

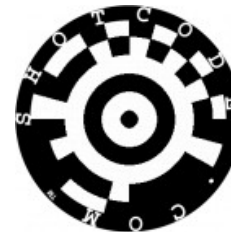
Ubiquitous Web Applications

Towards the Web of Things

Dave Raggett, W3C & JustSystems

Web of Things

Barcodes as a way to connect physical objects to the Web

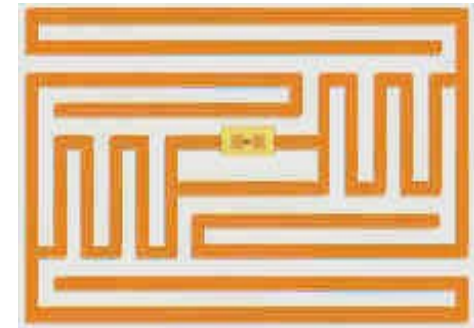


Hyperlink your world!

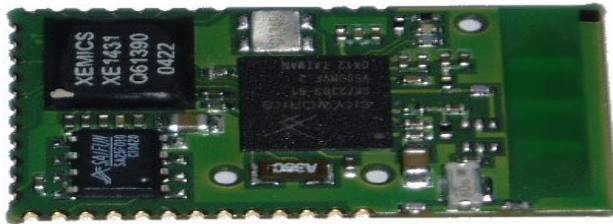
With Semapedia you can connect Wikipedia knowledge with relevant places in physical space.
Learn more...

RFID

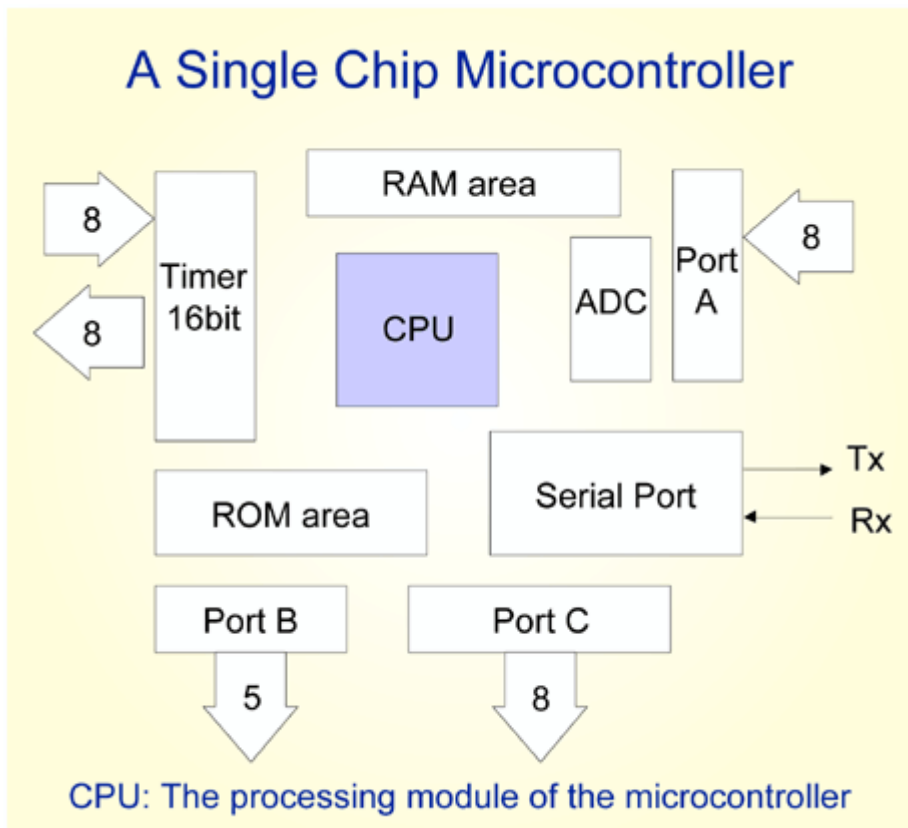
Electronic versions of barcodes
but with extended capabilities



