security Config
- Register Server

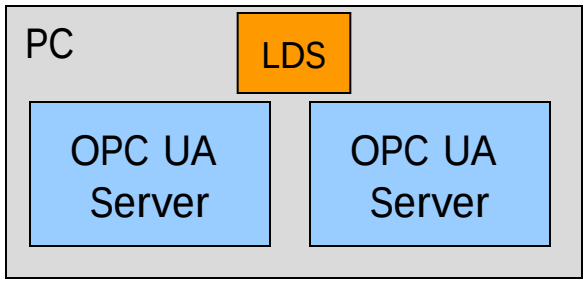
Central Server

GDS (Port:4840)

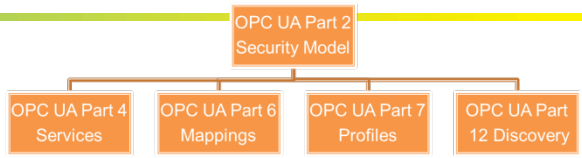
Pull / Push Certificates | CA

List of registered UA Servers





Conclusion



- OPC UA security should be part of a security management system
- OPC UA is secure-by-design addressing security concerns by providing:
  - Authentication of Users, Application instances (Software)
  - Confidentiality and integrity by signing and encrypting messages
  - Availability by minimum processing before authentication
  - Auditability by defined audit events for OPC UA operations
- OPC UA allows different levels of security
- OPC UA certificate management can be retrofitted or new!

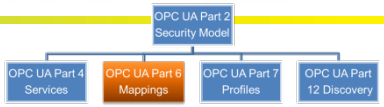
OPC UA Security: Standards Based

- ICS Security Is Nothing New!
- Developed with industry security experts from multiple companies
- NIST and other experts reviewed the OPC standard
- Working with security Certification Groups to ensure it is current

Questions

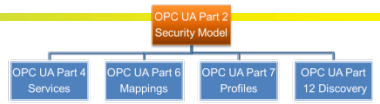
- **Paul Hunkar**
- Technical Director
- Paul.Hunkar@DSInteroperability.com

OPC UA Security: Technologies



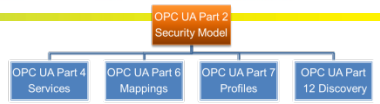
	Main goal(s)	Algorithm(s)/ Standard(s)	Usage
MACs	**Authentication, Integrity**	► **HMAC-SHA1** ► **HMAC-SHA256**	► **Message authentication**
Signature	**Authentication, Integrity**	► **RSA-SHA1**	► **Signing certificates, security handshaking**
Symmetric Encryption	**Confidentiality**	► **AES-128-CBC** ► **AES-192-CBC** ► **AES-256-CBC**	► **Message encryption**
Asymmetric Encryption	**Confidentiality**	► **RSA-PKCS1** ► **RSA-OAEP**	► **Security handshaking**
Key Generation	**Confidentiality**	► **P-SHA1**	► **Session key generation (for message encryption)**
Certificates	**Authentication, Authorization**	► **X.509** ► **X.509v3 (Extensions)**	► **Application authentication, user authentication, key exchange**

Subject Names



- Subject names identify the holder of the certificate
  - Structured value with multiple fields
  - Common Name (CN)
  - Organization (O)
  - Country (C)
  - Domain (DC)
- String syntax for display purposes
  - CN=UASampleServer,O=MyCompany,DC=MyComputer
- Subject names are not guaranteed to be unique
  - Thumbprints better choice when a unique id is required
  - Thumbprint is the SHA1 digest of the DER encoded certificate

