Ariba: A Framework for Developing Decentralized Services

Christian Hübsch, Christoph P. Mayer, and Oliver P. Waldhorst

Internet from the Service Perspective

Today's services need to cope with
- middleboxes
- mobility and multihoming
- growing heterogeneity

Resulting in
- incompatibilities, complexity
  - e.g. Skype employs large set of mechanisms to 'just work'
- services reside to web-based technology
  - the Internet can provide more than just web
- applications use contradictive paradigms
  - p2p uses client/server, group communication uses unicast
Existing Solutions are …

🚫 not autonomous
  - require infrastructure support (e.g., agents, rendezvous/directory server, gateways, etc.)

🚫 not self-organizing
  - need manual configuration
  - not automatically reconnecting
  - assume end-to-end connectivity

🚫 not dynamically dealing with protocol and network heterogeneity
  - do not work across different protocol domains (e.g. IPv6/IPv4)
  - do not adapt to network reconfiguration

🚫 very costly due to servers, infrastructure, bandwidth
  - fair for large companies, what about user-provided services?
Opportunities through decentralization?

- Today's services are mainly centralized
  - low complexity, high cost for infrastructure and bandwidth

- Can decentralized services provide new opportunities?
  - lowered cost for infrastructure and bandwidth
  - service overlays more flexible and spontaneous
  - decentralized services can't solve all problems

High entrance barrier: complexity of decentralized services is orders of magnitude higher!
Ariba: Decentralized Service Framework

- **Overlay-based virtual network substrate**
  - self-organizing transport connectivity across heterogeneous networks
  - integrated solution with ID-based addressing, providing a virtual network per application context
  - eases service and application development
  - transparently copes with middleboxes, mobility, protocol heterogeneity

*Low cost without the complexity: Ariba hides the complexity of decentralized service development*
Architecture of Ariba Network Substrate

- Video Source
- Video Subscriber
- Dissemination Tree
- Base Overlay
- Base Communication
- Underlay

**Requirements-oriented Interfaces**
- Decentralized overlay for signaling
- ID/Locator split
- Link/Transport split
- Mobility support
- E2E connectivity
- Multihoming

**Value-added Services and Applications**

**Ariba Interface**
- Layer 4 Transports
- Ariba

**Ariba**
- Application
- Group Communication Service

**Group Communication Service**
- Application
- Video Source

**Application**
- Video Subscriber

**Value-added Services and Applications**
- Handling of Middleboxes
- Protocol Heterogeneity

**Layer 4 Transports**
- Ariba Interface

Hübsch, Mayer, Waldhorst – Institute of Telematics
Main concepts (1/2)

- Identifier-based addressing of Nodes and Links

  - Node-Identifiers
    - decouples locators (IPv4, IPv6, UDP, TCP, …) from node identity
    - node identifier is static, locators can change
    - allows for transparent handling of mobility, multihoming
    - cryptographic identifiers allow for source authenticity

  - Link-Identifiers
    - decouple transport connections from transport context
    - allows for transparent protocol switching during connection lifetime
    - allows for relaying of links and piecewise transport connections
Main concepts (2/2)

- Requirements-oriented interfaces
  - developers state requirements
  - decouple developer from specifying mechanisms explicitly
  - link properties can describe reliability, security, …
  - overlay properties can describe robustness, performance, cost, …

- Integrated security
  - a network substrate can integrate security
  - securing links between nodes, handle crypto complexity
  - authenticity of nodes through cryptographic Node-Identifiers
  - requirements-oriented interface to security
Service Development with Ariba

Ariba provides a two-fold interface: **Node-specific** and **Communication-specific**

- **Node-specific**: controlling the overlay
  - bootstrapping/joining
  - overlay selection, state event callbacks, DHT functionality

- **Communication-specific**: controlling links
  - binding services to service-specific IDs
  - establishing communication links with requirements

- Exemplary services spanning own overlays
  - Application-layer multicast (ITM Karlsruhe)
  - Event-communication and -correlation (IPVS Stuttgart)
Open Source efforts

- Ariba is an Open Source implementation
  - FreeBSD license model
  - C++ with few library dependencies
  - runs on Linux flavors and Nokia Internet Tablets
  - lightweight to run on mobile devices
  - developed in context of the Spontaneous Virtual Networks project (SpoVNet)

www.ariba-underlay.org
Summary and Outlook

- **Ariba**
  - provides an overlay-based, flexible, and low cost solution for service developers
  - Demo at ACM SIGCOMM09 (*Honorable-Mention Award*)

- **Outlook**
  - current porting efforts (OpenWRT, Windows, iPhone)
  - bringing Ariba into the network (c.f. B. Davie, PRESTO09)
  - integrating security (e2e link security and cryptographic identifiers)
  - porting applications to Ariba (VLC media player)

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Thank you! Questions?