Achieving Better Buying Power for Mobile Open Architecture Software Systems Through Diverse Acquisition Scenarios

Walt Scacchi and Thomas Alspaugh

INSTITUTE *for* SOFTWARE RESEARCH
UNIVERSITY *of* CALIFORNIA · IRVINE

Overview

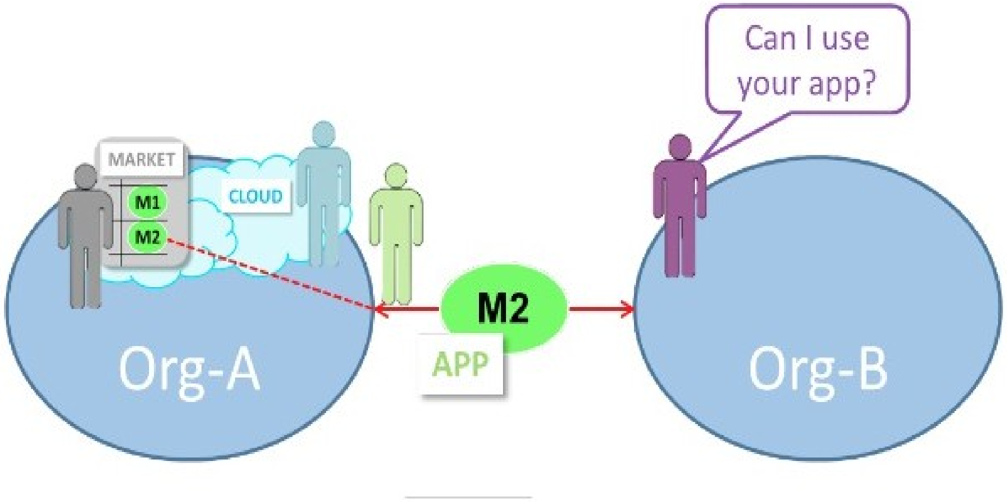
- Background
- *Case Study*: Multi-party acquisition of components for a secure Open Architecture C2 systems within an agile, adaptive software ecosystem
- Emerging R&D challenges in acquiring secure, component-based OA C2 systems
- Emerging challenges in achieving Better Buying Power via component-based OA systems
- Conclusions

Background

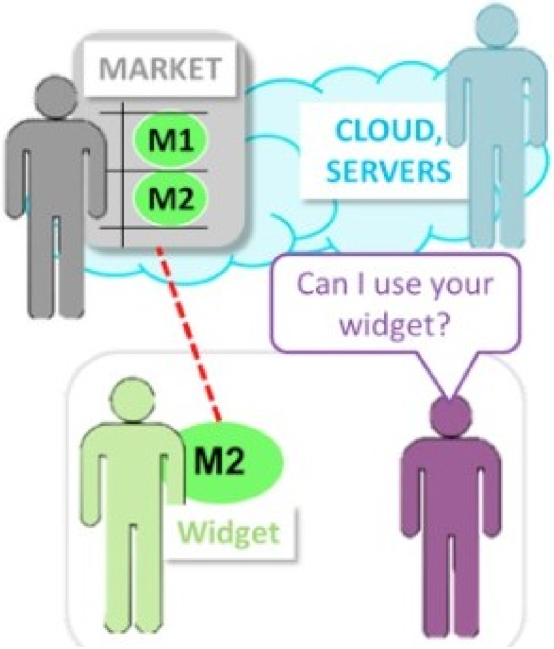
- New ways and means for acquisition, development, and deployment of C2/C3CB systems.
  - Development and deployment of *assembled capabilities* (AC) across the Defense open architecture (OA) software ecosystem
- Who is pursuing AC for C2/C3BC system capabilities?

Transforming to multi-party acquisition of software elements within OA ecosystems

Mobile Reciprocity



Multi-Party Interactions

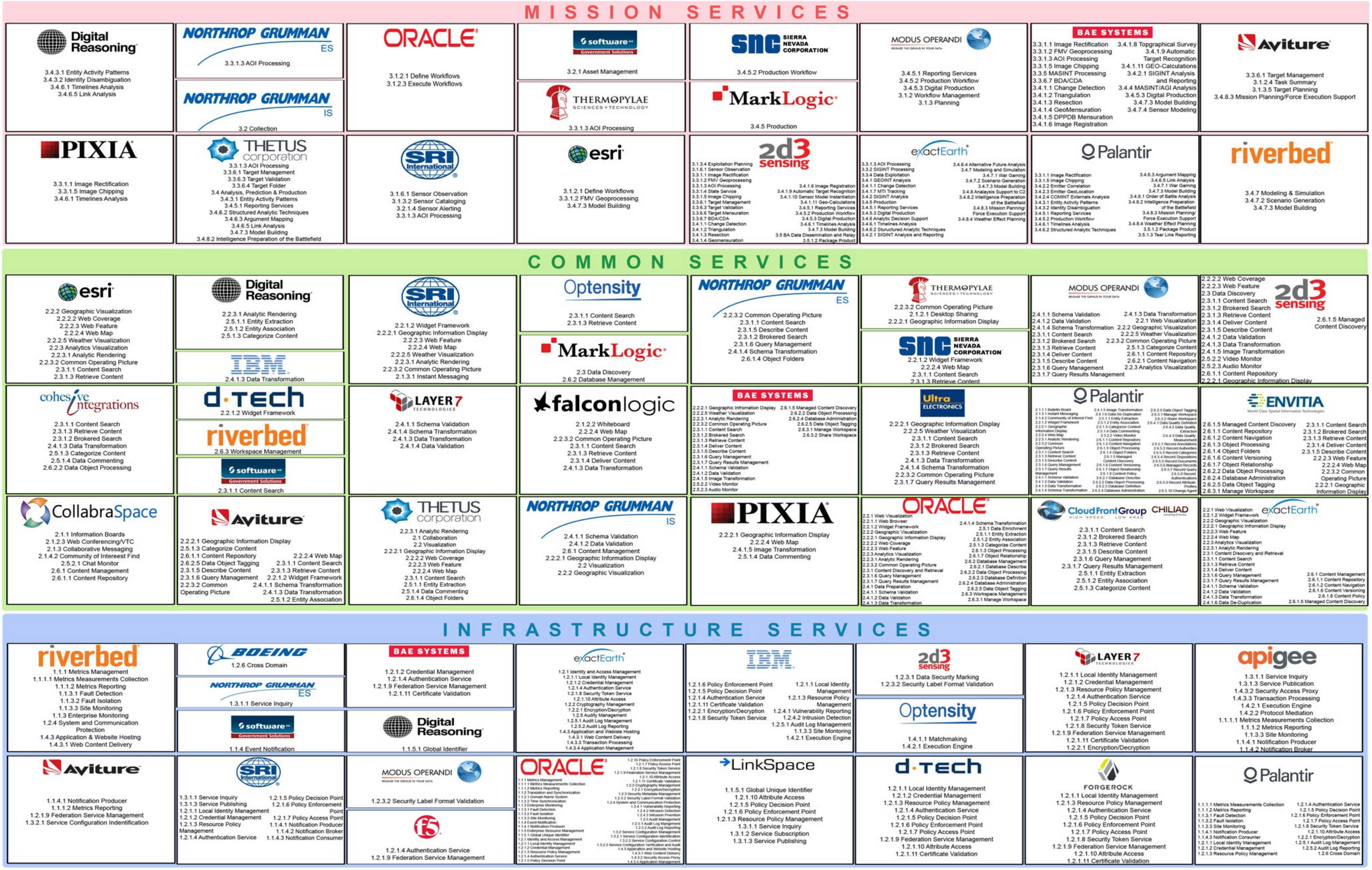


Customer/end-user organizations now looking for ways to reduce acquisition cost and effort through *shared development/use of common OA software system components* (apps, widgets).

C3CB Software Component Types

- *Mission Component*s enable C3CB processes and present common operating picture data to end-users.
  - Mission components realized as apps/widgets that may be deployed on mission-specific platforms including secured Web/mobile devices.
- *Common Development Technology Components* provide AC development tools and common run-time applications servers that support the mission components, where these servers are bundled with Shared Infrastructure.
- S*hared Infrastructure Components* combine local/remote application servers and data repositories with networking services and deployment platforms.

Sample of producers for mission components, common technologies, infrastructure components



MISSION SERVICES

Digital Reasoning
3.4.3.1 Entity Activity Patterns
3.4.3.2 Identity Disambiguation
3.4.6.1 Timelines Analysis
3.4.6.5 Link Analysis

NORTHROP GRUMMAN ES
3.3.1.3 AOI Processing

NORTHROP GRUMMAN IS
3.2 Collection

ORACLE
3.1.2.1 Define Workflows
3.1.2.3 Execute Workflows

software AG Government Solutions
3.2.1 Asset Management

THERMOPYLAE SCIENCES + TECHNOLOGY
3.3.1.3 AOI Processing

SNC SIERRA NEVADA CORPORATION
3.4.5.2 Production Workflow

MarkLogic
3.4.5 Production

MODUS OPERANDI RELEASE THE GENIUS IN YOUR DATA
3.4.5.1 Reporting Services
3.4.5.2 Production Workflow
3.4.5.3 Digital Production
3.1.2 Workflow Management
3.1.3 Planning

BAE SYSTEMS
3.3.1.1 Image Rectification
3.3.1.2 FMV Geoprocessing
3.3.1.3 AOI Processing
3.3.1.5 Image Chipping
3.3.5 MASINT Processing
3.3.6.7 BDA/CDA
3.4.1.1 Change Detection
3.4.1.2 Triangulation
3.4.1.3 Resection
3.4.1.4 GeoMensuration
3.4.1.5 DPPDB Mensuration
3.4.1.6 Image Registration
3.4.1.8 Topgraphical Survey
3.4.1.9 Automatic Target Recognition
3.4.1.11 GEO-Calculations
3.4.2.1 SIGINT Analysis and Reporting
3.4.4 MASINT/AGI Analysis
3.4.5.3 Digital Production
3.4.7.3 Model Building
3.4.7.4 Sensor Modeling

Aviture
3.3.6.1 Target Management
3.1.2.4 Task Summary
3.1.3.5 Target Planning
3.4.8.3 Mission Planning/Force Execution Support

PIXIA
3.3.1.1 Image Rectification
3.3.1.5 Image Chipping
3.4.6.1 Timelines Analysis

