Moving the Web out of the Browser

Dave Raggett, W3C

Information Sciences & Digital Media Department,
Bristol Institute of Technology,
Faculty of Environment and Technology,
University of West of England

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Contact: dsr@w3.org

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What is the Web?

- According to W3C, the Web is
  - An information space in which the items of interest, referred to as resources, are identified by global identifiers called Uniform Resource Identifiers
    - See http://www.w3.org/TR/webarch/

What is the Web?

- Earlier version of webarch defined the Web in terms of a system rather than a space
  - Networked information system consisting of agents (programs acting on behalf of a person, entity, or process) that exchange information
    - http://www.w3.org/TR/2003/WD-webarch-20030627/
- But many people just conceive of the Web as
  - The set of HTML pages you can access from a Web browser

Tunnel Vision
and coming out into the sunlight

- Conceiving the Web only in terms of today's browsers is very limiting
  - Undue focus on HTML and browser APIs
- What about
  - Other modes of interaction (aural, tactile)
  - Explosion of new kinds of networked devices
  - Distributed applications & end-to-end models
  - Agents acting on behalf of people
  - Semantic Web of symbolic and statistical knowledge
  - Web of trust and human relationships

The Web of Things

Ubiquitous Web Application Working Group

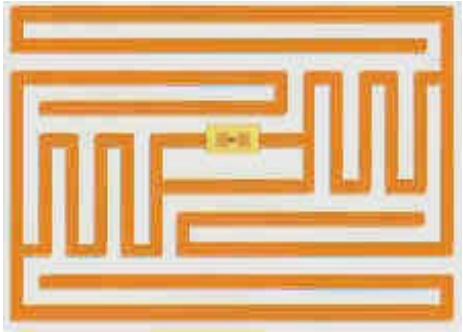
http://www.w3.org/2007/uwa/

URIs for physical objects

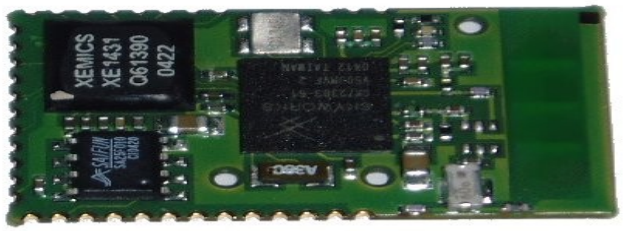
Barcodes as a way to connect physical objects to the Web

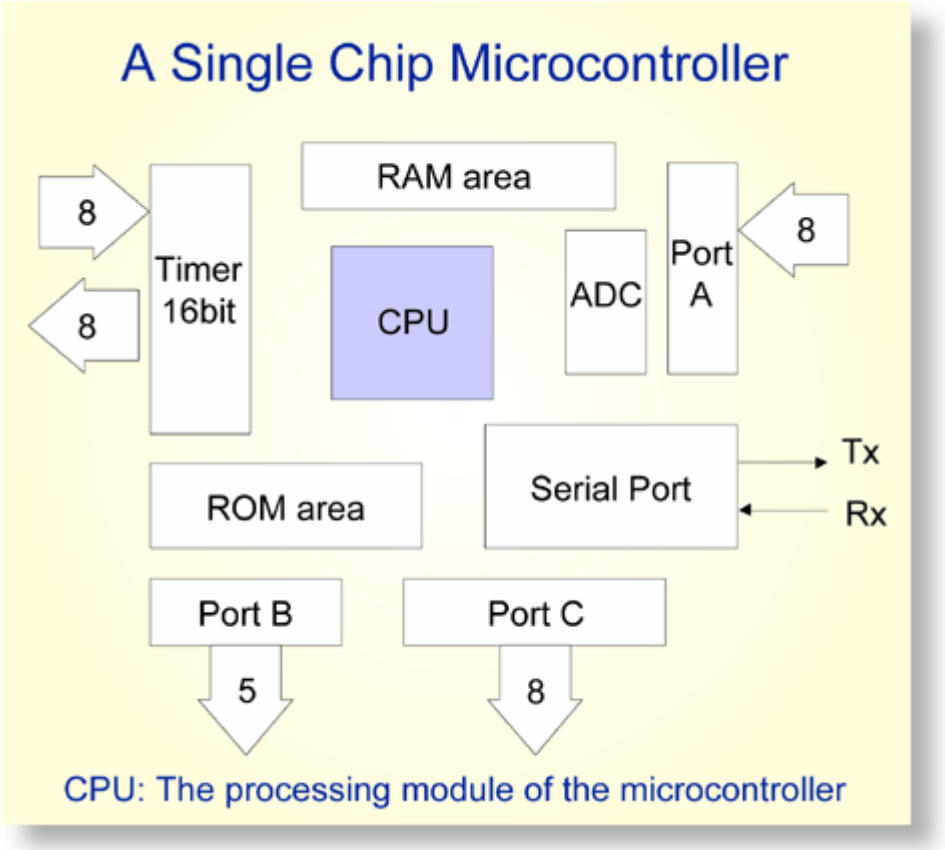
RFID

Electronic versions of barcodes
but with extended capabilities



Microcontrollers





- Computer on a chip
- Fastest growing segment of computer industry
- Average home now contains around 200
- Cars between 35 and 100 for luxury models

Uses of Microcontrollers

- TV sets, TV remote controls, Video recorders printers, cameras, scanners, fax machines
- Ovens, toasters, refrigerators, washing machines, central heating systems
- Mobile phones, PDAs, MP3 players, computer monitors
- Car body electronics, air conditioning, seat control, chassis and safety, infotainment, power train
- The list goes on and on ...

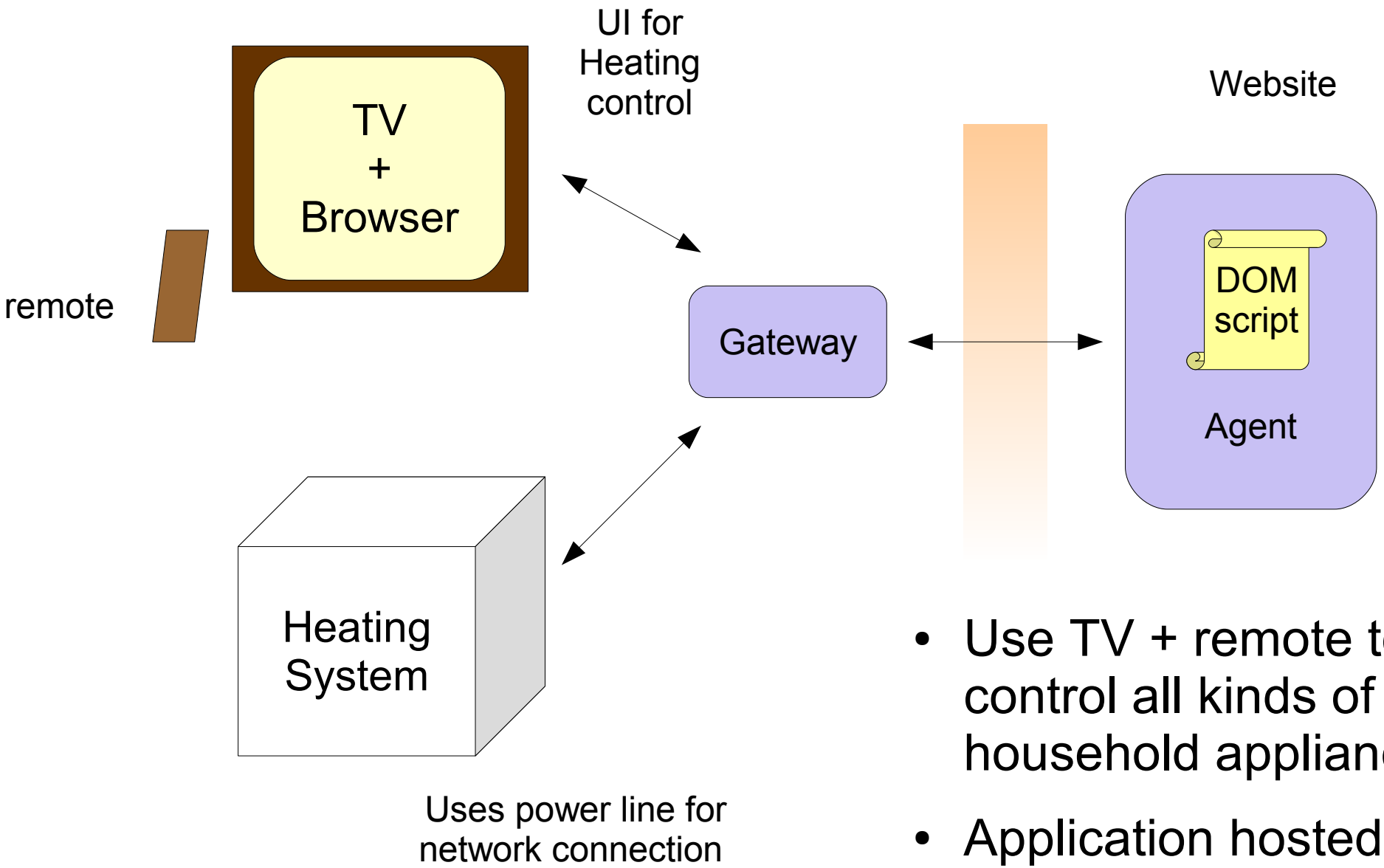
Towards the Web of Things

- Rapidly diminishing incremental cost for networking all kinds of devices
- The challenge for how to integrate devices as part of distributed applications
- Changing the way we think of the Web
  - No longer just about viewing websites on desktop browsers with big screens
  - Instead apply Web technologies to ease the task of developing new kinds of applications across a very wide range of devices

What's the Value?

