

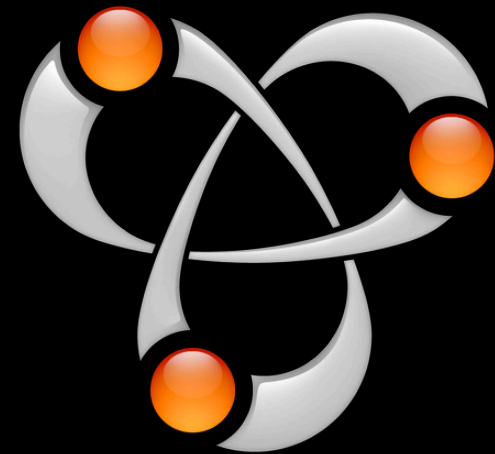


Simplifying Networking Using Bonjour

Dr Stuart Cheshire
Bonjour Architect

Introduction

- Bonjour overview
- Bonjour on iPhone OS
 - Peer-to-Peer Bonjour over Bluetooth
 - New API: `DNSServiceSetDispatchQueue`
 - iOS 4 Multitasking
- Bonjour for Windows 2.0.2
 - `kDNSServiceFlagsShareConnection`
 - Weak-linking helper stub
- Bonjour on other devices
- Tips and reminders



Bonjour Overview

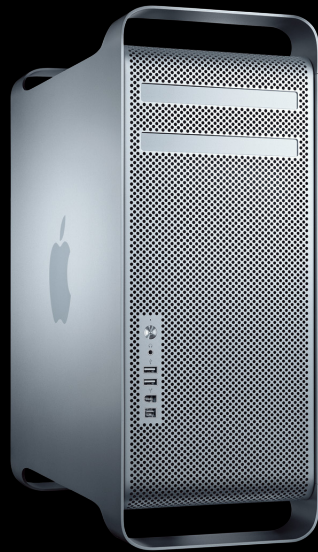
TCP/IP over Ethernet, Wi-Fi, Bluetooth...
...with the ease of use of USB

Technology

- Link-local addressing
 - IPv4 (RFC 3927)
 - IPv6 (RFC 2462)
- Multicast DNS
 - <http://www.multicastdns.org/>
- DNS Service Discovery
 - Link-local and wide-area
 - <http://www.dns-sd.org/>

Three Basic Operations

Server



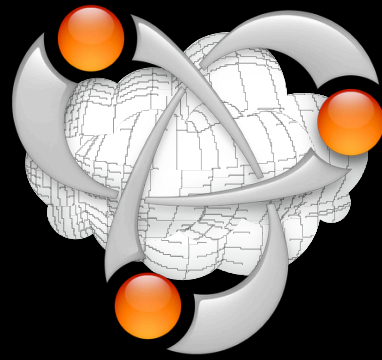
Register

Client



Browse
(Discover Domains and Services)