THETUS corporation
3.3.1.3 AOI Processing
3.3.6.1 Target Management
3.3.6.3 Target Validation
3.3.6.4 Target Folder
3.4 Analysis, Prediction & Production
3.4.3.1 Entity Activity Patterns
3.4.5.1 Reporting Services
3.4.6.2 Structured Analytic Techniques
3.4.6.3 Argument Mapping
3.4.6.5 Link Analysis
3.4.7.3 Model Building
3.4.8.2 Intelligence Preparation of the Battlefield

SRI International
3.1.6.1 Sensor Observation
3.1.3.2 Sensor Cataloging
3.2.1.4 Sensor Alerting
3.3.1.3 AOI Processing

esri
3.1.2.1 Define Workflows
3.3.1.2 FMV Geoprocessing
3.4.7.3 Model Building

2d3 sensing
3.1.3.4 Exploitation Planning
3.1.6.1 Sensor Observation
3.3.1.1 Image Rectification
3.3.1.2 FMV Geoprocessing
3.3.1.3 AOI Processing
3.3.1.4 State Service
3.3.1.5 Image Chipping
3.3.6.1 Target Management
3.3.6.3 Target Validation
3.3.6.6 Target Mensuration
3.3.6.7 BDA/CDA
3.4.1.1 Change Detection
3.4.1.2 Triangulation
3.4.1.3 Resection
3.4.1.4 Geomensuration
3.4.1.6 Image Registration
3.4.1.9 Automatic Target Recognition
3.4.1.10 Sensor Model Instantiation
3.4.1.11 Geo-Calculations
3.4.5.1 Reporting Services
3.4.5.2 Production Workflow
3.4.5.3 Digital Production
3.4.6.1 Timelines Analysis
3.4.7.3 Model Building
3.5 BA Data Dissemination and Relay
3.5.1.2 Package Product

exactEarth
3.3.1.3 AOI Processing
3.3.2 SIGINT Processing
3.3.4 Data Exploitation
3.4.1 GEOINT Analysis
3.4.1.1 Change Detection
3.4.1.7 MTI Tracking
3.4.2 SIGINT Analysis
3.4.5 Production
3.4.5.1 Reporting Services
3.4.5.3 Digital Production
3.4.6 Analytic Decision Support
3.4.6.1 Timelines Analysis
3.4.6.2 Stuructured Analytic Techniques
3.4.2.1 SIGINT Analysis and Reporting
3.4.6.4 Alternative Future Analysis
3.4.7 Modeling and Simulation
3.4.7.1 War Gaming
3.4.7.2 Scenario Generation
3.4.7.3 Model Building
3.4.8 Anaalysis Support to C2
3.4.8.2 Intelligence Preparation of the Battlefield
3.4.8.3 Mission Panning/ Force Execution Support
3.4.8.4 Weather Effect Planning

Palantir
3.3.1.1 Image Rectification
3.3.1.5 Image Chipping
3.4.2.2 Emitter Correlation
3.4.2.3 Emitter GeoLocation
3.4.2.4 COMINT Externals Analysis
3.4.3.1 Entity Activity Patterns
3.4.3.2 Identity Disambiguation
3.4.5.1 Reporting Services
3.4.5.2 Production Workflow
3.4.6.1 Timelines Analysis
3.4.6.2 Structured Analytic Techniques
3.4.6.3 Argument Mapping
3.4.6.5 Link Analysis
3.4.7.1 War Gaming
3.4.7.3 Model Building
3.4.8.1 Order of Battle Analysis
3.4.8.2 Intelligence Preparation of the Battlefield
3.4.8.3 Mission Planning/ Force Execution Support
3.4.8.4 Weather Effect Planning
3.5.1.2 Package Product
3.5.1.3 Tear Line Reporting

riverbed
3.4.7 Modeling & Simulation
3.4.7.2 Scenario Generation
3.4.7.3 Model Building

COMMON SERVICES

esri
2.2.2 Geographic Visualization
2.2.2.2 Web Coverage
2.2.2.3 Web Feature
2.2.2.4 Web Map
2.2.2.5 Weather Visualization
2.2.3 Analytics Visualization
2.2.3.1 Analytic Rendering
2.2.3.2 Common Operating Picture
2.3.1.1 Content Search
2.3.1.3 Retrieve Content

Digital Reasoning
2.2.3.1 Analytic Rendering
2.5.1.1 Entity Extraction
2.5.1.2 Entity Association
2.5.1.3 Categorize Content

IBM
2.4.1.3 Data Transformation

SRI International
2.2.1.2 Widget Framework
2.2.2.1 Geographic Information Display
2.2.2.3 Web Feature
2.2.2.4 Web Map
2.2.2.5 Weather Visualization
2.2.3.1 Analytic Rendering
2.2.3.2 Common Operating Picture
2.1.3.1 Instant Messaging

Optensity
2.3.1.1 Content Search
2.3.1.3 Retrieve Content

MarkLogic
2.3 Data Discovery
2.6.2 Database Management

NORTHROP GRUMMAN ES
2.2.3.2 Common Operating Picture
2.3.1.1 Content Search
2.3.1.5 Describe Content
2.3.1.2 Brokered Search
2.3.1.6 Query Management
2.4.1.4 Schema Transformation
2.6.1.4 Object Folders

THERMOPYLAE SCIENCES + TECHNOLOGY
2.2.3.2 Common Operating Picture
2.1.2.1 Desktop Sharing
2.2.2.1 Geographic Information Display

SNC SIERRA NEVADA CORPORATION
2.2.1.2 Widget Framework
2.2.2.4 Web Map
2.3.1.1 Content Search
2.3.1.3 Retrieve Content

MODUS OPERANDI RELEASE THE GENIUS IN YOUR DATA
2.4.1.1 Schema Validation
2.4.1.2 Data Validation
2.4.1.4 Schema Transformation
2.3.1.1 Content Search
2.3.1.2 Brokered Search
2.3.1.3 Retrieve Content
2.3.1.4 Deliver Content
2.3.1.5 Describe Content
2.3.1.6 Query Management
2.3.1.7 Query Results Management
2.4.1.3 Data Transformation
2.2.1 Web Visualization
2.2.2 Geographic Visualization
2.2.2.5 Weather Visualization
2.2.3.2 Common Operating Picture
2.5.1.3 Categorize Content
2.6.1.1 Content Repository
2.6.2.1 Content Navigation
2.2.3 Analytics Visualization

2d3 sensing
2.2.2.2 Web Coverage
2.2.2.3 Web Feature
2.3 Data Discovery
2.3.1.1 Content Search
2.3.1.2 Brokered Search
2.3.1.3 Retrieve Content
2.3.1.4 Deliver Content
2.3.1.5 Describe Content
2.4.1.2 Data Validation
2.4.1.3 Data Transformation
2.4.1.5 Image Transformation
2.5.2.2 Video Monitor
2.5.2.3 Audio Monitor
2.6.1.1 Content Repository
2.2.2.1 Geographic Information Display
2.6.1.5 Managed Content Discovery

cohesive integrations
2.3.1.1 Content Search
2.3.1.3 Retrieve Content
2.3.1.2 Brokered Search
2.4.1.3 Data Transformation
2.5.1.3 Categorize Content
2.5.1.4 Data Commenting
2.6.2.2 Data Object Processing

d·tech
2.2.1.2 Widget Framework

riverbed
2.6.3 Workspace Management

software AG Government Solutions
2.3.1.1 Content Search

LAYER 7 TECHNOLOGIES
2.4.1.1 Schema Validation
2.4.1.4 Schema Transformation
2.4.1.3 Data Transformation
2.4.1.4 Data Validation

falconlogic
2.1.2.2 Whiteboard
2.2.2.4 Web Map
2.2.3.2 Common Operating Picture
2.3.1.1 Content Search
2.3.1.3 Retrieve Content
2.3.1.4 Deliver Content
2.4.1.3 Data Transformation

BAE SYSTEMS
2.2.2.1 Geographic Infromation Display
2.2.2.5 Weather Visualization
2.2.3.1 Analytic Rendering
2.2.3.2 Common Operating Picture
2.3.1.1 Content Search
2.3.1.2 Brokered Search
2.3.1.3 Retrieve Content
2.3.1.4 Deliver Content
2.3.1.5 Describe Content
2.3.1.6 Query Management
2.3.1.7 Query Results Management
2.4.1.1 Schema Validation
2.4.1.2 Data Validation
2.4.1.5 Image Transformation
2.5.2.2 Video Monitor
2.5.2.3 Audio Monitor
2.6.1.5 Managed Content Discovery
2.6.2.2 Data Object Processing
2.6.2.4 Database Administration
2.6.2.5 Data Object Tagging
2.6.3.1 Manage Workspace
2.6.3.2 Share Workspace

Ultra ELECTRONICS
2.2.2.1 Geographic Information Display
2.2.2.5 Weather Visualization
2.3.1.1 Content Search
2.3.1.2 Brokered Search
2.3.1.3 Retrieve Content
2.4.1.3 Data Transformation
2.4.1.4 Schema Transformation
2.2.3.2 Common Operating Picture
2.3.1.7 Query Results Management

Palantir
2.1.1.1 Bulletin Board
2.1.3.1 Instant Messaging
2.1.4.2 Community of Interest Find
2.2.1.2 Widget Framework
2.2.2.1 Geographic Information Display
2.2.2.4 Web Map
2.2.3.1 Analytic Rendering
2.2.3.2 Common Operating Picture
2.3.1.1 Content Search
2.3.1.3 Retrieve Content
2.3.1.5 Describe Content
2.3.1.6 Query Management
2.3.1.7 Query Results Management
2.4.1.1 Schema Validation
2.4.1.2 Data Validation
2.4.1.3 Data Transformation
2.4.1.4 Schema Transformation
2.4.1.5 Image Transformation
2.4.1.6 Data De-Duplication
2.5.1.1 Entity Extraction
2.5.1.2 Entity Association
2.5.1.3 Categorize Content
2.5.1.4 Data Commenting
2.5.2.2 Video Monitor
2.6.1.1 Content Repository
2.6.1.2 Content Navigation
2.6.1.3 Object Processing
2.6.1.4 Object Folders
2.6.1.5 Managed Content Discovery
2.6.1.6 Content Versioning
2.6.1.7 Object Relationship
2.6.1.8 Content Policy
2.6.2.1 Database Describe
2.6.2.2 Data Object Processing
2.6.2.3 Database Definition
2.6.2.4 Database Administration
2.6.2.5 Data Object Tagging
2.6.3.1 Manage Workspace
2.6.3.2 Share Workspace
2.6.4.1 Data Quality Definition
2.6.4.2 Data Quality Extraction
2.6.4.3 Data Quality Measurement
2.6.5.1 Record Annotations
2.6.5.2 Record Authorities
2.6.5.3 Record Categories
2.6.5.4 Record Dispositions
2.6.5.5 Record Documents
2.6.5.6 Managed Records
2.6.5.7 Record Query
2.6.5.8 Record Authentications
2.6.5.9 Record Attribute Profiles
2.6.5.10 Change Agent