- Improved physical security and peace of mind
- Reduced costs of heating/cooling/lighting homes and offices
- Preventative maintenance in advance of appliances breaking down
- Better choices for home entertainment systems
- Access to information services any time, any where and on any device you choose
- Fulfilling the potential for applications that combine local and remote services

Home network example



- Use TV + remote to control all kinds of household appliance
- Application hosted by website

Networking Technologies

- Applications will need to work over a mix of rapidly evolving networking technologies
  - Ethernet over twisted pair or coax
  - DSL over copper phone lines
  - Ethernet over building power wiring
  - WiFi and WiMax
  - Bluetooth
  - ZigBee sensor networks
  - GSM and cellular packet radio
- Further challenge of different addressing schemes, e.g. peer to peer networks

Moving up the Network Stack

- Current academic and industry focus is on networking and low level services
  - Internet of things, not yet the Web of things
- Next stage will be to focus on how to make it easier to create distributed applications
- How to create applications that can work across
  - Different networking technologies
  - Different generations of devices
  - Different vendors
  - Different trust boundaries

Realizing the Potential

- Initially, just proprietary solutions
  - End user purchases complete solution
  - Single vendor and single product generation
- Followed by narrowly focused industry standards
  - Pictbridge for printing direct from camera when printer and camera from different vendors
  - DLNA for connecting multimedia devices in the home
- Broader standards follow later, enabling new applications
  - Traditional programming languages like C++ and Java offer low level control but are costly to develop with
  - Web technologies will make applications easier and cheaper to develop, enabling a much bigger ecosystem

Device Coordination

- How to ensure that devices and services function as part of a distributed application
  - Support for discovery and adaptation
  - Descriptions of devices and services (resources)
    - Including basis for access control, identity and trust
    - Coordination and control
      - Services provided by an individual device or a collaboration between multiple devices
      - Scheduling and fair access to scarce resources
      - Services as an orchestrated sequence of events
      - Error handling and recovery

Control and event routing

- Strongly coordinated, no delegation
  - Controller manages access to services
  - All events routed through control point
- Weakly coordinated, partial delegation
  - Controller manages access control, but delegates event management
- Uncoordinated, full delegation
  - Peer to peer communication model
  - Devices responsible for resource management

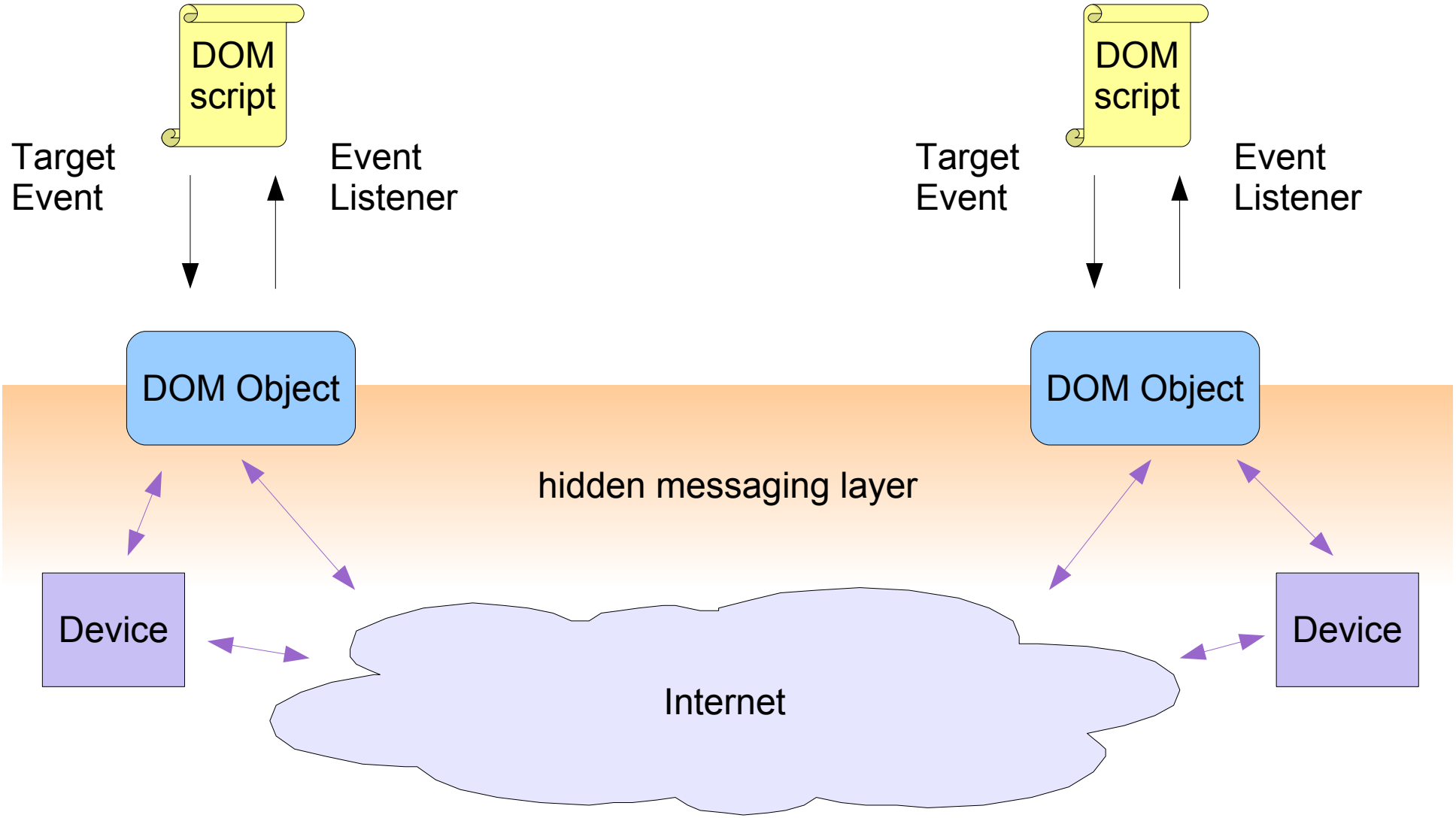
Web-based Device Coordination

- Describing UI and behaviour
  - XML Events and scripted event handlers, or
  - Declarative models in SCXML (State Chart XML)
- Using URIs to name devices and services
  - Rich meta-data for describing device capabilities and security policies
- Expose device/service as object in local object model
  - Hides addressing/communication details
  - Enable application to continue to work when devices and network technology/topology change

Web-based Resource Binding

- Either name resource or provide description
  - URI for resource name or description, or
  - Explicit description
    - XML element, or
    - meta data (RDF) or
    - scripting API
- Implicit or explicit resource binding service
  - Broker and access control may be local or remote
  - Event when resource is bound and unbound or on access control error
  - On success, resource exposed as DOM object