Resolve



API Architecture

NSNetServices

CFNetServices

dns_sd.h

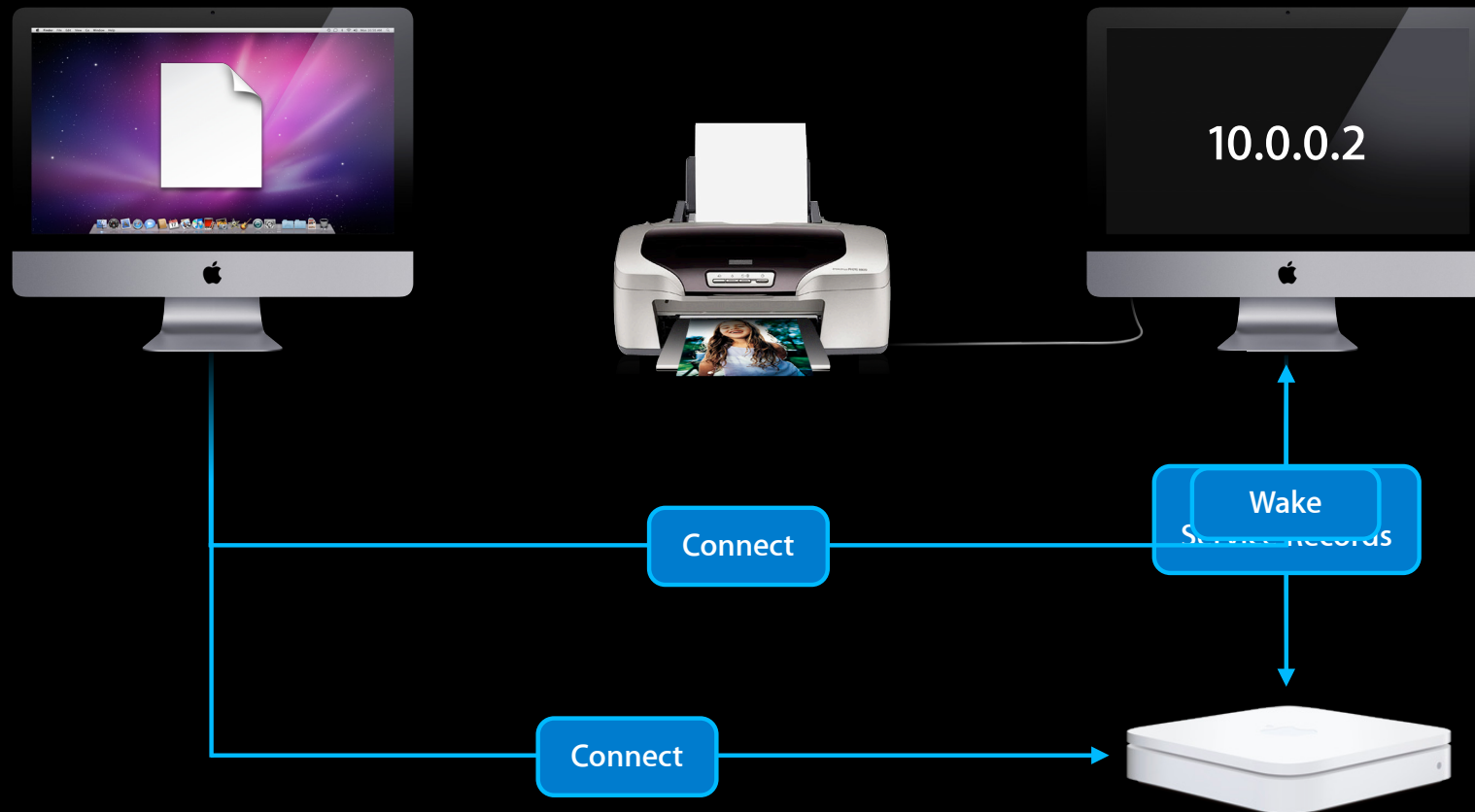
mDNSResponder

Kernel

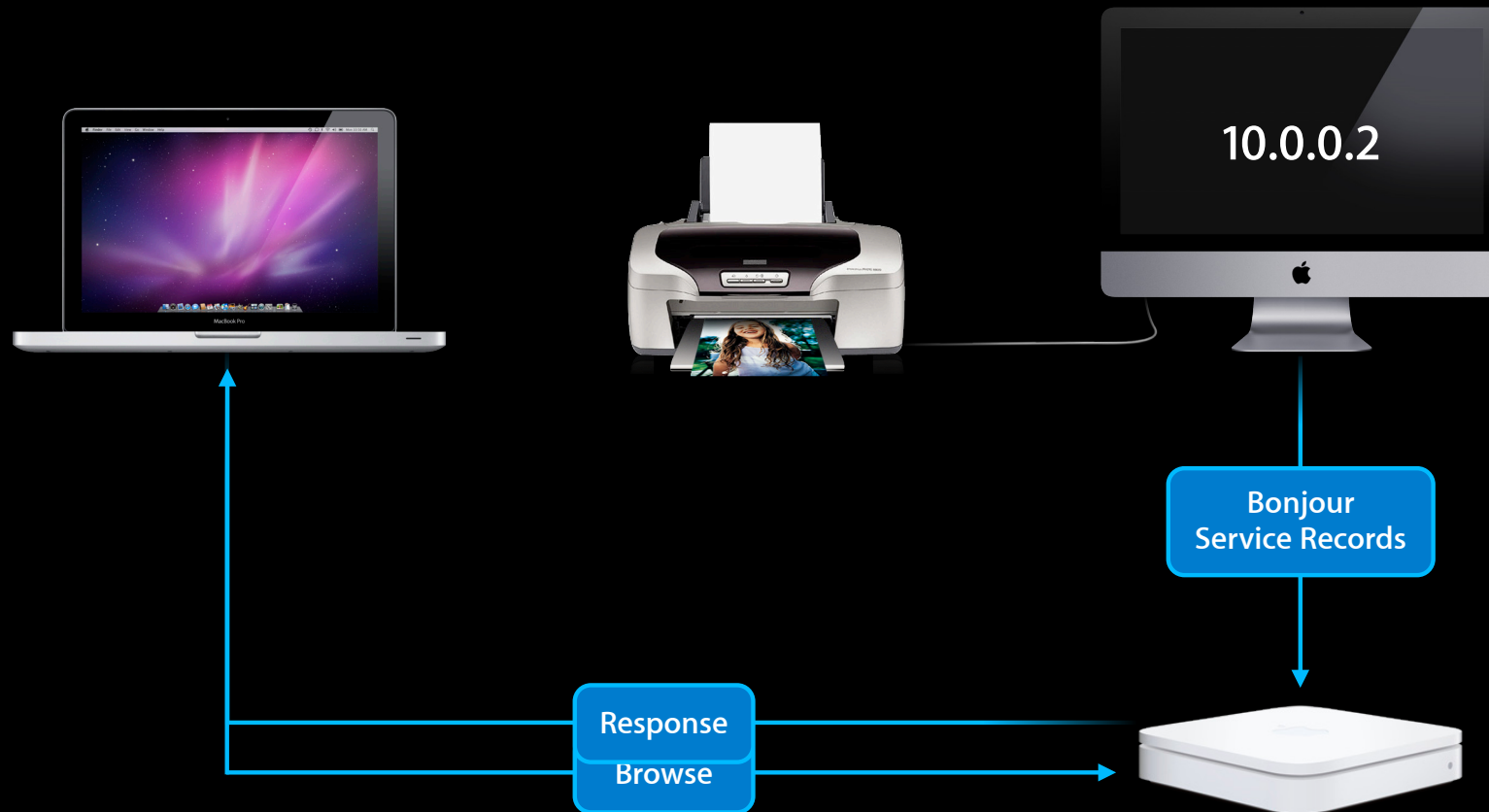
Bonjour Features

- Bonjour APIs let you discover services...
 - On local devices
 - On remote devices
 - On sleeping devices
 - Via Bluetooth

Bonjour Sleep Proxy



Bonjour Sleep Proxy



Why?