ENVITIA World Class Spatial Information Technologies
2.6.1.5 Managed Content Discovery
2.6.1.1 Content Repository
2.6.1.2 Content Navigation
2.6.1.3 Object Processing
2.6.1.4 Object Folders
2.6.1.6 Content Versioning
2.6.1.7 Object Relationship
2.6.2.2 Data Object Processing
2.6.2.4 Database Administration
2.6.2.5 Data Object Tagging
2.6.3.1 Manage Workspace
2.3.1.1 Content Search
2.3.1.2 Brokered Search
2.3.1.3 Retrieve Content
2.3.1.4 Deliver Content
2.3.1.5 Describe Content
2.2.2.3 Web Feature
2.2.2.4 Web Map
2.2.3.2 Common Operating Picture
2.2.2.1 Geographic Information Display

CollabraSpace
2.1.1 Information Boards
2.1.2.3 Web Conferencing/VTC
2.1.3 Collaborative Messaging
2.1.4.2 Community of Intereest Find
2.5.2.1 Chat Monitor
2.6.1 Content Management
2.6.1.1 Content Repository

Aviture
2.2.2.1 Geographic Information Display
2.5.1.3 Categorize Content
2.6.1.1 Content Repository
2.6.2.5 Data Object Tagging
2.3.1.5 Describe Content
2.3.1.6 Query Management
2.2.3.2 Common Operating Picture
2.2.2.4 Web Map
2.3.1.1 Content Search
2.3.1.3 Retrieve Content
2.2.1.2 Widget Framework
2.4.1.1 Schema Transformation
2.4.1.3 Data Transformation
2.5.1.2 Entity Association

THETUS corporation
2.2.3.1 Analytic Rendering
2.1 Collaboration
2.2 Visualization
2.2.2.1 Geographic Information Display
2.2.2.2 Web Coverage
2.2.2.3 Web Feature
2.2.2.4 Web Map
2.3.1.1 Content Search
2.5.1.1 Entity Extraction
2.5.1.4 Data Commenting
2.6.1.4 Object Folders

NORTHROP GRUMMAN IS
2.4.1.1 Schema Validation
2.4.1.2 Data Validation
2.6.1 Content Management
2.2.2.1 Geographic Information Display
2.2 Visualization
2.2.2 Geographic Visualization

PIXIA
2.2.2.1 Geographic Information Display
2.2.2.4 Web Map
2.4.1.5 Image Transformation
2.5.1.4 Data Commenting

ORACLE
2.2.1 Web Visualization
2.2.1.1 Web Browser
2.2.1.2 Widget Framework
2.2.2 Geographic Visualization
2.2.2.1 Geographic Information Display
2.2.2.2 Web Coverage
2.2.2.3 Web Feature
2.2.3 Analytics Visualization
2.2.3.1 Analytic Rendering
2.2.3.2 Common Operating Picture
2.3.1 Content Discovery and Retrieval
2.3.1.6 Query Management
2.3.1.7 Query Results Management
2.4.1 Data Preparation
2.4.1.1 Schema Validation
2.4.1.2 Data Validation
2.4.1.3 Data Transformation
2.4.1.4 Schema Transformation
2.5.1 Data Enrichment
2.5.1.1 Entity Extraction
2.5.1.2 Entity Association
2.5.1.3 Categorize Content
2.6.1.3 Object Processing
2.6.1.7 Object Relationship
2.6.2 Database Management
2.6.2.1 Database Describe
2.6.2.2 Data Object Processing
2.6.2.3 Database Definition
2.6.2.4 Database Administration
2.6.2.5 Data Object Tagging
2.6.3 Workspace Management
2.6.3.1 Manage Workspace

CloudFrontGroup HIGH SPEED LOW DRAG **CHILIAD**
2.3.1.1 Content Search
2.3.1.2 Brokered Search
2.3.1.3 Retrieve Content
2.3.1.5 Describe Content
2.3.1.6 Query Management
2.3.1.7 Query Results Management
2.5.1.1 Entity Extraction
2.5.1.2 Entity Association
2.5.1.3 Categorize Content

exactEarth
2.2.1 Web Visualization
2.2.1.2 Widget Framework
2.2.2 Geographic Visualization
2.2.2.1 Geographic Infromation Display
2.2.2.3 Web Feature
2.2.2.4 Web Map
2.2.3 Analytics Visualization
2.2.3.1 Analytic Rendering
2.3.1 Content Disocvery and Retrieval
2.3.1.1 Content Search
2.3.1.3 Retrieve Content
2.3.1.4 Deliver Content
2.3.1.6 Query Management
2.3.1.7 Query Results Management
2.4.1.1 Schema Validation
2.4.1.2 Data Validation
2.4.1.3 Data Transformation
2.4.1.6 Data De-Duplication
2.6.1 Content Management
2.6.1.1 Content Repository
2.6.1.2 Content Navigation
2.6.1.6 Content Versioning
2.6.1.8 Content Policy
2.6.1.5 Managed Content Discovery

INFRASTRUCTURE SERVICES

riverbed
1.1.1 Metrics Management
1.1.1.1 Metrics Measurements Collection
1.1.1.2 Metrics Reporting
1.1.3.1 Fault Detection
1.1.3.2 Fault Isolation
1.1.3.3 Site Monitoring
1.1.3 Enterprise Monitoring
1.2.4 System and Communication Protection
1.4.3 Application & Website Hosting
1.4.3.1 Web Content Delivery

BOEING
1.2.6 Cross Domain

NORTHROP GRUMMAN ES
1.3.1.1 Service Inquiry

software AG Government Solutions
1.1.4 Event Notification

BAE SYSTEMS
1.2.1.2 Credential Management
1.2.1.4 Authentication Service
1.2.1.9 Federation Service Management
1.2.1.11 Certificate Validation

Digital Reasoning
1.1.5.1 Global Identifier

exactEarth
1.2.1 Identity and Access Management
1.2.1.1 Local Identity Management
1.2.1.2 Credential Management
1.2.1.4 Authentication Service
1.2.1.8 Security Token Service
1.2.1.10 Attribute Access
1.2.2 Cryptography Management
1.2.2.1 Encryption/Decryption
1.2.5 Audity Management
1.2.5.1 Audit Log Management
1.2.5.2 Audit Log Reporting
1.4.3 Application and Webiste Hosting
1.4.3.1 Web Content Delivery
1.4.3.3 Transaction Processing
1.4.3.4 Application Management

IBM
1.2.1.6 Policy Enforcement Point
1.2.1.5 Policy Decision Point
1.2.1.4 Authentication Service
1.2.1.11 Certificate Validation
1.2.2.1 Encryption/Decryption
1.2.1.8 Security Token Service
1.2.1.1 Local Identity Management
1.2.1.3 Resource Policy Management
1.2.4.1 Vulnerability Reporting
1.2.4.2 Intrusion Detection
1.2.5.1 Audit Log Management
1.1.3.3 Site Montoring
1.4.2.1 Execution Engine

2d3 sensing
1.2.3.1 Data Security Marking
1.2.3.2 Security Label Format Validation

Optensity
1.4.1.1 Matchmaking
1.4.2.1 Execution Engine

LAYER 7 TECHNOLOGIES
1.2.1.1 Local Identity Management
1.2.1.2 Credential Management
1.2.1.3 Resource Policy Management
1.2.1.4 Authentication Service
1.2.1.5 Policy Decision Point
1.2.1.6 Policy Enforcement Point
1.2.1.7 Policy Access Point
1.2.1.8 Security Token Service
1.2.1.9 Federation Service Management
1.2.1.11 Certificate Validation
1.2.2.1 Encryption/Decryption

apigee
1.3.1.1 Service Inquiry
1.3.1.3 Service Publication
1.4.3.2 Security Access Proxy
1.4.3.3 Transaction Processing
1.4.2.1 Execution Engine
1.4.2.2 Protocol Mediation
1.1.1.1 Metrics Measurements Collection
1.1.1.2 Metrics Reporting
1.1.3.3 Site Monitoring
1.1.4.1 Notification Producer
1.1.4.2 Notification Broker

Aviture
1.1.4.1 Notification Producer
1.1.1.2 Metrics Reporting
1.2.1.9 Federation Service Management
1.3.2.1 Service Configuration Indentification

SRI International
1.3.1.1 Service Inquiry
1.3.1.3 Service Publishing
1.2.1.1 Local Identity Management
1.2.1.2 Credential Management
1.2.1.3 Resource Policy Management
1.2.1.4 Authentication Service
1.2.1.5 Policy Decision Point
1.2.1.6 Policy Enforcement Point
1.2.1.7 Policy Access Point
1.1.4.1 Notification Producer
1.1.4.2 Notification Broker
1.1.4.3 Notification Consumer

MODUS OPERANDI RELEASE THE GENIUS IN YOUR DATA
1.2.3.2 Security Label Format Validation

f5
1.2.1.4 Authentication Service
1.2.1.9 Federation Service Management

ORACLE
1.1.1 Metrics Management
1.1.1.1 Metrics Measurements Collection
1.1.1.2 Metrics Reporting
1.1.2 Translation and Synchronization
1.1.2.1 Domain Name System
1.1.2.2 Time Synchronization
1.1.3 Enterprise Monitoring
1.1.3.1 Fault Detection
1.1.3.2 Fault Isolation
1.1.3.3 Site Monitoring
1.1.4 Event Notification
1.1.4.1 Notification Producer
1.1.5 Enterprise Resource Management
1.1.5.1 Global Unique Identifier
1.2.1 Identity and Access Management
1.2.1.1 Local Identity Management
1.2.1.2 Credential Management
1.2.1.3 Resource Policy Management
1.2.1.4 Authentication Service
1.2.1.5 Policy Decision Point
1.2.16 Policy Enforcement Point
1.2.1.7 Policy Access Point
1.2.1.8 Security Token Service
1.2.1.9 Federation Service Management
1.2.1.10 Attribute Access
1.2.1.11 Certificate Validation
1.2.2 Cryptography Management
1.2.2.1 Encryption/Decryption
1.2.3 Security Metadata Management
1.2.3.2 Security Label Format Validation
1.2.4 System and Communication Protection
1.2.4.1 Vulnerability Reporting
1.2.4.2 Intrusion Detection
1.2.4.3 Intrusion Prvention
1.2.5 Audit Management
1.2.5.1 Audit Log Mangement
1.2.5.2 Audit Log Reporting
1.3.2 Service Configuration Management
1.3.2.1 Service Configuration Identification
1.3.2.2 Service Configuration Control
1.3.2.3 Service Configuration Verification and Audit
1.4.3 Application and Website Hosting
1.4.3.1 Web Content Delivery
1.4.3.2 Security Access Pony
1.4.3.4 Application Management