Proxies for accessing services



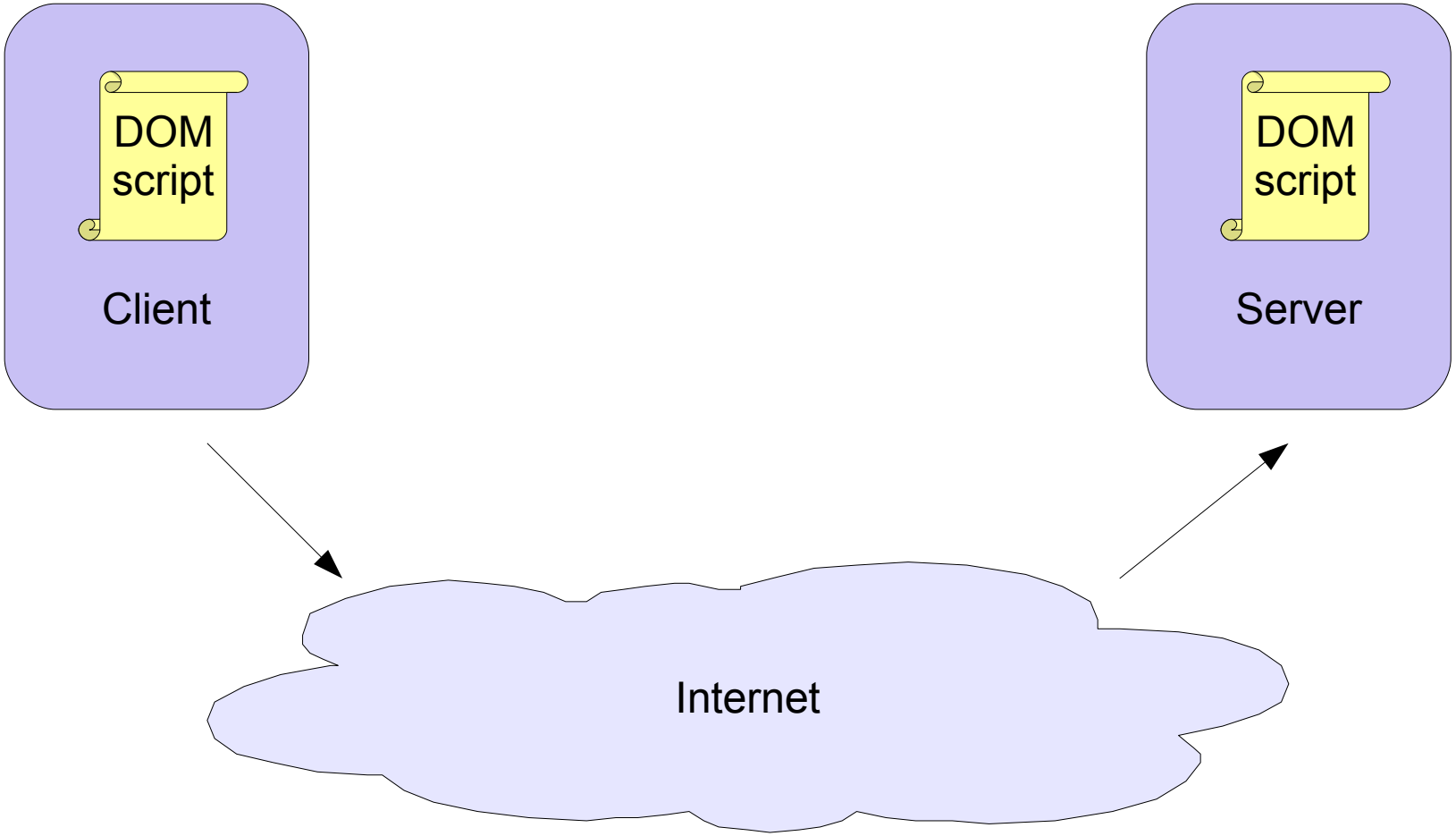
DOM – XML Document Object Model

Event Transport

How to deliver events to devices?

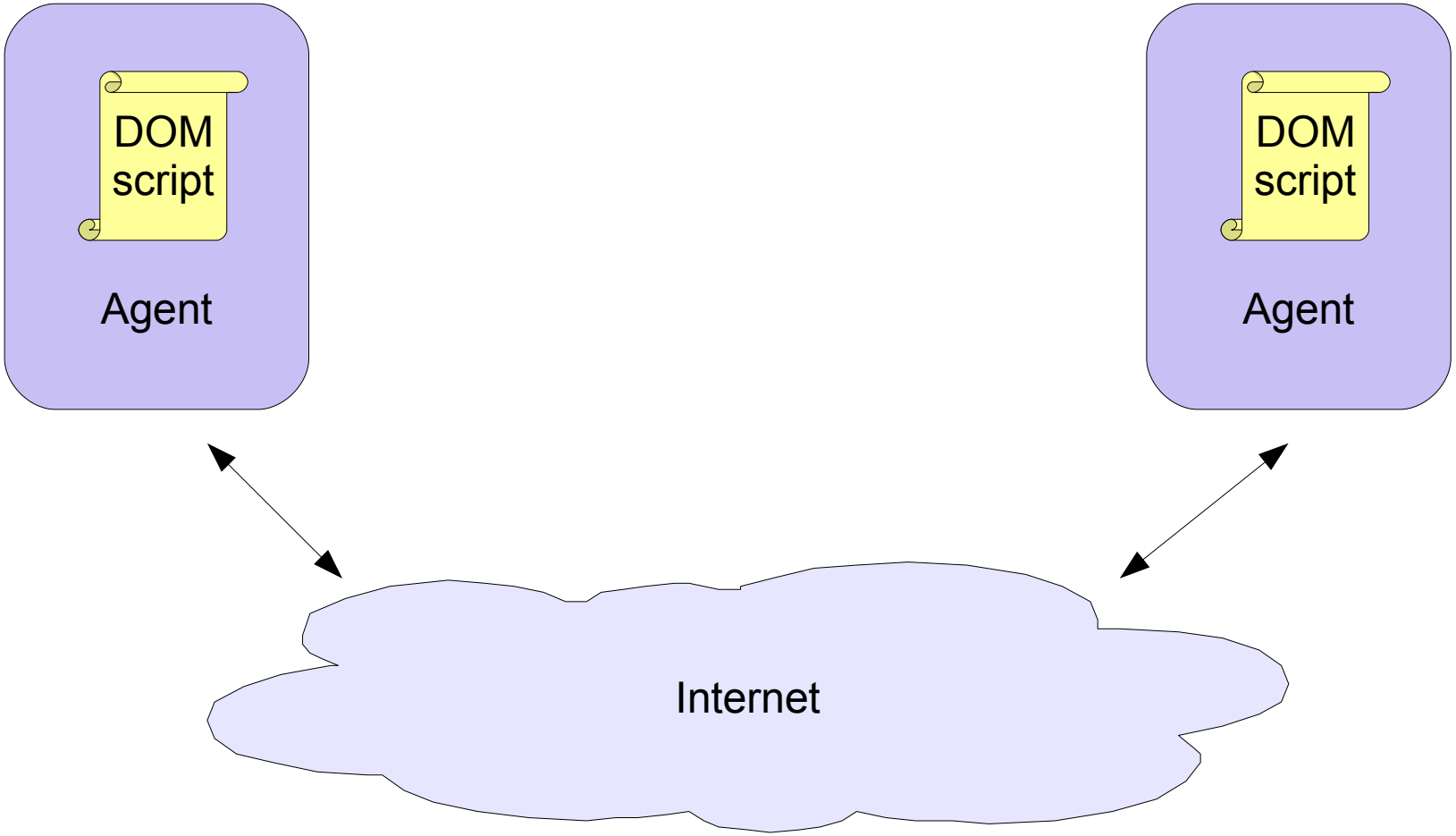
- Firewalls are intended to block undesired traffic
  - No incoming HTTP connections by default
- Evolution of mechanisms to tunnel events through Network Address Translation
  - STUN, STUNT, TURN, etc.
  - Skype and success at a cost
- Bindings to event transport protocols
  - HTTP, SIP, XMPP

Client or Server?