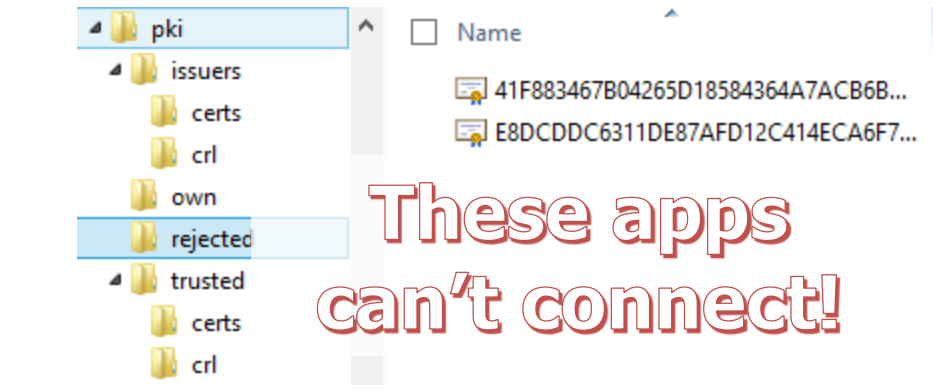
Subject Alternate Names

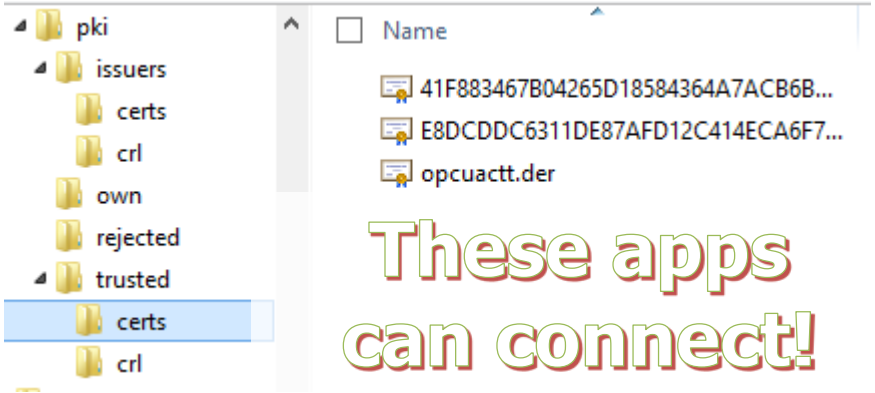


- Specify additional names for the certificate
  - Used for validation purposes
  - Domain Name, IP Address, Application URI
- The alternate name binds the certificate to a context
  - Domain/IP address must match the host in the Endpoint URL
  - The URI must match the URI in the Application Description
- Helps prevent spoofing

Administrator Perspective: Certificates

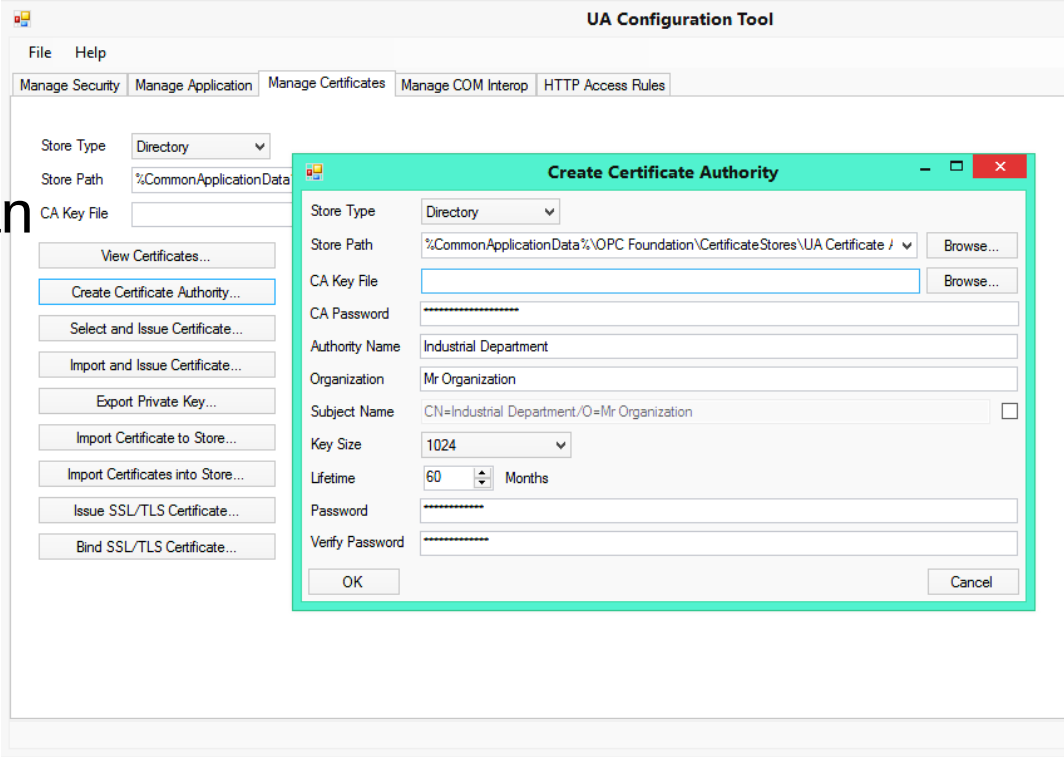
- Certificates stored in a “trust list”:
  - File structure
  - Windows Certificate Store
- Application’s certificates must be trusted, to connect
- Move certificates from “rejected” to “trusted”