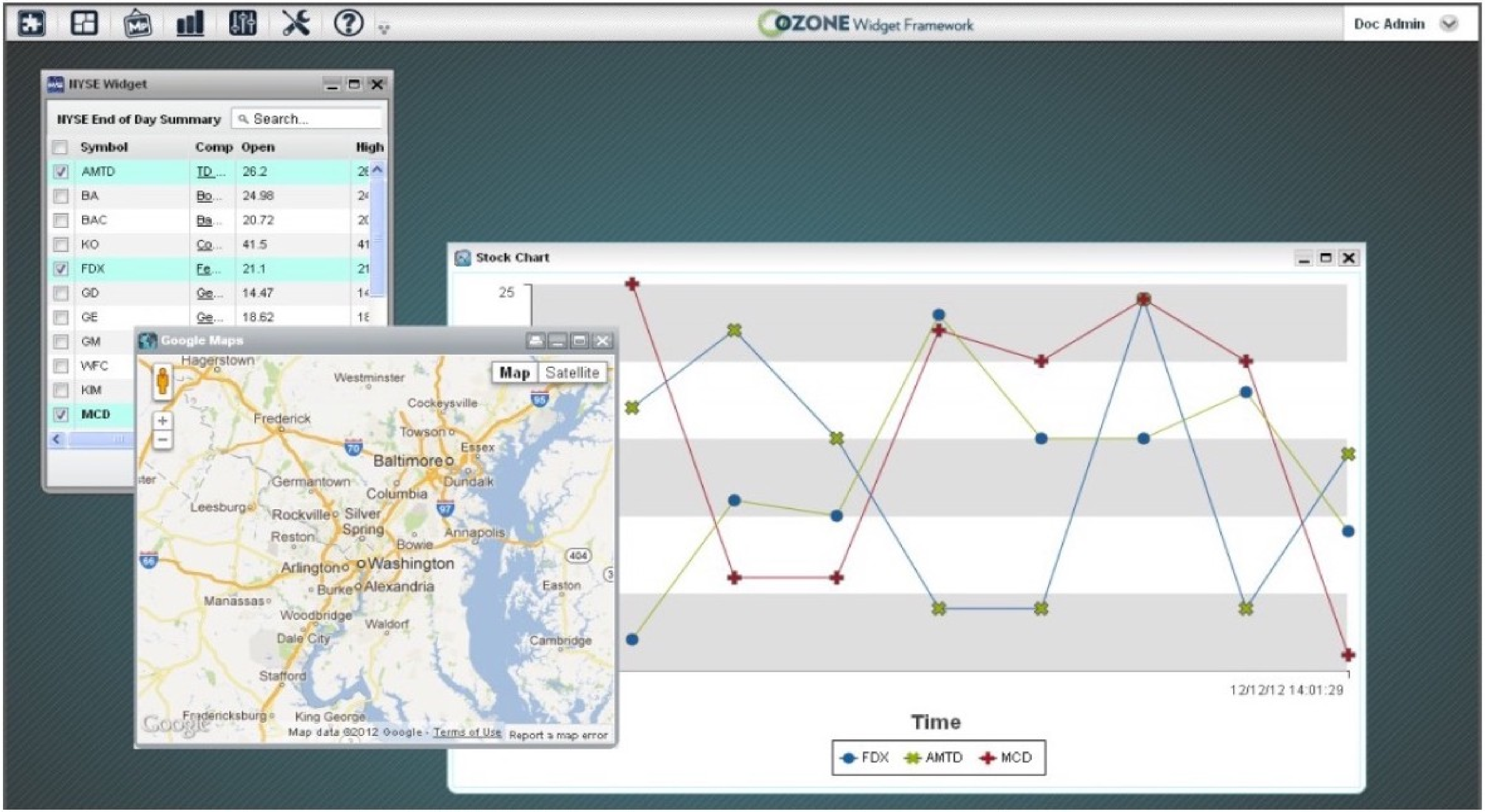
LinkSpace
1.1.5.1 Global Unique Identifier
1.2.1.10 Attribute Access
1.2.1.5 Policy Decision Point
1.2.1.6 Policy Enforcement Point
1.2.1.3 Resource Policy Management
1.3.1.1 Service Inquiry
1.3.1.2 Service Subscription
1.3.1.3 Service Publishing

d·tech
1.2.1.1 Local Identity Management
1.2.1.2 Credential Management
1.2.1.3 Resource Policy Management
1.2.1.4 Authentication Service
1.2.1.5 Policy Decision Point
1.2.1.6 Policy Enforcement Point
1.2.1.7 Policy Access Point
1.2.1.9 Federation Service Management
1.2.1.10 Attribute Access
1.2.1.11 Certificate Validation

FORGEROCK
1.2.1.1 Local Identity Management
1.2.1.3 Resource Policy Management
1.2.1.4 Authentication Service
1.2.1.5 Policy Decision Point
1.2.1.6 Policy Enforcement Point
1.2.1.7 Policy Access Point
1.2.1.8 Security Token Service
1.2.1.9 Federation Service Management
1.2.1.10 Attribute Access
1.2.1.11 Certificate Validation

Palantir
1.1.1.1 Metrics Measurements Collection
1.1.1.2 Metrics Reporting
1.1.3.1 Fault Detection
1.1.3.2 Fault Isolation
1.1.3.3 Site Monitoring
1.1.4.1 Notification Producer
1.1.4.3 Notification Consumer
1.2.1.1 Local Identity Management
1.2.1.2 Credential Management
1.2.1.3 Resource Policy Management
1.2.1.4 Authentication Service
1.2.1.5 Policy Decision Point
1.2.1.6 Policy Enforcement Point
1.2.1.7 Policy Access Point
1.2.1.8 Security Token Service
1.2.1.10 Attribute Access
1.2.2.1 Encryption/Decryption
1.2.5.1 Audit Log Management
1.2.5.2 Audit Log Reporting
1.2.6 Cross Domain

New paths for software component acquisition and development using inter-communicating widgets/apps acquired from online App Stores

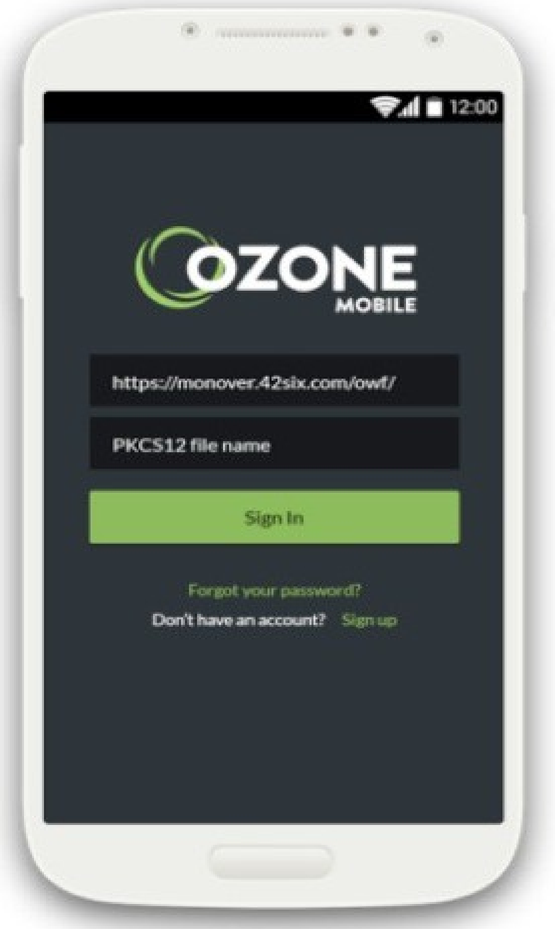


NYSE End of Day Summary

□	Symbol	Comp	Open	High
☑	AMTD	TD...	26.2	26
□	BA	Bo...	24.98	24
□	BAC	Ba...	20.72	20
□	KO	Co...	41.5	41
☑	FDX	Fe...	21.1	21
□	GD	Ge...	14.47	14
□	GE	Ge...	18.62	18
□	GM			
□	WFC			
□	KIM			
☑	MCD			