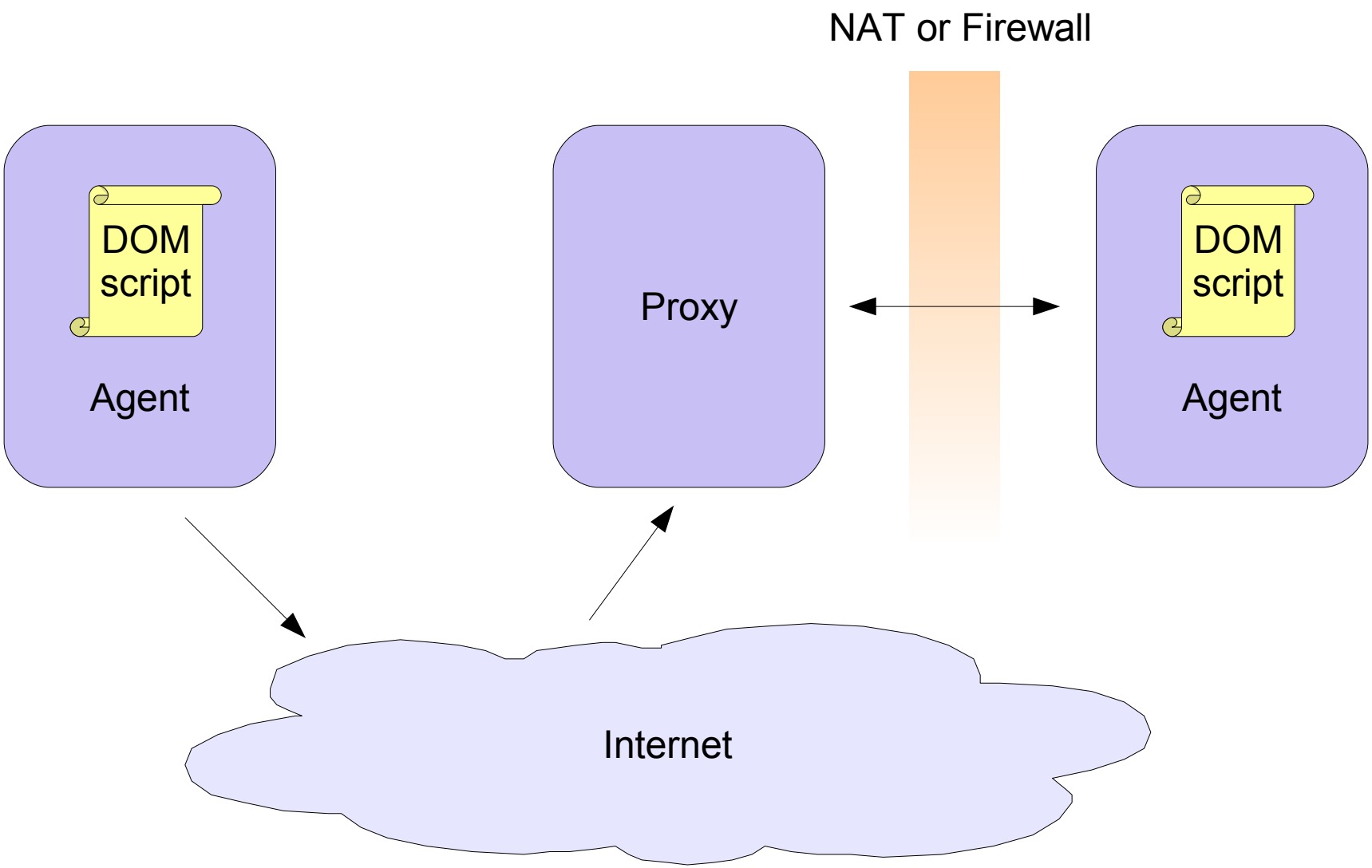


Client or Server?