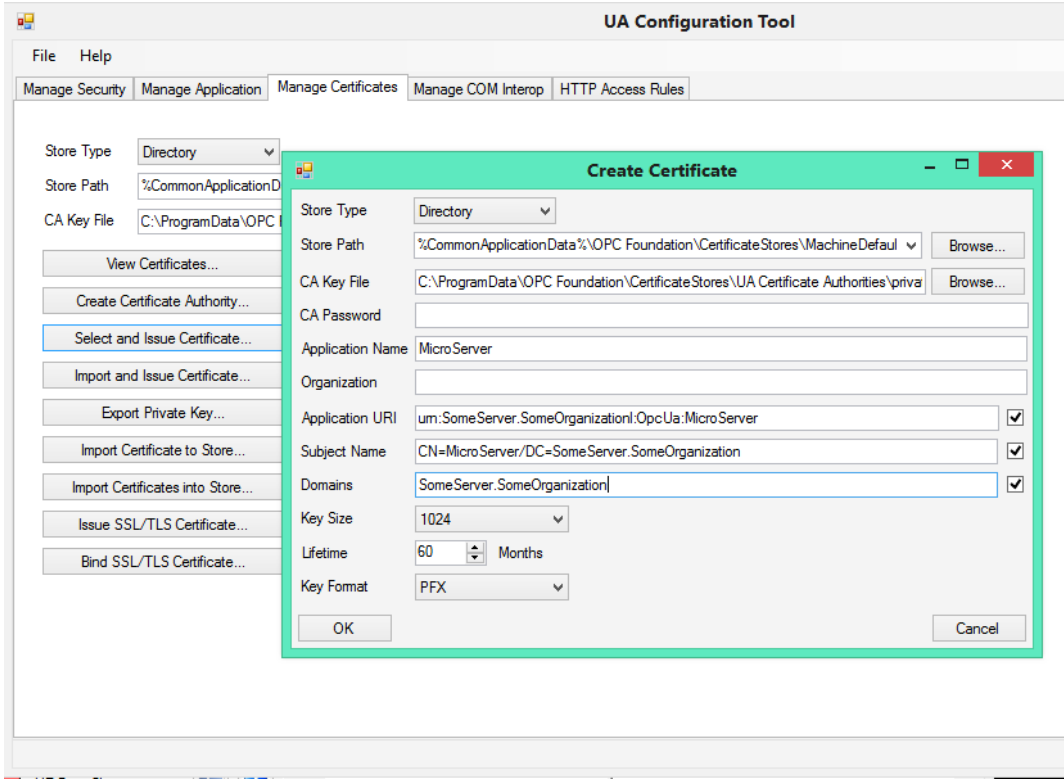
Administrator Perspective: Certificates

- Certificate stores scale poorly in large environments.
- Administrative burden of trusts and no-trusts etc.
- Certificate Authorities (CA) can issue certificates.
- Trust the CA, and implicitly trust all apps who certificate was issued