Shared development of Apps and Widgets as OA system components

CAS Sign In



12:00

OZONE MOBILE

https://monover.42six.com/owf/

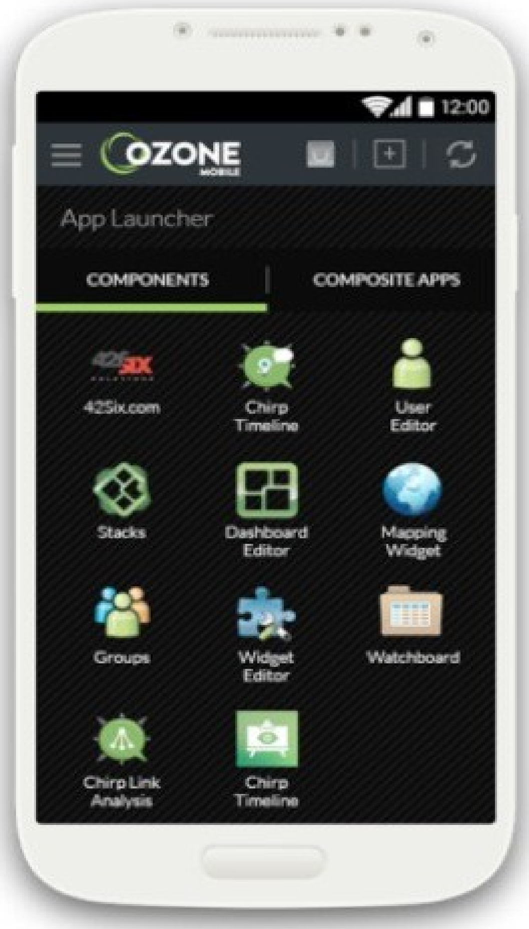
PKCS12 file name

Sign In

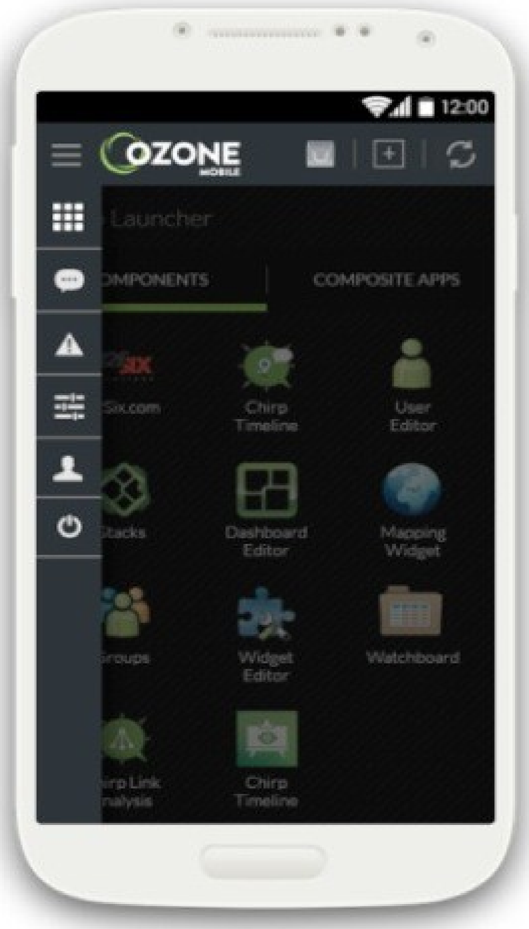
Forgot your password?

Don't have an account? Sign up

App Launcher



Ozone Mobile Drawer Menu



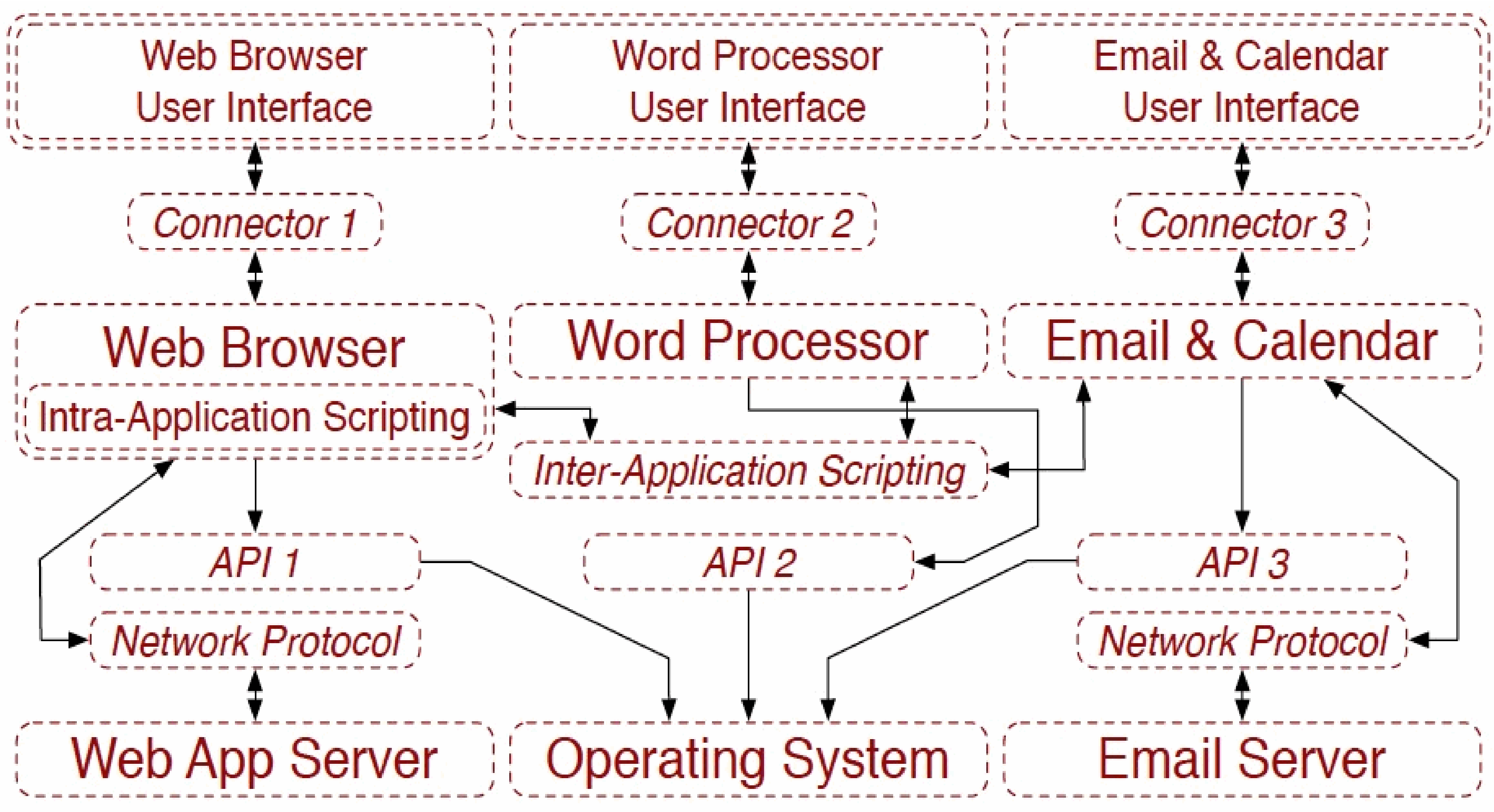
Ozone Platform for Mobile Devices

Who is pursuing AC for C2/C3BC systems?

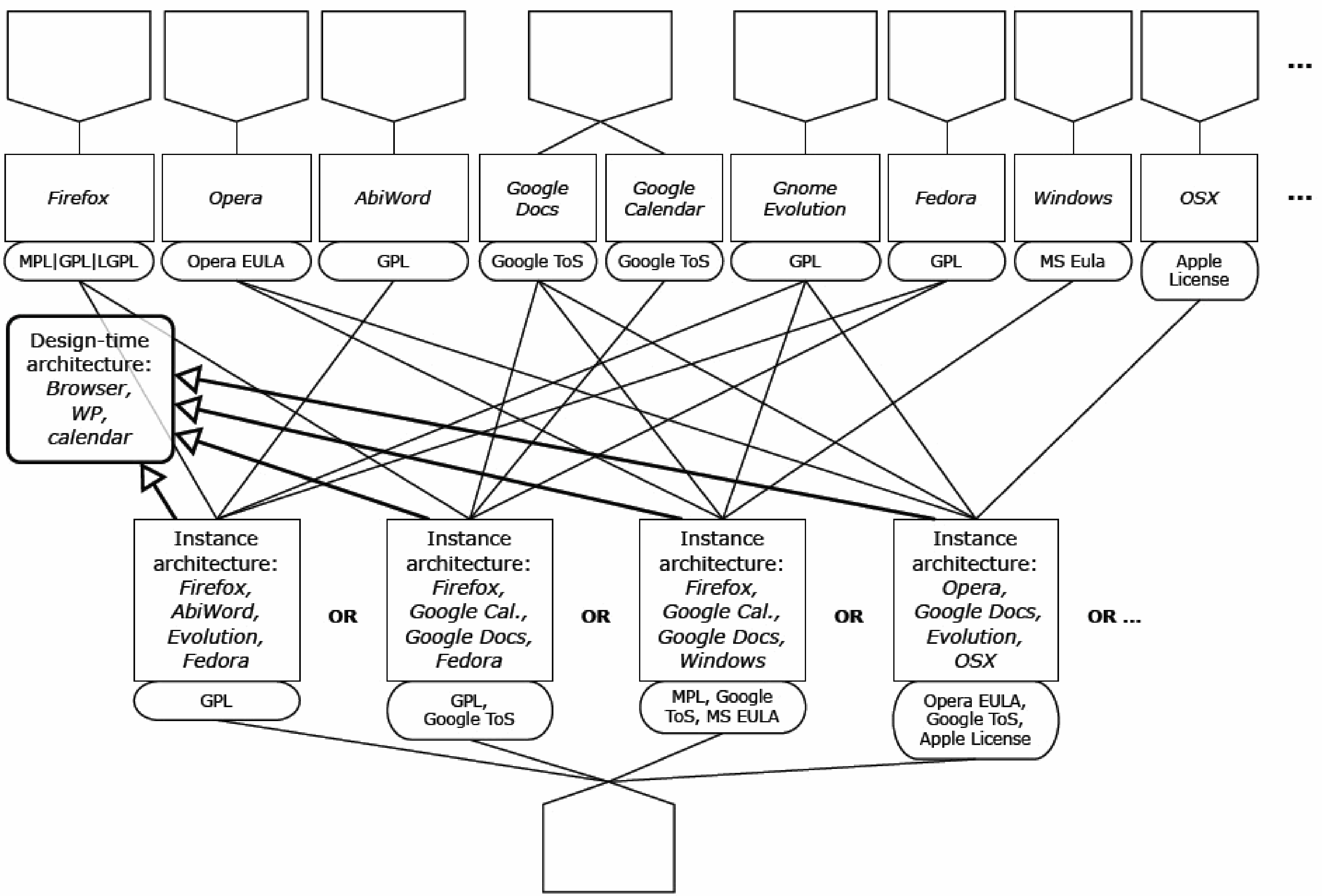
- OUSD (AT+L), DASD(A)-C3CB Working Group
- Air Force – TBMCS-FL (manages ATOs, manages Airspace)
- Air Force – AOC (Air Operations Center, using harvested components from TBMCS-FL, and CANES)
- Army – DCGS-A, DIB (DCGS Integration Backbone), and DMO (DIB Management Office)
- Navy – CANES and ACS (Afloat Core Services)
- Navy – PEO C4ISR Storefront and Tactical Cloud Marketplace
- DI2E

Case Study: OSS, open architectures, and software licenses for C2 or C3CB systems