Agent combines client and server

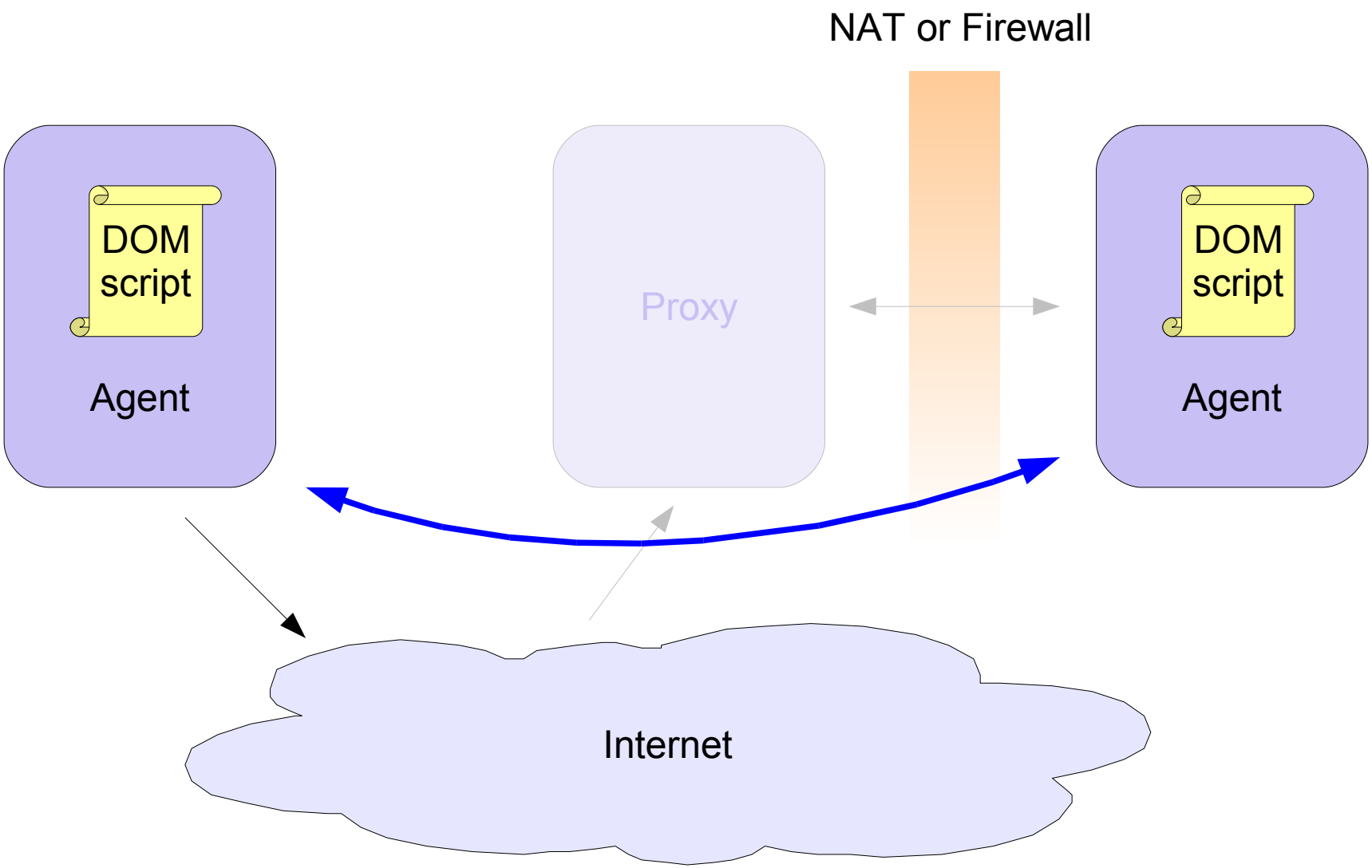


Tunnelling through NAT



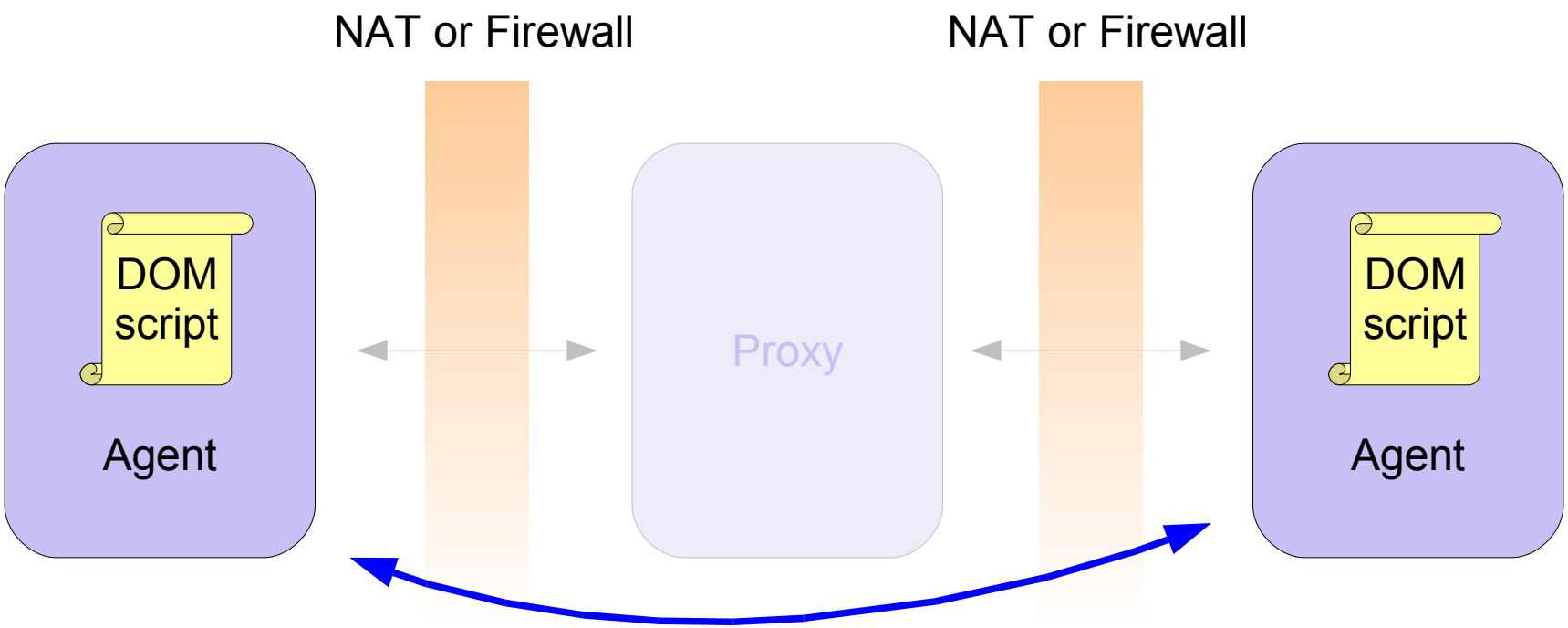
Tunnelling through NAT

Proxy may arrange for direct link through NAT



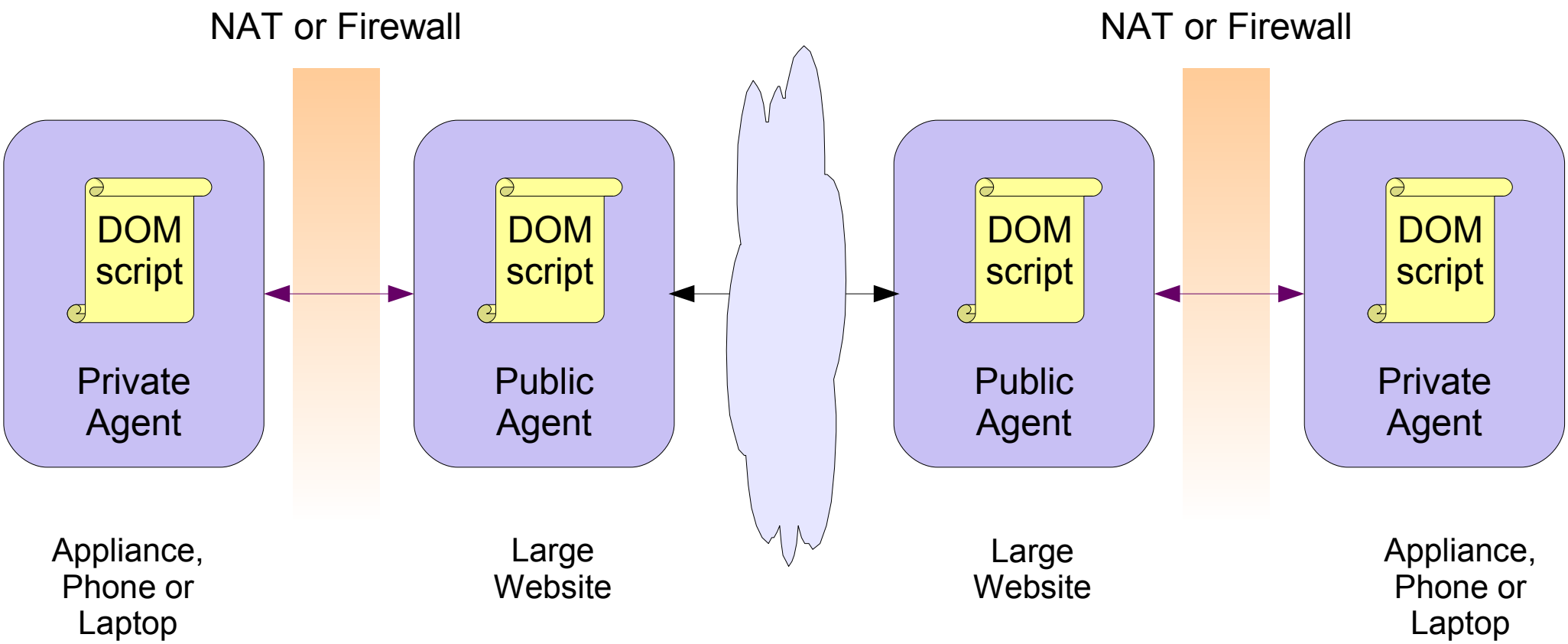
See STUN, TURN and other techniques

Tunnelling through NAT



Connecting devices behind different NATs

Public and Private Agents



- Private agents may be off-line or powered down
- Enabling off-line operation via data synchronization

Agents not Web Pages

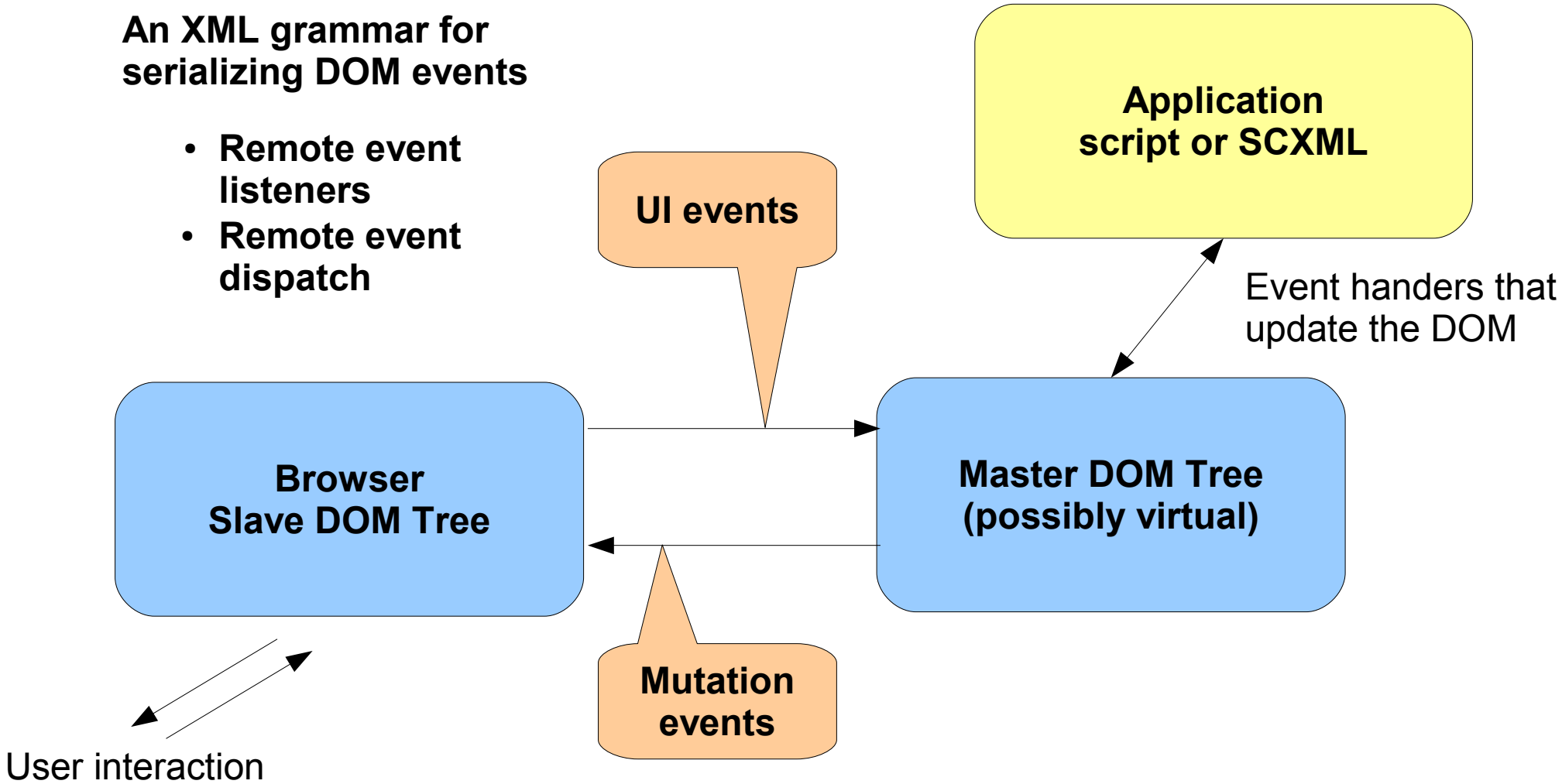
Remote User Interfaces

- Moving beyond Web browsers to new kinds of applications
  - based upon distributed document object models
  - application running on one device is coupled to a user interface on another via an exchange of events
- Layered architecture involving mappings between different levels of abstraction
  - High level events as interpretations of lower level ones
  - Realizing high level tasks as particular UI behaviour