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



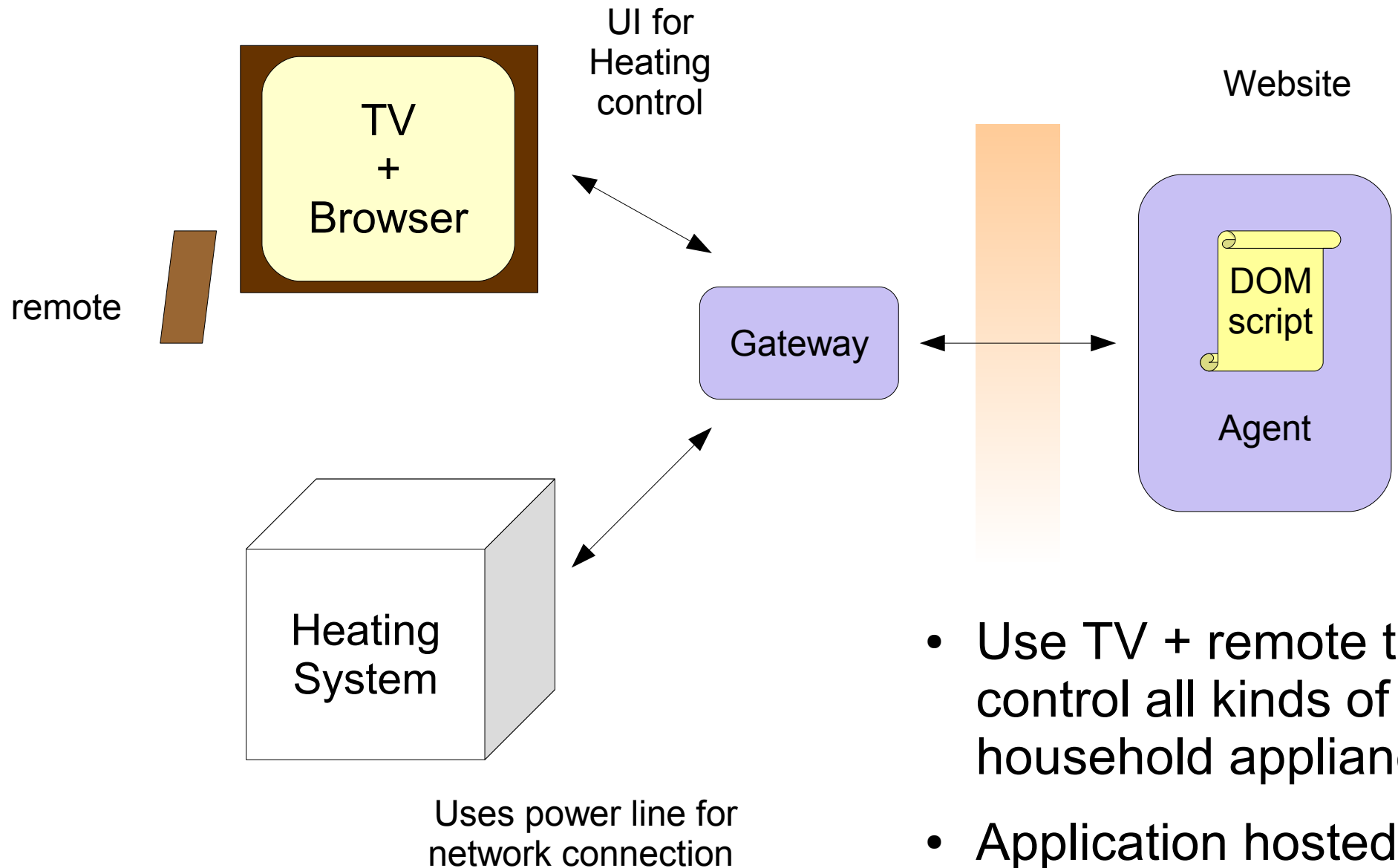
Uses of Microcontrollers

- 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 ...