- Printer sharing
 - iTunes media
 - Back to My Mac screen sharing and file sharing
 - Command-line ssh
- ...and all other Bonjour-advertised network services

Bonjour on iPhone OS

Rory McGuire
Senior Packet Wrangler

Bonjour on iPhone OS

- Peer-to-peer
- `DNSServiceSetDispatchQueue`
- Multitasking

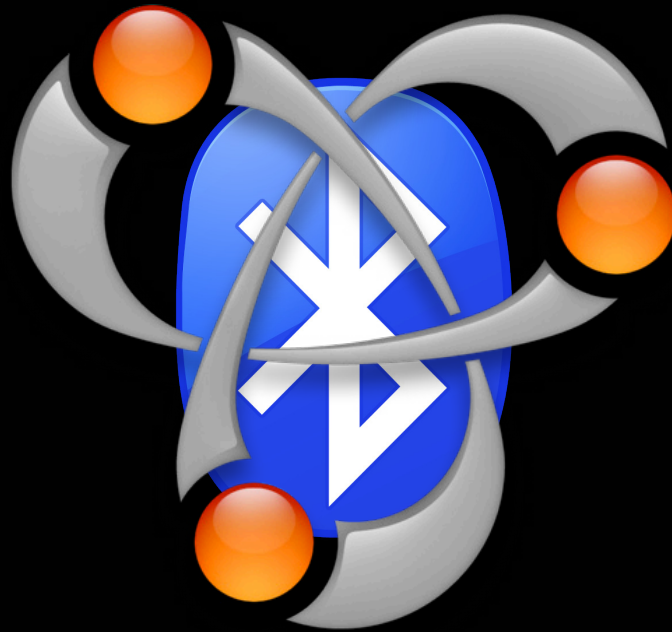
Peer-to-Peer



What Does It Do?