Remote User interfaces

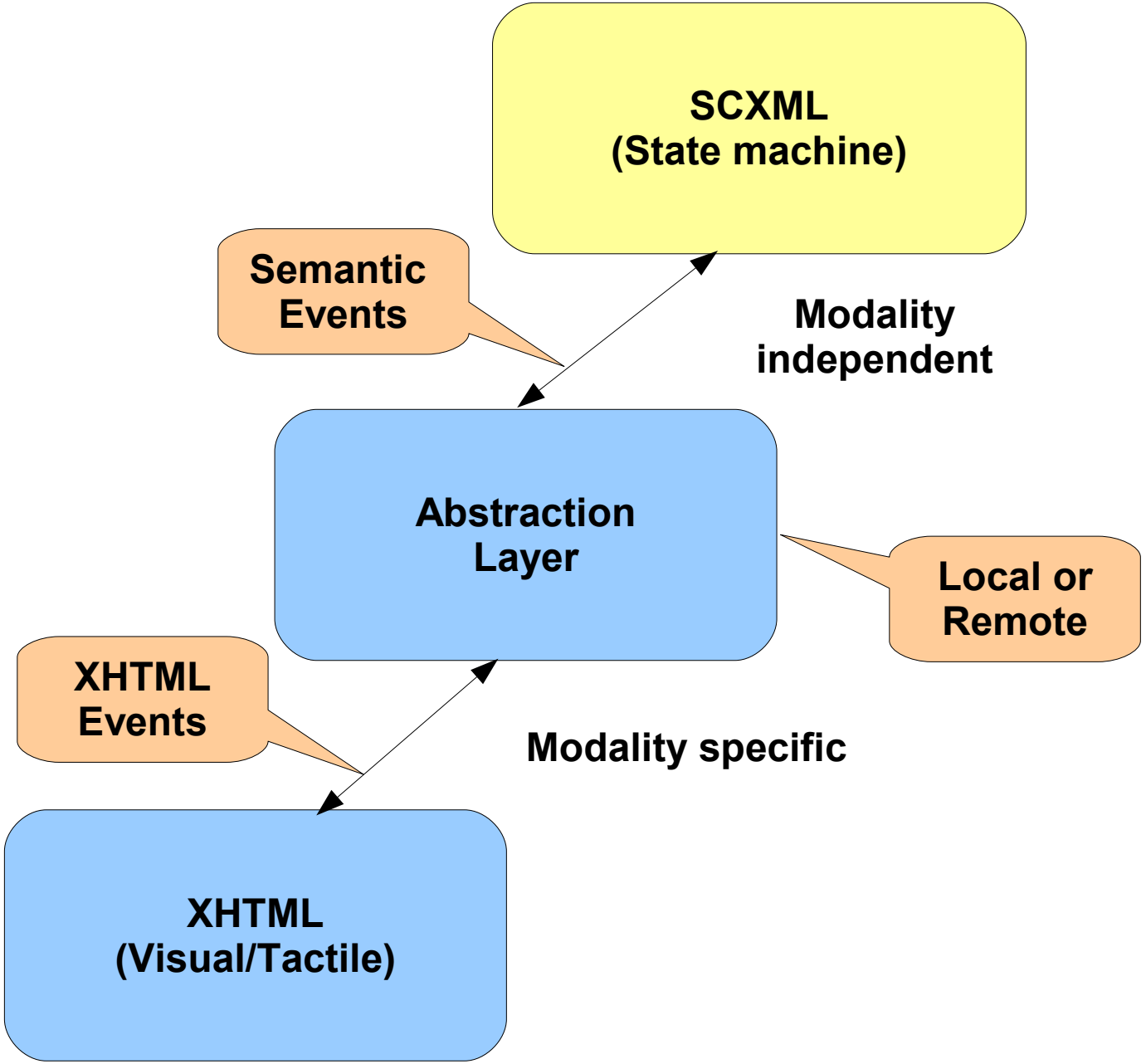
An XML grammar for serializing DOM events

- **Remote event listeners**
- **Remote event dispatch**



DOM = Document Object Model

Abstraction layer for Events



Adaptation

- Describing applications in a way that makes them easier to run on a wide range of devices
- Dynamic adaptation to user preferences, device capabilities and environmental conditions
  - Catering for adaptation at authoring time
  - Server-side use of rich meta-data for adaptation
    - tailor content to match screen, memory, bandwidth, etc.
  - Client-side access to hierarchy of properties and the means to make changes
    - expose battery level within web page UI
    - client side mashup based on access to device location
    - change audio settings from web page UI

Policy-based Adaptation

- Author markup in device independent representation
  - authoring format is freed from browser restrictions
  - high level events in place of low level scripts
- Describe policies for adaptation to classes of devices
  - what layout, images, style sheets, scripts, etc.
  - skinning apps as combo of markup, CSS, script
- Adaptation process executes policies for specific delivery context
  - work arounds for variations across browsers
  - split content for low memory devices
  - exploit client APIs for rich web apps (e.g. Ajax)

Delivery Context Ontology

- Ontology covering user preferences, device capabilities and environmental conditions
  - Modular design for scalability
  - Exposed through client and server-side APIs
    - These are being worked on in parallel
  - Coordinated effort to avoid inconsistent models
    - Success story for device orientation
    - Too late for conflicting treatment of pixels
  - Current focus on mobile devices
    - Other kinds of consumer devices expected next
    - New work started on personalization (accessibility)

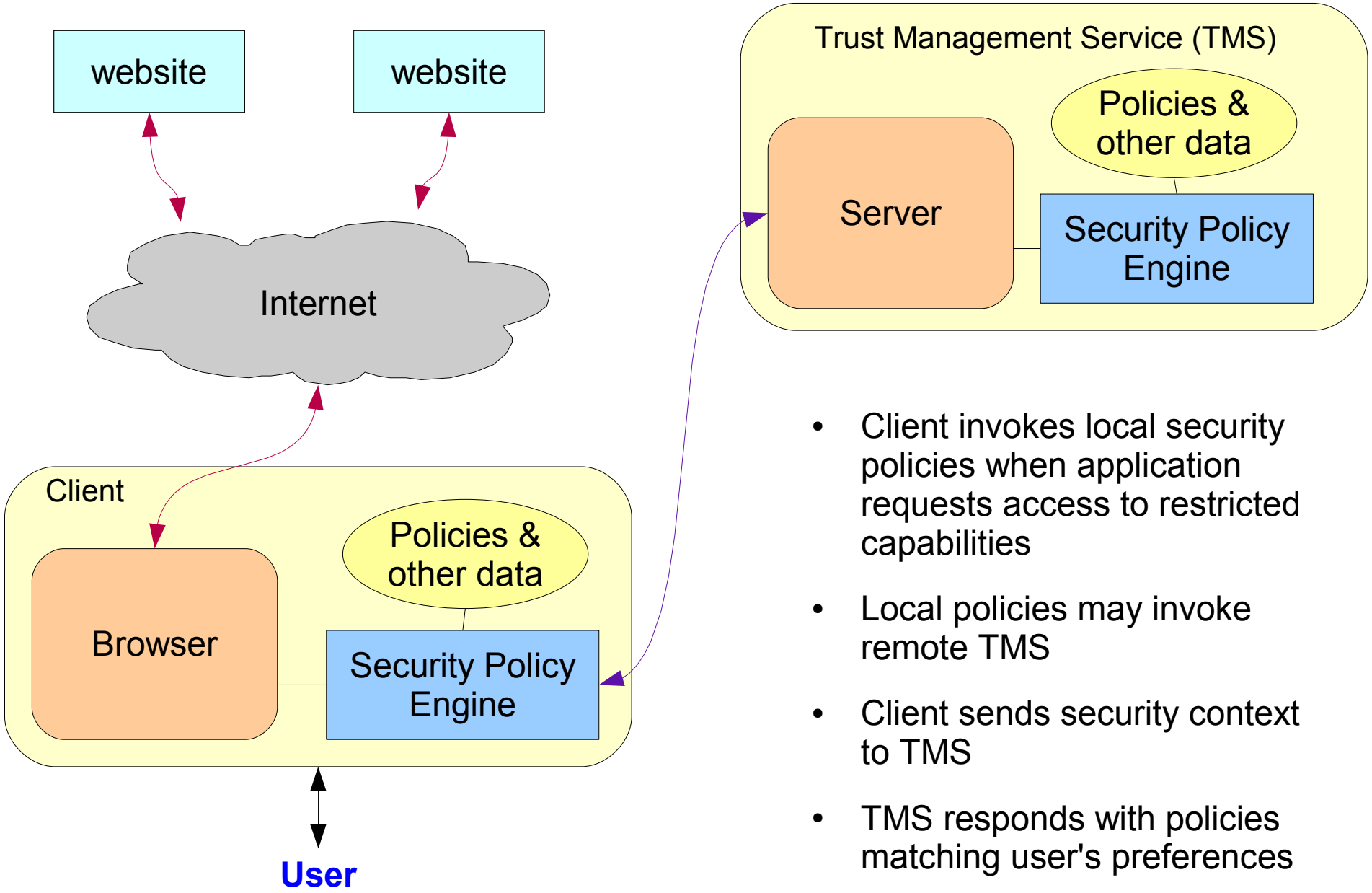
Security and Privacy Concerns

- The Web is a mess when it comes to security
- Different user name/password for each website encourages people to use weak passwords
- Wide open to phishing attacks
- Criminal gangs harnessing compromised PCs to send out spam and to launch attacks
- Privacy abuses are commonplace
- Browser sandbox model and same-site policy are too weak and work-arounds introduce major security/privacy holes