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

Home network example



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

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

Business Opportunities

- The means to link devices together creates new business opportunities
- Profitable services with clear value proposition for users
- Innovating with ways to supplement low profit margins on devices
- Building upon experience with mobile
 - Service contracts
 - Pay as you go
 - Encouraging people to upgrade

Realizing the Potential

- Initially, just proprietary solutions
 - end user purchases complete solution
 - single vendor and single product generation
- Followed by narrowly focused industry standards
 - e.g. Pictbridge as solution for printing direct from camera when printer and camera from different vendors
- 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

Ubiquitous Web Applications

Architectural Challenges

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
 - Near field communications
 - GSM and cellular packet radio

Coping with Change

- Devices are continuing to evolve rapidly
- Some devices are in use for many years
 - televisions, heating systems
- Others are replaced quite frequently
 - mobile phones upgraded every 18 months (or so)
- Coping with minor malfunctions in ageing kit

Coping with Change

- Developers need ways to create applications that can
 - cope with a mix of device vendors
 - cope with a mix of device generations
 - and likelihood of new versions of software APIs
 - cope with a mix of networking technologies
 - cope with minor device malfunctions
- Solve through mix of standards and modular architecture that minimizes dependencies

Ubiquitous Web Applications

Device Coordination

Device Coordination

- The means for devices to expose their capabilities/services
 - rich descriptions and APIs
- The means to search for and bind to such services whether local or remote
 - brokers, security and trust management
- The means to exchange events across devices and services
 - asynchronous communications
- The means to coordinate the operation of one or more devices (managed services)

Rich Descriptions

- Apply Web technologies for rich descriptions
 - ontology as meta model (data about models)
 - ontologies that describe data models, service models, trust models, and relationships
- Enabling applications to dynamically adapt to the changing context
 - user preferences, device capabilities and environmental conditions
 - descriptions of APIs and versioning
- Reasoning over security policies and trust relationships

Device Ontologies and APIs

- Current focus on mobile devices, but other kinds of devices are expected to follow
- Risk of market fragmentation as each company define its own API for accessing device capabilities
- Increasing importance of defining common standards with involvement of all stakeholders
 - first tackle simple properties e.g. screen orientation, volume level, vibrator on/off, battery level, etc.
 - later tackle harder properties e.g. location
 - security and trust implications, legal framework

Ambient Intelligence

Dynamically adapting to the Delivery Context

- User
- Device
- Environment

User Preferences

- Some people prefer tiny fonts, while others can only read text in big fonts
- Some people require high contrast and may be unable to distinguish certain colours
- Some people are more sensitive to the price they are paying for data and want smaller pages
- Some people may be willing to see advertisements if this means content is free

Device Variations

- Variations across browsers
 - markup, scripting, style sheets, media support
 - very expensive for design and testing
- Variations in screen size
 - major impact on usability
- Variations in available memory
 - may be unable to load large web pages
- Huge gap in capabilities between high-end smart phones and the rest
- Need to support heterogeneous mix of devices

Environmental Factors

- **Bandwidth**
 - not everyone is on a high speed connection
 - applications that adapt to changing bandwidth
- **Web applications that can work offline**
 - and sync up when next connected
- **Battery Level**
 - large pages with big scripts drain the battery
- **Location**
 - huge potential for location based services

Content Adaptation

Through access to the Delivery Context

- Authoring time
 - Design for different classes of devices
- Request time
 - Taking details of a specific device into account when a page is requested by an HTTP client
- Run time
 - Dynamic adaptation after page has loaded
 - Dynamic adaptation of media streams

Delivery Context

- Descriptions of user preferences, device capabilities and environmental conditions
 - For individual users and devices
 - For classes of devices, e.g. all Nokia N95s
- Exposed through APIs
 - Client and Server-side
- Delivery Context Ontology
 - defines concepts and relationships
 - provides underlying model for APIs