Design-time view of an OA system

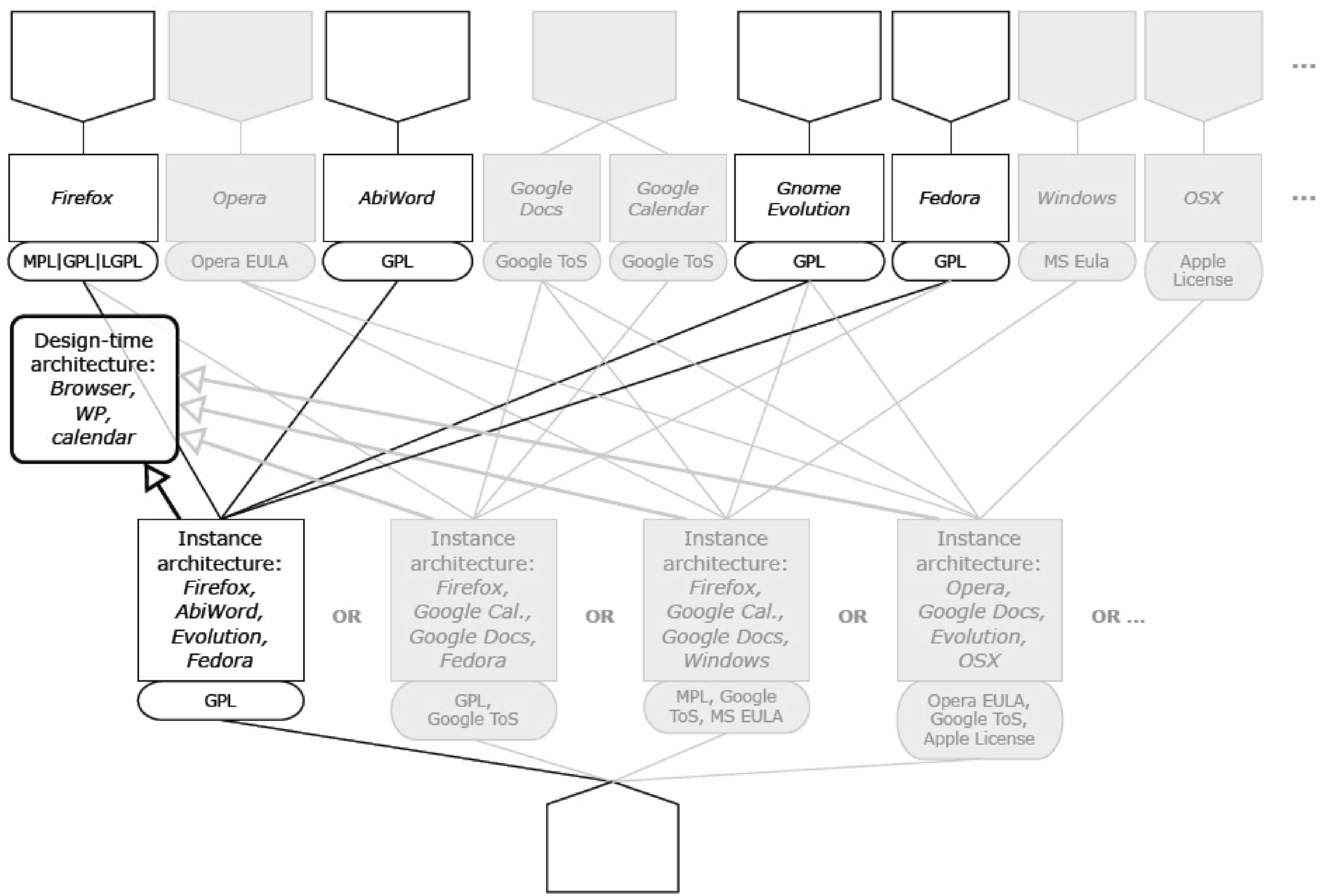


Software product line of *functionally similar* OA system alternatives



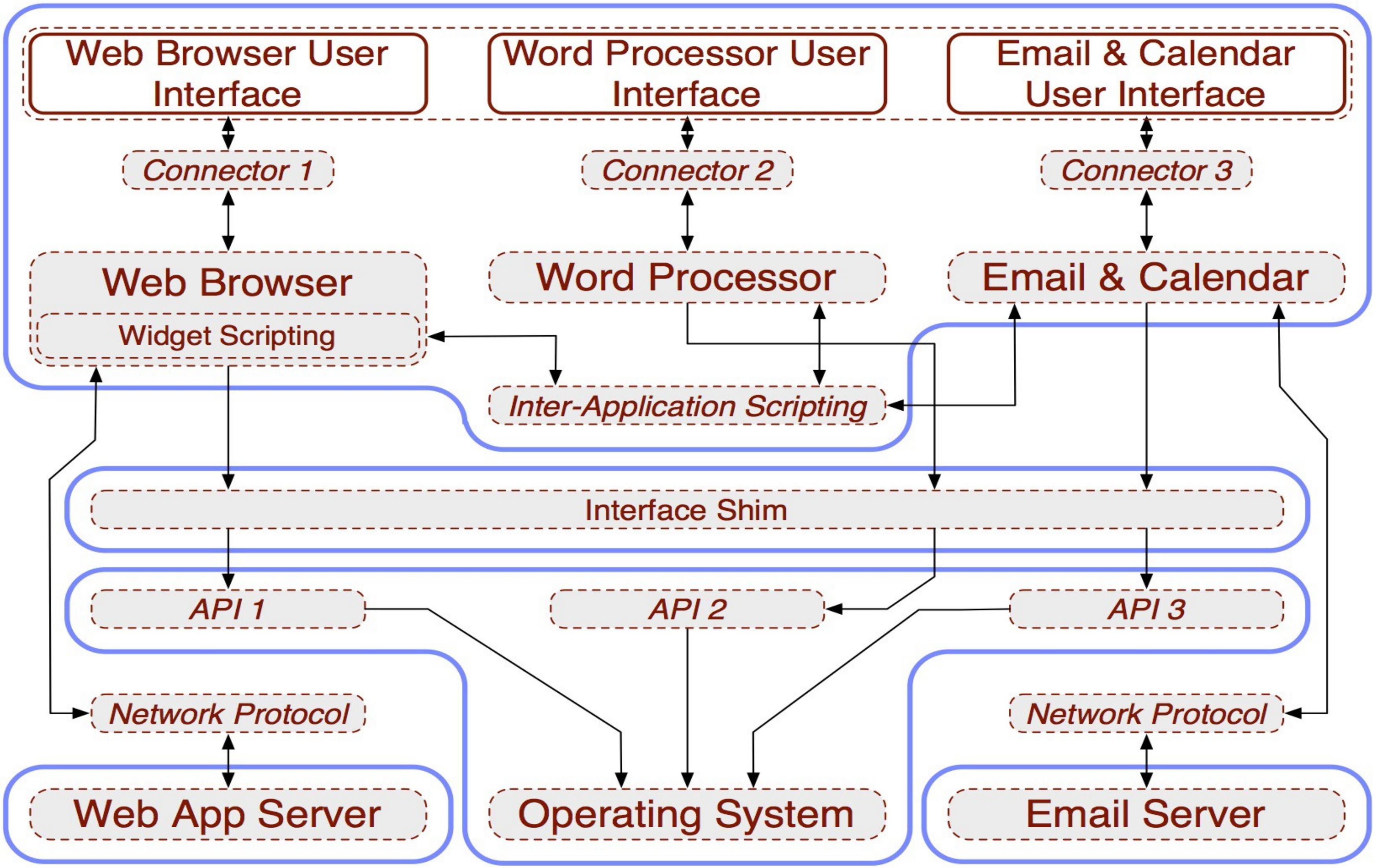
...
Firefox
Opera
AbiWord
Google Docs
Google Calendar
Gnome Evolution
Fedora
Windows
OSX
...
MPL|GPL|LGPL
Opera EULA
GPL
Google ToS
Google ToS
GPL
GPL
MS Eula
Apple License
Design-time architecture: Browser, WP, calendar
Instance architecture: Firefox, AbiWord, Evolution, Fedora
GPL
OR
Instance architecture: Firefox, Google Cal., Google Docs, Fedora
GPL, Google ToS
OR
Instance architecture: Firefox, Google Cal., Google Docs, Windows
MPL, Google ToS, MS EULA
OR
Instance architecture: Opera, Google Docs, Evolution, OSX
Opera EULA, Google ToS, Apple License
OR ...