Trust Management Solutions

- Users tend to click through security related dialogues that “get in the way” of the task
- Users are often not really informed about the trustworthiness of a website/application
- We need to find solutions that offer greater security with improved usability
- Improved security through SIM cards and biometric techniques
- New ideas for trust management solutions involving a trusted third party

Trust Management



- Client invokes local security policies when application requests access to restricted capabilities
- Local policies may invoke remote TMS
- Client sends security context to TMS
- TMS responds with policies matching user's preferences

New Directions for Web Authoring

Model-Based UI Incubator Group

http://www.w3.org/2005/Incubator/model-based-ui/

Motivation

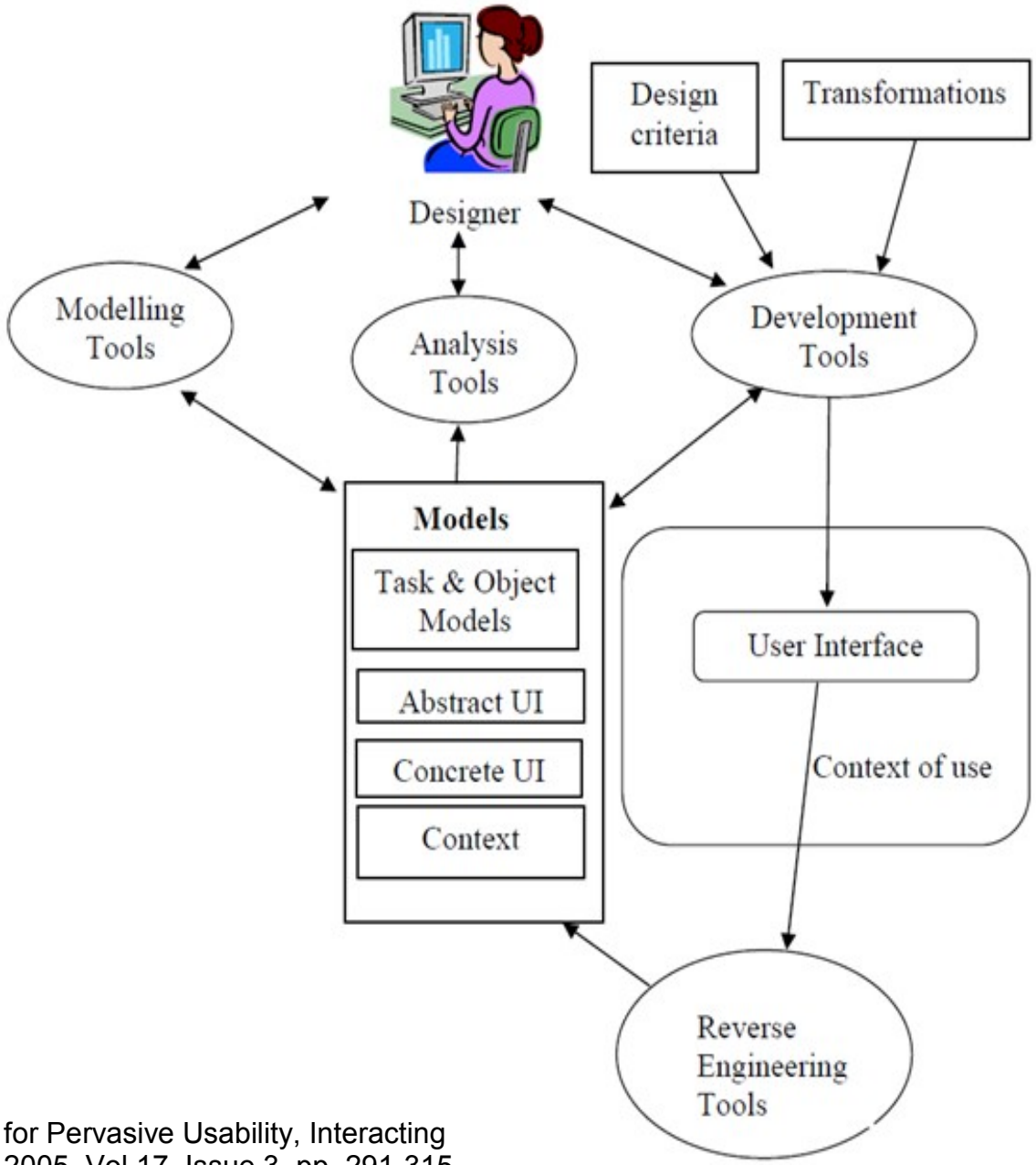
- Professional Web applications are developed by teams of people with different roles & skills
- Frequent need for redesign as data models, business requirements and branding changes
- Reduce costs and increase re-use through separation of concerns
- Allows team members to focus on what they each do best
- Outsource tough task of adaptation to particular browsers and devices (analogous to compilers)

Model-based UI Layer Cake

1) Application task and data models
2) Abstract User Interface
   - modality independent, e.g. select 1 from n
   - set size, grouping and ordering considerations
3) Concrete User Interface
   - Commitment to modality and broad class of devices,
     - e.g. radio buttons vs drop-down menu
4) Final User Interface
   - Automatic generation guided by author's preferences
   - Target HTML, SVG, Flash, Java, .Net, etc.
   - Generation of client and server-side components

with transformations defined between each layer

Model-based Development Process



F.Paternò, Model-based Tools for Pervasive Usability, Interacting with Computers, Elsevier, May 2005, Vol.17, Issue 3, pp. 291-315.

Design Steps

- Start with domain concepts and tasks
  - Arrival and departure dates for a hotel reservation
- What kinds of interaction objects are needed?
  - Selection mechanism for dates
- How do we want to realise these in concrete terms?
  - Pop-up date picker and reservation summary
- What kinds of devices do we want to support?
  - Detailed choices of layout, fonts, colours, and art work

What does this mean for authors?

- Authoring tools should hide details of markup
  - Markup languages designed for authoring tools, not for browsers, and not for human editing
  - Focus on separation of concerns, not on brevity
  - Tools that support top-down and bottom up design
- Models held in server-side repositories
  - Enables distributed authoring by team members
- Use of diagrams and rules that are translated into the internal representations of models
  - Much nicer than hacking JavaScript for IE6
  - Painless adaptation to devices and browsers

Model-Based UI Incubator Group

http://www.w3.org/2005/Incubator/model-based-ui/

- W3C Group launched in November 2009
- Mission to study work on model-based UI and see what if anything is ready for standardization
- Participating organizations
  - CNR -- Consiglio Nazionale delle Ricerche
  - Department of Informatics, PUC-Rio
  - Fraunhofer Gesellschaft
  - JustSystems
  - Siemens AG
  - Telefónica de España, SAU
  - Université catholique de Louvain

MBUI XG

- Meets every other week by phone
- Occasional face to face meetings
- Initial charter for 12 months, ending Nov '09
- Deliverables: Incubator Group Report
  - Survey of existing work
  - Use cases and requirements
  - Suggestions for standardization
- Wiki as basis for joint authoring
  - http://www.w3.org/2005/Incubator/model-based-ui/wiki/Main_Page

MBUI XG Use Cases

- Smart Home Network
  - UI for controlling and monitoring a dynamic network of heterogeneous devices
    - security system, washer/dryer combo, and room fan
- Remote access and control of home devices
  - Did I remember to turn the heating off?
  - Has the neighbour fed the cats?
- Easy development for wide range of devices
  - Accessing services from Desktop, PDA, Phone
  - Rapid prototyping for early user feedback