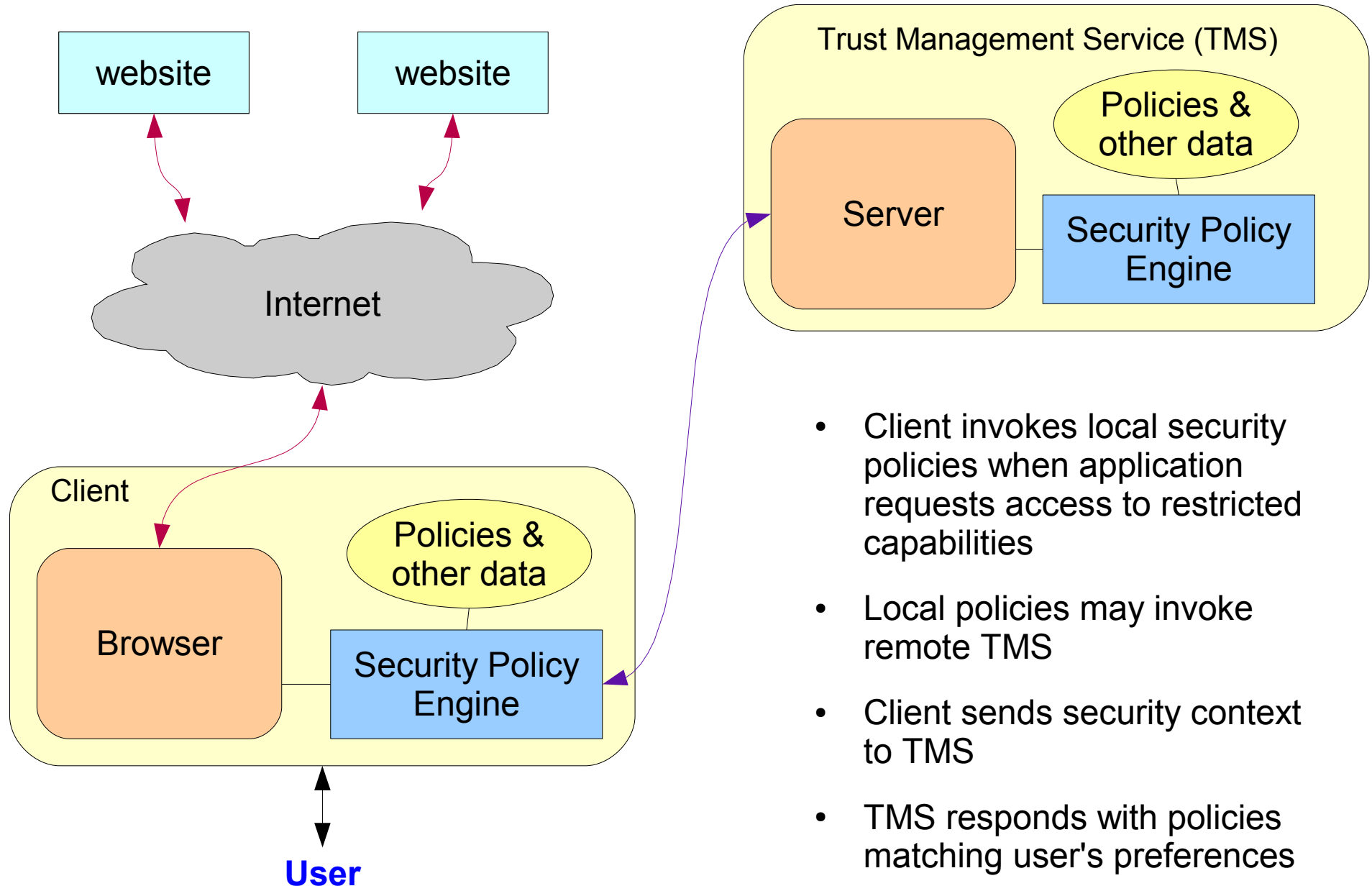
W3C work on Device Ontologies

- Ubiquitous Web Applications working group
 - owns work on Delivery Context Ontology
 - coordination with DD WG and OMA, etc.
- DD WG focus on static descriptions for classes of mobile devices, e.g. all Nokia N95s
- OMA defining server-side API for dynamic device properties for streaming media control
 - screen orientation and bandwidth
- UWA WG work item on client-side API (DCCI)
 - Exposing device capabilities to web page scripts