Product line selection of one alternative system configuration

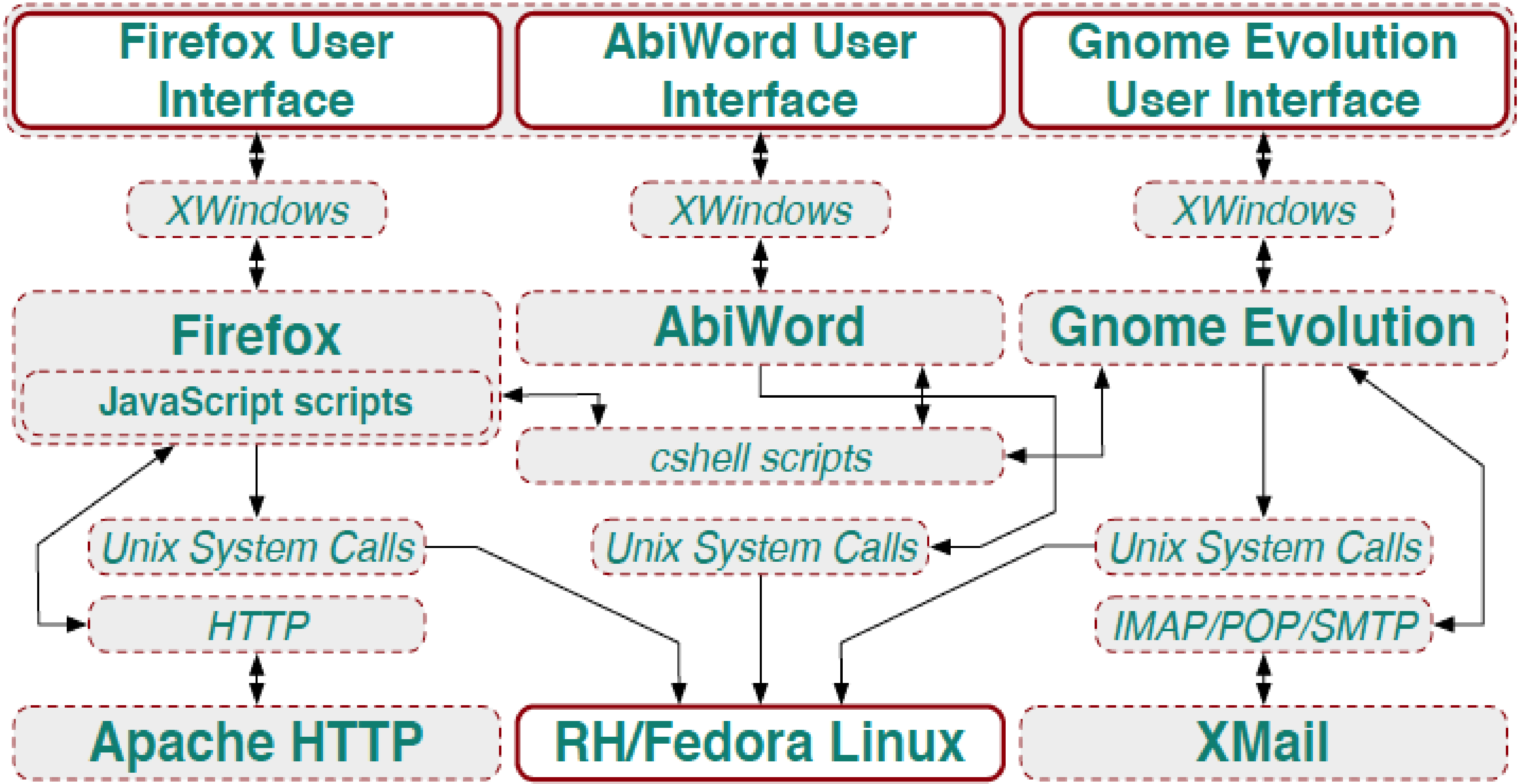


...
Firefox
Opera
AbiWord
Google Docs
Google Calendar
Gnome Evolution
Fedora
Windows
OSX
...
MPL|GPL|LGPL
Opera EULA
GPL
Google ToS
Google ToS
GPL
GPL
MS Eula
Apple License
Design-time architecture: Browser, WP, calendar
Instance architecture: Firefox, AbiWord, Evolution, Fedora
GPL
OR
Instance architecture: Firefox, Google Cal., Google Docs, Fedora
GPL, Google ToS
OR
Instance architecture: Firefox, Google Cal., Google Docs, Windows
MPL, Google ToS, MS EULA
OR
Instance architecture: Opera, Google Docs, Evolution, OSX
Opera EULA, Google ToS, Apple License
OR ...

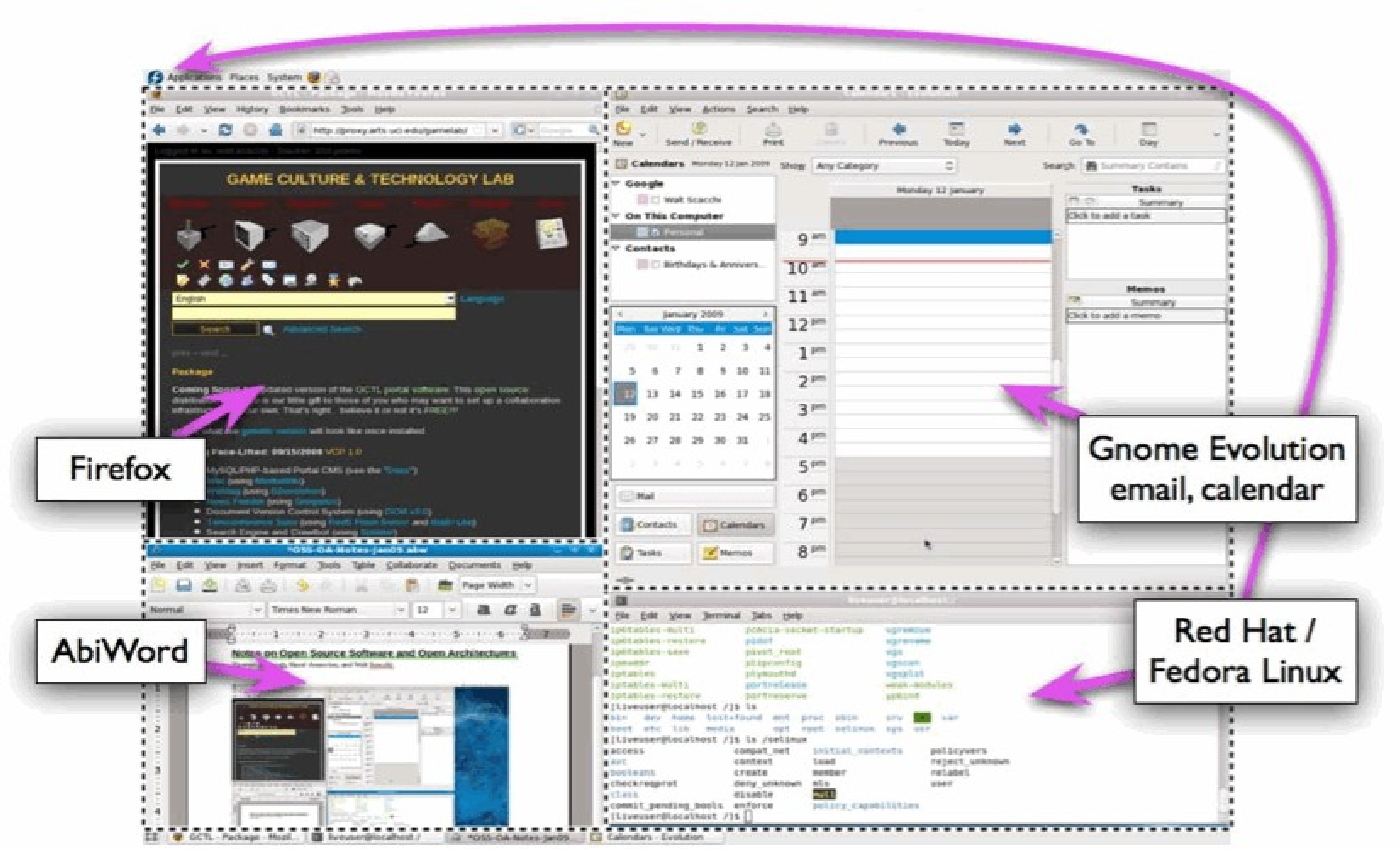
A security capability specification encapsulating the *design-time* configuration via multiple virtual machine containers



Build-time view of OA design selecting *OSS* product family alternatives



Run-time deployment view of OA system family member configuration



Firefox

Gnome Evolution email, calendar

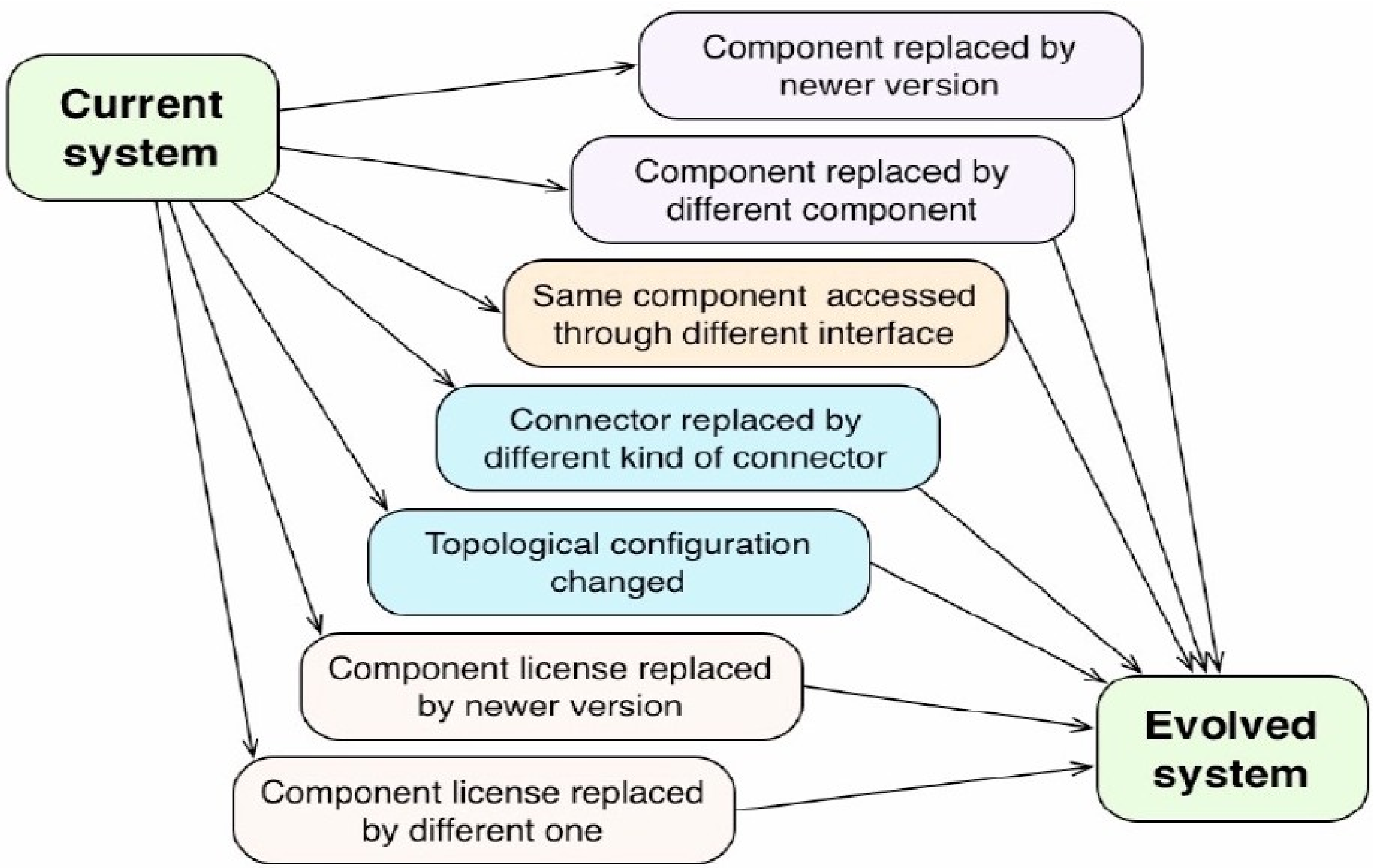
AbiWord

Red Hat / Fedora Linux

```
ip6tables-multi        pcmcia-socket-startup   vgremove
ip6tables-restore      pidof                   vgrename
ip6tables-save         pivot_root              vgs
ipmaddr                plipconfig              vgscan
iptables               plymouthd               vgsplit
iptables-multi         portrelease             weak-modules
iptables-restore       portreserve             ypbind
[liveuser@localhost /]$ ls
bin   dev  home  lost+found  mnt  proc  sbin     srv  tmp  var
boot  etc  lib   media       opt  root  selinux  sys  usr
[liveuser@localhost /]$ ls /selinux
access                compat_net    initial_contexts   policyvers
avc                   context       load               reject_unknown
booleans              create        member             relabel
checkreqprot          deny_unknown  mls                user
class                 disable       null
commit_pending_bools  enforce       policy_capabilities
[liveuser@localhost /]$ 
```