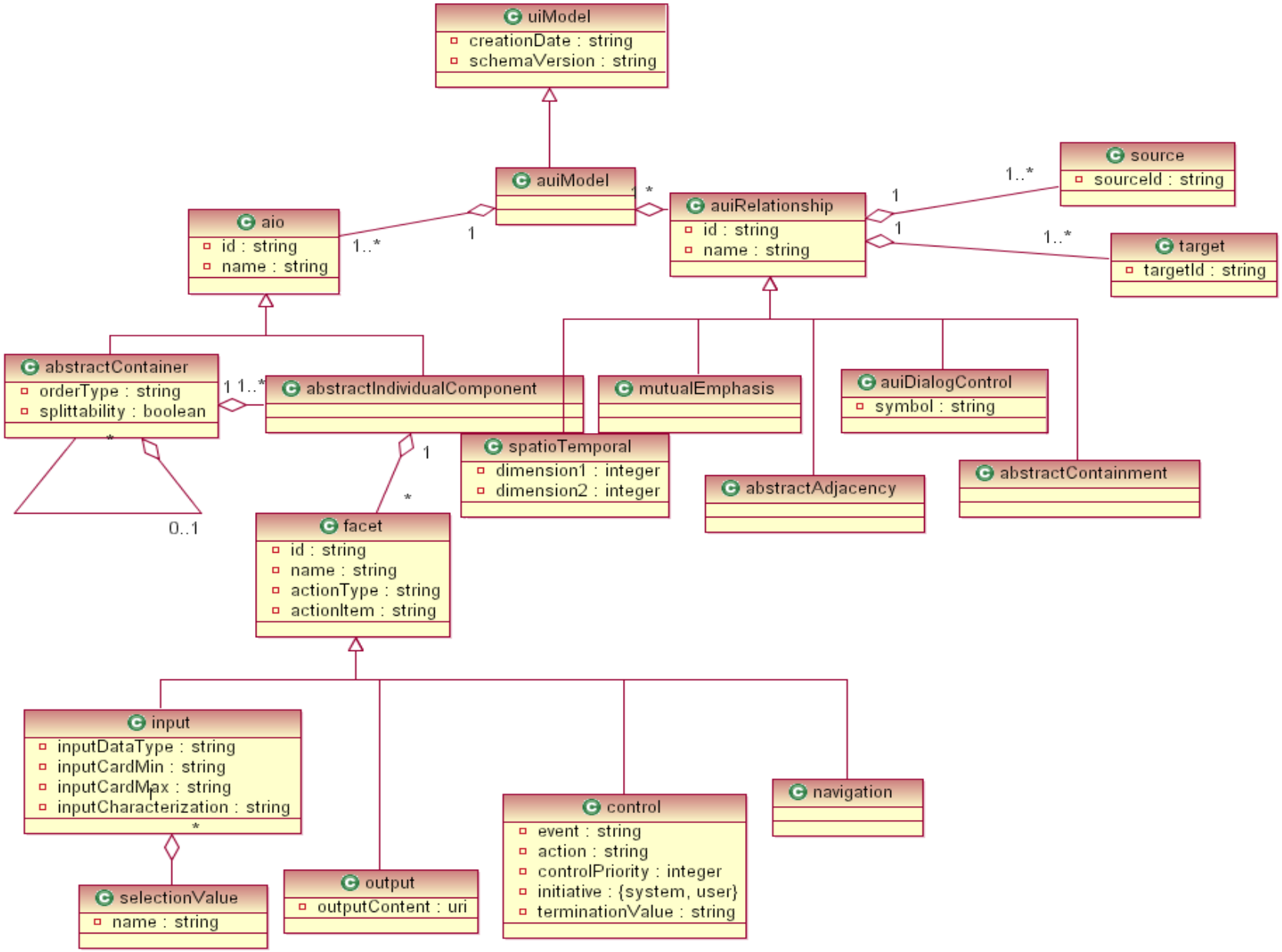
Task Models for UI Design

- Expressible at various abstraction levels
  - High level requirements (task meta models)
    - Concur Task Trees
  - Detailed representation of activities
    - Statecharts, e.g. SCXML
- Some other approaches for task meta-modesl
  - UsiXML
  - TOOD
  - Diane
  - HTA
  - GOMS

Abstract UI Model

- Interaction at a level independent of modality and device
  - Valuable for creating accessible applications
- UsiXML
  - Guerrero Garcia, J., Vanderdonckt, J. (2008), Towards a Multi-Users Interaction Meta-Model. IAG Working Paper 08/25, Université catholique de Louvain, 2008.
- XForms
  - W3C specifications for Forms
    - Model-View-Controller design pattern
    - Abstract UI controls

UsiXML Meta Model



Concrete UI

- Commitment to specific modalities and broad classes of device capabilities
- W3C WAI/ARIA taxonomy
  - Controls, properties and events
  - Aimed at retrofitting HTML/JS web apps
- UsiXML
- UIML
- Platform specific concrete UI
  - Adobe Flex and MXML
  - Microsoft Silverlight and XAML

Transformations between Layers

- Mappings between objects and events
  - Events as messages exchanged by objects
- Managed by authoring tool
  - Let the machine take the strain
  - Experts can tweak mappings if really needed
- If Layers described in XML, use XSLT, right?
  - Wrong, too powerful to allow machine reasoning
- Principle of reduced power
  - Just sufficient to express what is needed

Relationship to Current Practice

- Tag soup and scripting hell
  - Variations across browsers
  - Ever greater complexity
  - Browser is just the tip of the iceberg
  - Much of the work is on server-side scripts
- Content is locked into specific CMS
- Expensive to deliver content to multiple channels e.g. mobile
- Model-Based approach offer the promise of a way out, eventually ...

The Semantic Web and the Global Economy

Financial Reporting

- Recent events have heightened the need for transparency in reporting of financial data
- Companies are required to submit regular reports and disclosures conforming to accepted accounting principles, e.g. IFRS, US GAAP
- New legislation is likely to be even more encompassing as regulators attempt to avoid repeats of the current credit crisis
  - Credit default swaps and obfuscation of risk
- Reports will soon have to be made in XBRL

XBRL

- Extensible Business Reporting Language
- Based on XML, Schema, XLink and XPointer
- Developed by XBRL International with the help of regional chapters around the World and with strong support from regulatory authorities
- Large amounts of financial data will soon be available in XBRL
- This is a paradigm shifting event ...

XBRL + Semantic Web

- XBRL brings precise semantics to financial data via reference to external accounting principles
- The Semantic Web is a World Wide Web of machine interpretable data and meta-data
  - Think of it as a global database
- Combining XBRL and the Semantic Web creates tremendous potential for analysing and exploring huge amounts of financial information
  - On companies and markets world wide
- W3C and XBRL International are well placed to explore this potential

Why Semantic Web is relevant

- XBRL is hard to work with directly in XML
  - XSLT and xlink:type="extended"
- XBRL processors map XBRL into internal proprietary data models (closed world)
- By contrast, RDF and the Semantic Web will allow the use of open standards for XBRL data
  - Make it easier to create mash-ups of financial data and to compare data across different taxonomies
  - Facilitate a rich ecosystem of developers of value-added tools for collecting, exploring and analysing huge amounts of data

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W3C Interest Group

- Plan to launch a W3C Interest Group in near future to
  - Explore the potential of XBRL + Semantic Web
    - Understanding what analysts are looking for
    - Use of Semantic Web for financial data within companies
    - Ontologies relating different XBRL taxonomies
      - Across versions, companies, and jurisdictions
  - As well as broader opportunities for financial data
  - Propose standardization work on this that will complement the work of XBRL International
  - Ramifications for both XBRL and Semantic Web

Some Challenges

- Natural language processing for extracting knowledge from raw text
  - Footnotes in annual reports, news stories, ...
    - MUSING project, Reuters and Open Calais
- Making semantic queries run as quickly as conventional web search engines
  - Analytics on all companies in given market area
    - Uncovering risk and projecting forward
  - Apache Heart project and cloud computing
    - Planet scale RDF data store running on tens of thousands of cheap CPUs

See http://wiki.apache.org/incubator/HeartProposal

Summing up

Summary and Questions

This talk is available at **http://www.w3.org/2009/Talks/0115-dsr-uwe.pdf**

- The Web of Things
  - The potential for applying Web technologies to distributed applications of all kinds of devices
    - Web-based abstraction layer
    - Role of Semantic Web for rich descriptions
- The Web of Trust and role of delegation
- New directions for Web application authoring
  - Model-based User Interface design
- The Semantic Web and the Global Economy
  - Transparent access to financial data
  - Ramifications of cloud computing