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



- 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

The Web of Things

- The Ubiquitous Web will involve pretty much all networked devices
 - Mobile devices are just the start
- Next step is to look at range of consumer electronics
 - printers, cameras, media servers, digital TVs
 - making these devices into first class web devices
- Using XML to specify device behavior
 - Loose coupling of devices through events
 - Layered architecture for high level authoring

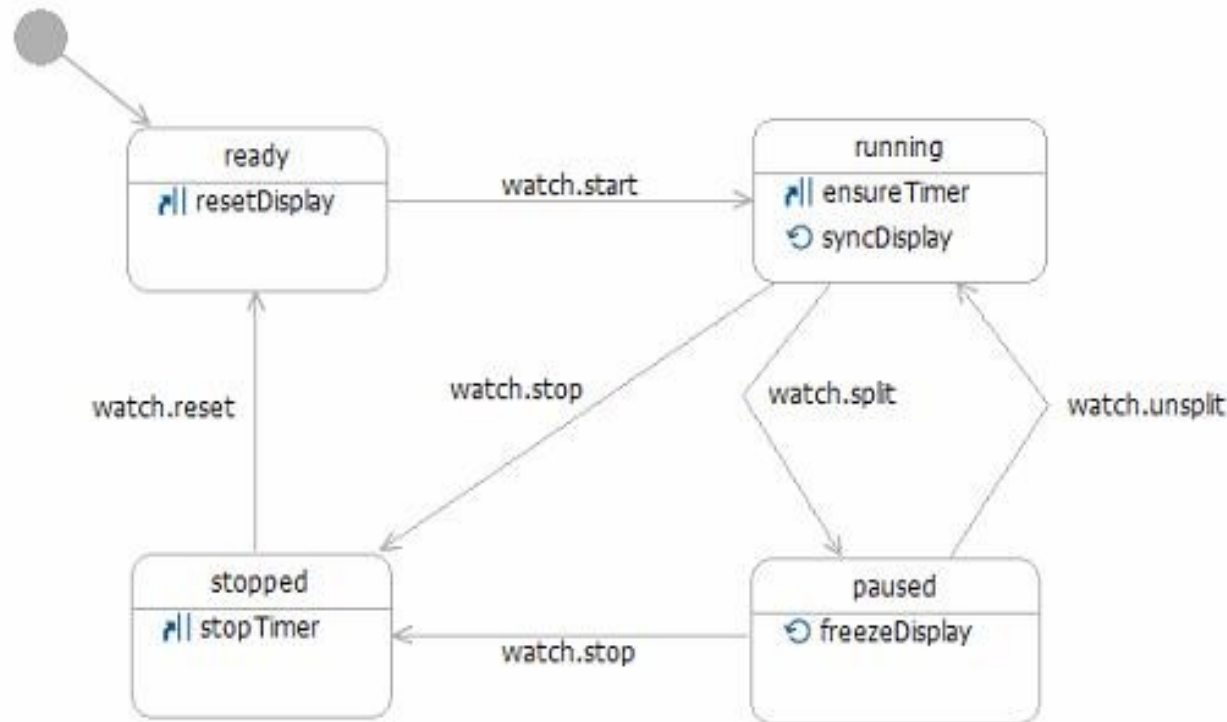
Eventing

- Used to couple devices and services as part of distributed applications
- XML based model of device behavior with a document object model (DOM)
- Application developer can set event handlers and can target events at DOM objects
- When the application wants to make use of some other device/resource it binds that as a proxy object in the local DOM
- Proxy object hides the details of communication with resource