Applications Places System
File Edit View History Bookmarks Tools Help
GAME CULTURE & TECHNOLOGY LAB
Package
File Edit View Actions Search Help
New
Send / Receive
Print
Previous
Today
Next
Go To
Day
Calendars
Google
On This Computer
Personal
Contacts
January 2009
Monday 12 January
Tasks
Memos
Mail
Contacts
Calendars
Tasks
Memos
*OSS-OA-Notes-Jan09.abw
File Edit View Insert Format Tools Table Collaborate Documents Help
Normal
Times New Roman
12
Notes on Open Source Software and Open Architectures
File Edit View Terminal Tabs Help
GCTL - Package - Mozil...
liveuser@localhost:/
*OSS-OA-Notes-Jan09...
Calendars - Evolution

Evolution-time software changes



Current system

Component replaced by newer version

Component replaced by different component

Same component accessed through different interface

Connector replaced by different kind of connector

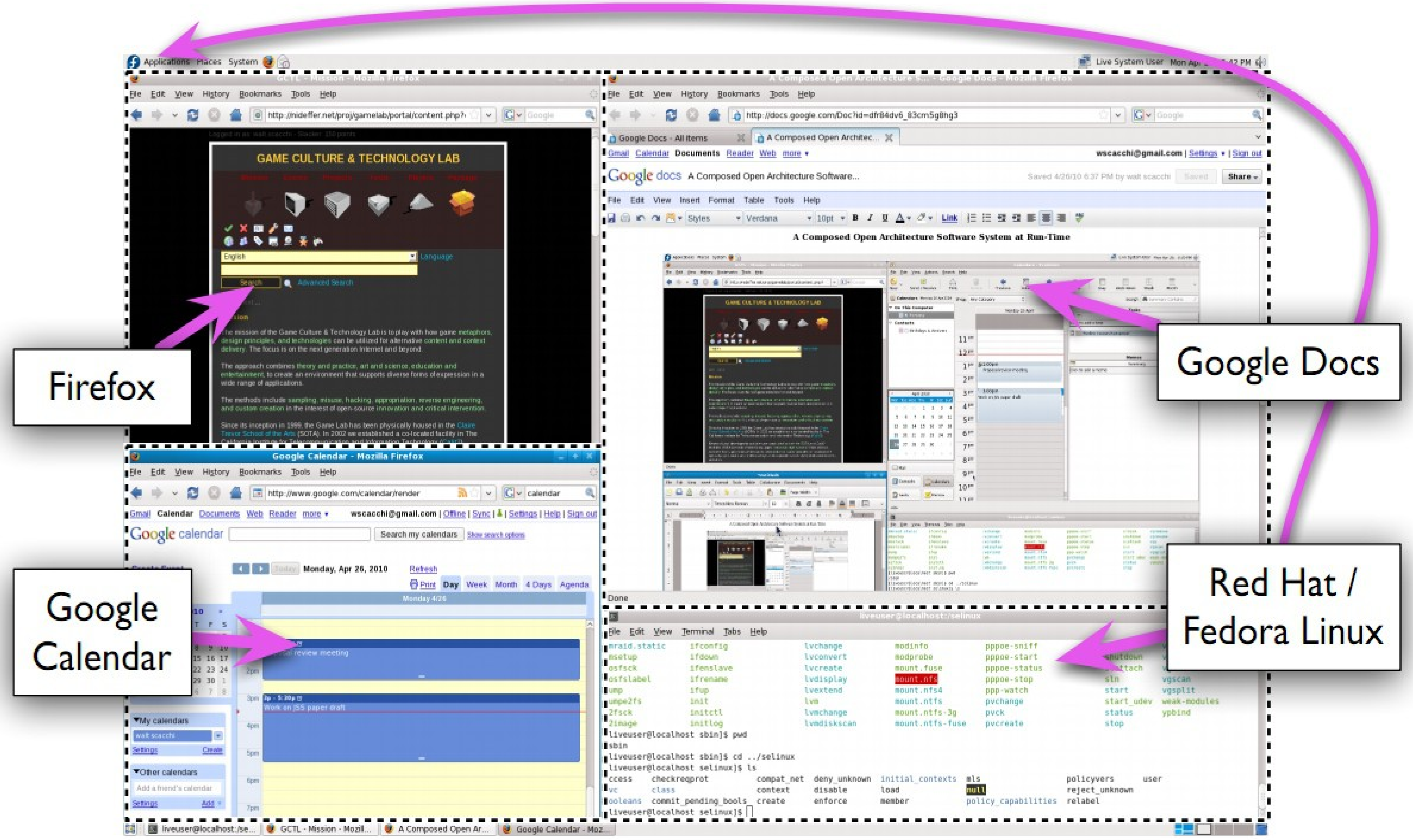
Topological configuration changed

Component license replaced by newer version

Component license replaced by different one

Evolved system

Evolved run-time deployment view of a *functionally similar* alternative OA system configuration


Firefox
Google Docs
Google Calendar
Red Hat / Fedora Linux
GCTL - Mission - Mozilla Firefox
A Composed Open Architecture S... - Google Docs - Mozilla Firefox
Google Calendar - Mozilla Firefox
liveuser@localhost:/selinux
GAME CULTURE & TECHNOLOGY LAB
A Composed Open Architecture Software...
A Composed Open Architecture Software System at Run-Time
Monday, Apr 26, 2010
Refresh
Print
Day
Week
Month
4 Days
Agenda
My calendars
Other calendars
Applications
Places
System
Live System User
Done

The mission of the Game Culture & Technology Lab is to play with how game metaphors, design principles, and technologies can be utilized for alternative content and context delivery. The focus is on the next generation Internet and beyond.

The approach combines theory and practice, art and science, education and entertainment, to create an environment that supports diverse forms of expression in a wide range of applications.

The methods include sampling, misuse, hacking, appropriation, reverse engineering, and custom creation in the interest of open-source innovation and critical intervention.

Since its inception in 1999, the Game Lab has been physically housed in the Claire Trevor School of the Arts (SOTA). In 2002 we established a co-located facility in The

```
mraid.static    ifconfig        lvchange        modinfo          pppoe-sniff
msetup          ifdown          lvconvert       modprobe         pppoe-start       shutdown
osfsck          ifenslave       lvcreate        mount.fuse       pppoe-status      ttach
osfslabel       ifrename        lvdisplay       mount.nfs        pppoe-stop        sln          vgscan
ump             ifup            lvextend        mount.nfs4       ppp-watch         start        vgsplit
umpe2fs         init            lvm             mount.ntfs       pvchange          start_udev   weak-modules
2fsck           initctl         lvmchange       mount.ntfs-3g    pvck              status       ypbind
2image          initlog         lvmdiskscan     mount.ntfs-fuse  pvcreate          stop
liveuser@localhost sbin]$ pwd
sbin
liveuser@localhost sbin]$ cd ../selinux
liveuser@localhost selinux]$ ls
ccess    checkreqprot          compat_net  deny_unknown  initial_contexts  mls                   policyvers      user
vc       class                 context     disable       load              null                  reject_unknown
ooleans  commit_pending_bools  create      enforce       member            policy_capabilities   relabel
liveuser@localhost selinux]$
```

Challenges of securing open OA C2/C3CB systems

Current security approaches

- Mandatory access control lists, firewalls;
- Multi-level security;
- Authentication (including certificate authority and passwords);
- Cryptographic support (including public key certificates);
- Encapsulation (including virtualization), hardware confinement (memory, storage, and external device isolation), and type enforcement capabilities;
- Secure programming practices;
- Data content or control signal flow logging/auditing;
- Honey-pots, traps, sink-holes;
- Security technical information guides (STIGs) for configuring the security parameters for applications and operating systems;
- Functionally equivalent but diverse multi-variant software executables.
- Software component security assurance processes.

Current approaches to software cybersecurity do not address the challenges of continuously evolving OA C2 systems emerging within agile, adaptive software ecosystems!

New business/pricing models for OA software components

- Franchising
- Enterprise licensing
- Metered usage
- Advertising supported
- Subscription
- Free component, paid service fees
- Federated reciprocity for shared development
- Collaborative buying
- Donation
- Sponsorship
- (Government) open source software
- and others

Managing acquisition costs will be demanding. Acquisition workforce will need automated assistance*, else acquisition management costs will dominate development costs for OA software components!*

New practices to realize cost-effective acquisition of OA AC systems

- Need to R&D ***worked examples*** of reference OA system models, and component evolution alternatives.
- Need ***open source models of*** app/widget security assurance ***processes and*** reusable cybersecurity ***requirements.***
- Need precise ***domain-specific languages*** (DSLs) and ***automated analysis tools*** for continuously assessing and continuously improving cybersecurity and IP requirements for OA C2 systems composed from apps/widgets.

Emerging challenges in achieving *Better Buying Power* via OA software systems

- Program managers/staff *may not understand* how software IP licenses affect OA system design, and vice-versa.
- Software IP and cybersecurity obligations and rights propagate across system development, deployment, and evolution activities *in ways not well understood* by system developers, integrators, end-users, or acquisition managers.
- *Failure to understand* software IP and cybersecurity obligations and rights propagation can reduce DoD buying power, increase software life cycle costs, and reduce competition.
- DoD and other Government agencies *would financially and administratively benefit* from engaging the development and deployment of an (open source) automated software obligations and rights management system for the acquisition workforce.

Conclusions

- Our research identifies how new software component technologies, IP and security requirements, and new business models interact to drive-down or drive-up acquisition costs.
- New technical risks for component-based OA software systems can dilute the cost-effectiveness of BBP efforts.
- Need R&D leading to automated systems that can model and analyze OA system IP licenses and cybersecurity requirements
    - Empower OA C2 system development workforce
    - Identify and manage cost-effectiveness trade-offs

Acknowledgements

Research collaborators

- Assembled Capabilities Working Group, DASD(A)-C3CB (2014-15).

Funding support ***(No endorsement, review, or approval implied)***.

- Naval Postgraduate School
  - Acquisition Research Program, #N00244-1-16-0004.

Thank you!