How Does It Work?



Bonjour over Bluetooth

- No manual pairing
- Bonjour connects automatically on Resolve
- Used by Game Kit
 - And all Bonjour apps

How It's the Same

- Same APIs
 - NSNetServices
 - CFNetServices
 - dns_sd.h
- Your code will just work

How It's Different

- Resolves may take longer
 - Bonjour automatically brings up Bluetooth PAN
 - So use `ResolveWithTimeout: 0.0`
 - Let the user decide when they've waited long enough
- That's all!

Browse vs. Resolve

Joe's Printer	joe.local	9100	pdl=application/postscript ...	Bluetooth PAN Connection
Sally's Printer	sally.local	9100	pdl=application/postscript ...	Bluetooth PAN Connection
Jim's Printer	jim.local	9100	pdl=application/postscript ...	Bluetooth PAN Connection
Penny's Printer	penny.local	9100	pdl=application/postscript ...	Bluetooth PAN Connection
Paul's Printer	paul.local	9100	pdl=application/postscript ...	Bluetooth PAN Connection
Mary's Printer	mary.local	9100	pdl=application/postscript ...	Bluetooth PAN Connection

Performance and Battery Life

- Don't browse continuously
- Don't resolve every service
 - Can query just TXT record
- Don't connect to every service

Wi-Fi Direct

- http://www.wi-fi.org/files/20091019_Wi-Fi_Direct_FAQ.pdf

Bonjour on iPhone OS

- Peer-to-peer
- `DNSServiceSetDispatchQueue`
- Multitasking

Bonjour on iPhone OS

- Peer-to-peer
- `DNSServiceSetDispatchQueue`
- Multitasking

DNSServiceSetDispatchQueue

```
DNSServiceErrorType DNSSD_API DNSServiceSetDispatchQueue  
(  
    DNSServiceRef service,  
    dispatch_queue_t queue  
);
```

DNSServiceSetDispatchQueue

```
DNSServiceRef ref;
```

```
err = DNSServiceBrowse(&ref, 0,  
    kDNSServiceInterfaceIndexAny, "_http._tcp", "", replyfn, context);  
if (err) ...
```

```
DNSServiceSetDispatchQueue(ref, dispatch_get_main_queue());
```

Bonjour on iPhone OS

- Peer-to-peer
- `DNSServiceSetDispatchQueue`
- Multitasking

Bonjour on iPhone OS

- Peer-to-peer
- `DNSServiceSetDispatchQueue`
- **Multitasking**

Bonjour and iOS 4 Multitasking

Request
Task Completion

Deal with aftermath
of cancelled
Bonjour operations
and invalidated sockets

applicationDid
EnterBackground

Your code
stops running

Bonjour operations may
be cancelled
(IPC connection broken)

Your code
resumes running

applicationWill
EnterForeground

Connections closed
(will send TCP FINs to peers)
Listening ports stop listening
All sockets invalidated

Bonjour and iOS 4 Multitasking

- Merely building with iOS 4 SDK gets this behavior automatically
- After resume, all Bonjour and networking will be broken for your app
 - Will no longer advertise anything
 - Will no longer discover anything
- Detect and fix all broken networking state, or user experience with your app will be worse than it was in iPhone OS 3

Detect When Bonjour Operations Cancelled

NSNetServices, CFNetServices

- Will call your callback with error code
- You need to restart Bonjour Operations