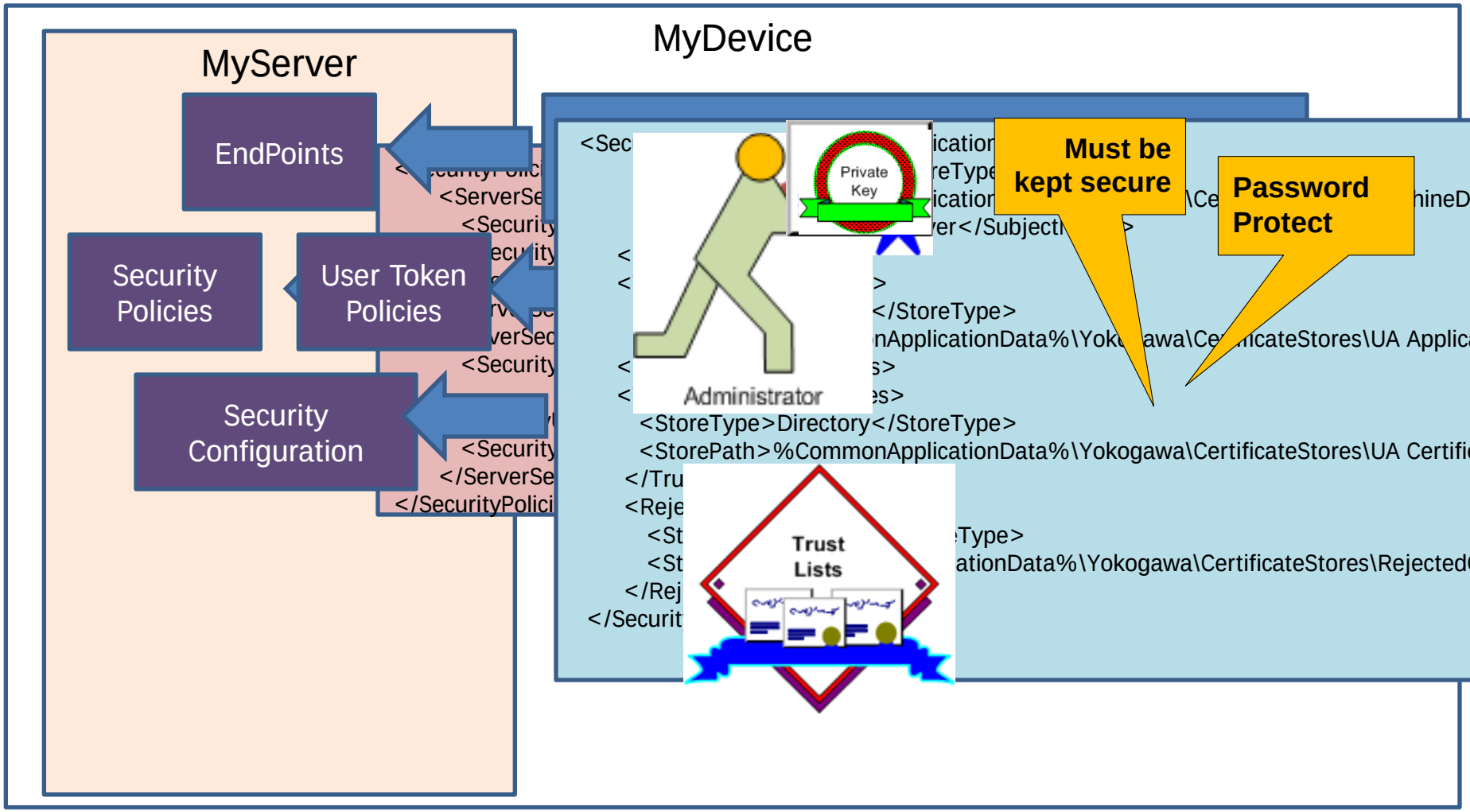


Administrator Perspective: Certificates

- CA issues App Certificate
- Easier to maintain
- Organization create have >1 CA
- CA's can also "revoke" certificates that have been compromised.



Provisioning / Setup - Server



Provisioning / Setup - Client