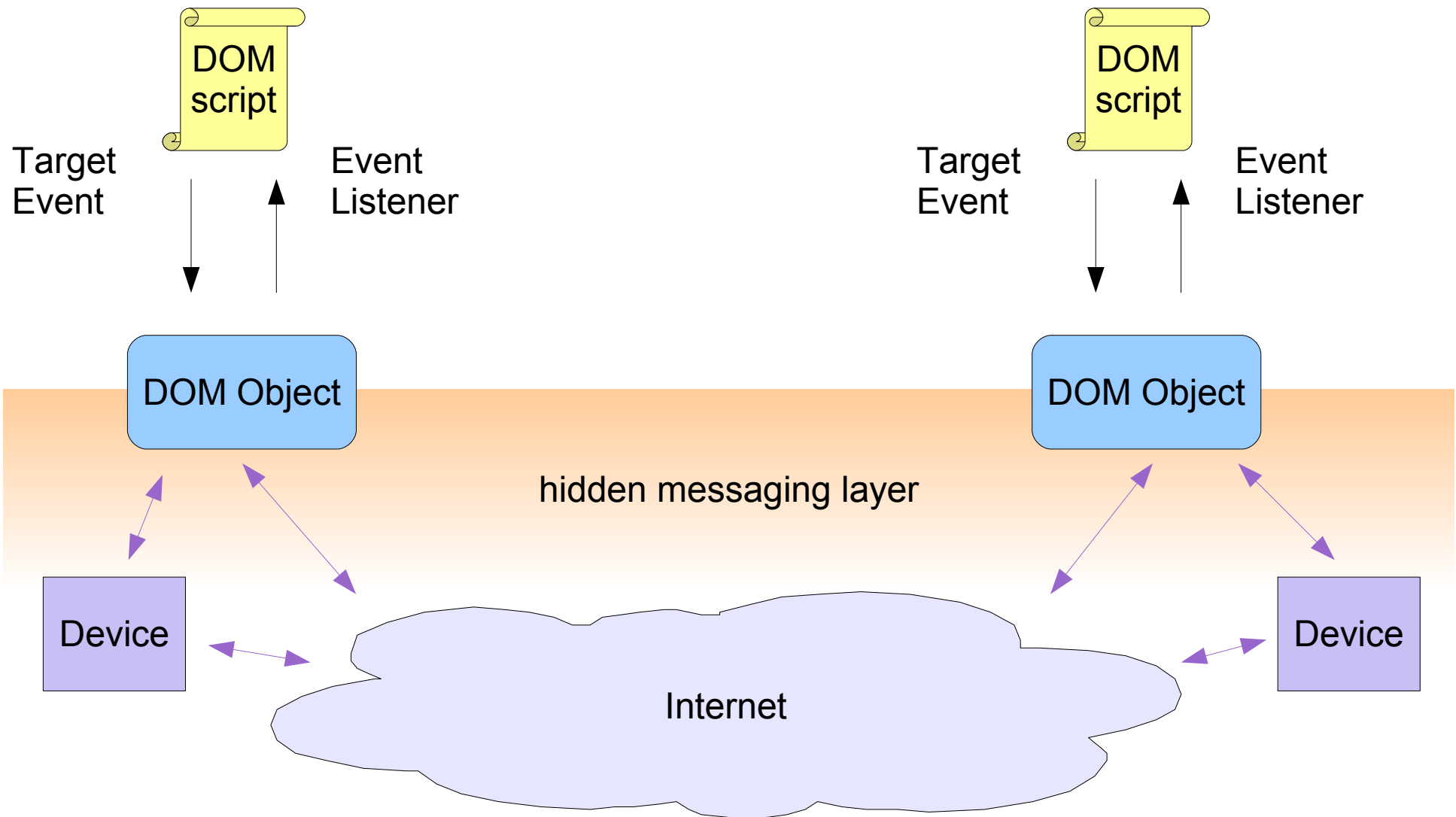
Executable Models of Behavior

XML plus diagrams for ease of authoring

- Models of tasks and the data they operate on
- State Chart XML for event driven state transition models



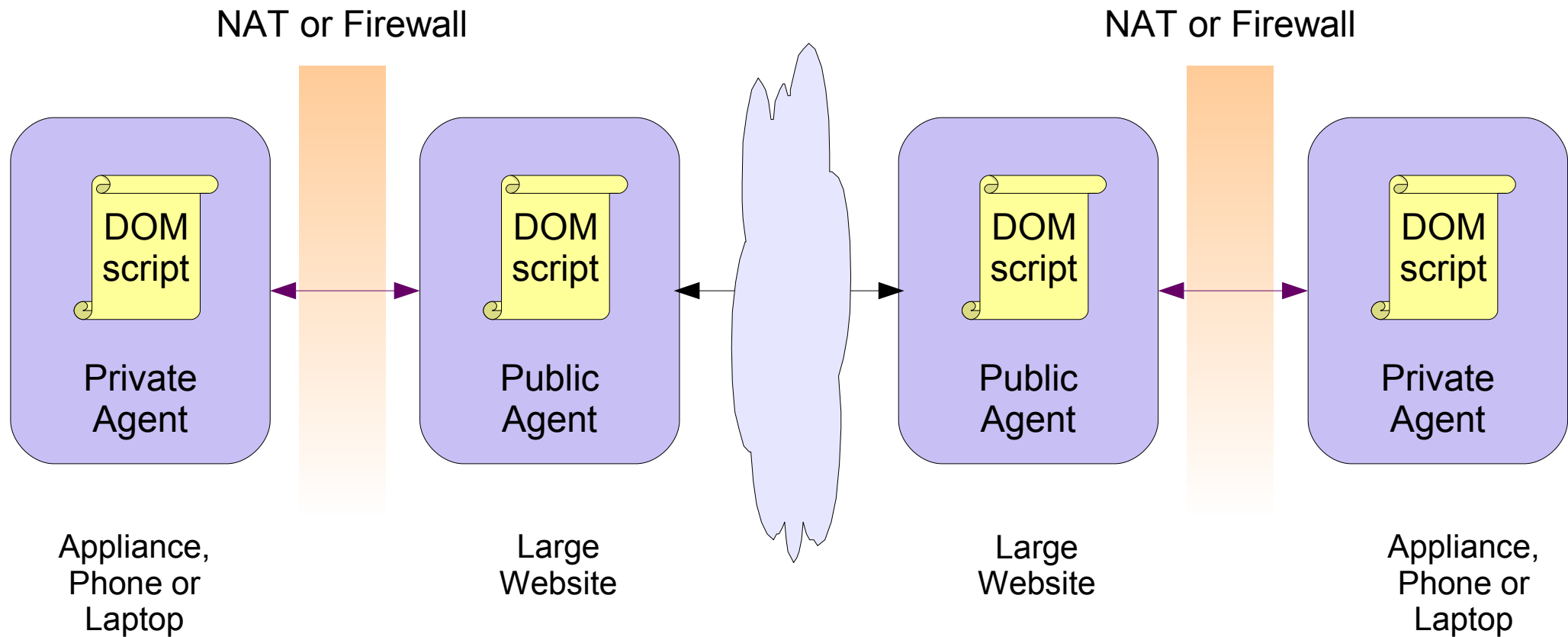
Proxies for accessing services



Agents

- Web-based applications that run on local or remote devices (e.g. large websites)
- Listen for incoming requests and in turn send requests to other agents
- Act on behalf of users and implements corresponding security/trust models
 - limiting access to trusted friends of its user
 - accessing other agents with its user's persona
- Function 24 by 7 and are never asleep or tired

Public and Private Agents



- Private agents may be off-line or powered down

- Enabling off-line operation via data synchronization

Ubiquitous Web Applications WG

- Home page <http://www.w3.org/2007/uwa>
- Follow on to former Device Independence WG
- Plus broadened focus on Ubiquitous Web Applications
- Looking for people interested in working on
 - enabling applications across multiple devices
 - content adaptation for multi-channel delivery
- UWA WG Charter
 - <http://www.w3.org/2006/10/uwa-charter.html>
 - chair: Dave Raggett <dsr@w3.org>
 - team contact: Stéphane Boyera <boyera@w3.org>

Ubiquitous Web Applications

Questions?