Detect When Bonjour Operations Cancelled

dns_sd.h

- If you call `DNSServiceProcessResult` yourself
 - Check for return code `kDNSServiceErr_ServiceNotRunning`
 - Restart Bonjour Operations
- If you use `DNSServiceSetDispatchQueue`
 - It will call all your callbacks with `kDNSServiceErr_ServiceNotRunning`
 - Restart Bonjour Operations
- We recommend `SetDispatchQueue`
 - Allows future improvements, resume Bonjour operations automatically
 - But only available on iOS 4 and later

Detect When Bonjour Operations Cancelled

Opt out of Multitasking altogether

- Add `UIApplicationExitsOnSuspend = YES` to your app's Info.plist file

Simplifying Networking Using Bonjour

Dr Stuart Cheshire
Bonjour Architect

Bonjour for Windows 2.0.2

- Installed with
 - iTunes for Windows
 - Safari for Windows
 - Bonjour Print Services for Windows
- Download SDK to get all the pieces
- Now supports `kDNSServiceFlagsShareConnection`
- New weak-linking helper stub
- Developer Preview of Sleep Proxy client for Windows
 - Install SDK and turn on in Control Panel

WaitForMultipleObjects

```
while (1)
{
    HANDLE * waitList      = NULL;
    DWORD   waitListCount = 0;
    BOOL    waitForAll    = FALSE;
    DWORD   timeout       = 0;    // in milliseconds

    SetupWaitList(&waitList, &waitListCount);
    result = WaitForMultipleObjects(waitListCount, waitList, waitForAll, timeout);
    ProcessWaitList(result, waitList, waitListCount);
}
```

Shared Connection API

- Registration of many services without consuming one socket per service
- Documented in `dns_sd.h`
- Example code in `dns-sd.c`
 - From Darwin: <http://developer.apple.com/bonjour/>

Shared Connection API

```
DNSServiceRef sc1, sc2, sc3;
```

```
err = DNSServiceCreateConnection(&sc1);  
if (err) ...
```

```
// Include this event source in your WaitForMultipleObjects
```

```
sc2 = sc1;  
err = DNSServiceBrowse(&sc2, kDNSServiceFlagsShareConnection,  
kDNSServiceInterfaceIndexAny, "_http._tcp", "", replyfn, c1);  
if (err) ...
```

```
sc3 = sc1;  
err = DNSServiceBrowse(&sc3, kDNSServiceFlagsShareConnection,  
kDNSServiceInterfaceIndexAny, "_ftp._tcp", "", replyfn, c2);  
if (err) ...
```

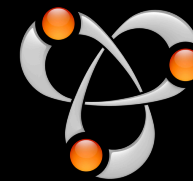
RealVNC

- RFB protocol version 3.8 moving towards RFC
- Bonjour advertising to be in server 4.6 for Windows
- Bonjour browsing to be in client 1.3 for iPad

Demo

Dr Stuart Cheshire
Bonjour Architect

Bonjour on Other Devices





Tips and Reminders

IPv6

- Now supported in iOS 4
- IPv6 link-local more dependable than IPv4 link-local

Use Asynchronous Calls

- DNS timeout is 30 seconds
- iPhone app jettison time is 20 seconds
 - Do a blocking DNS call on your main thread
 - DNS server is slow or unresponsive
 - Your app dies
- CFHost + CFRunLoop
- DNSServiceGetAddrInfo + select, kqueue, Grand Central, etc.

No 'Refresh' Button

- Browsing lists should always be live
 - iChat Bonjour buddies
 - iTunes sidebar
 - Finder sidebar
 - Safari Bonjour list
 - Terminal "New Remote Connection..."

Use Windows, Not Pull-Down Menus

- Users comfortable with window content updating
- Traditionally, menus not expected to change once displayed

Register Your Service Types

- Unique identifier for every service type
- 15 characters max
- Letters, digits, and hyphens allowed
- <http://www.dns-sd.org/ServiceTypes.html>

Do Not Ignore Domain (Local vs. Wide-Area)

- Browsing

- With wide-area Bonjour, can discover remote services
- Service identified by four-tuple
 - { Name, Type, Domain, interface index }
- Store at least { Name, Type, Domain }

- Resolving

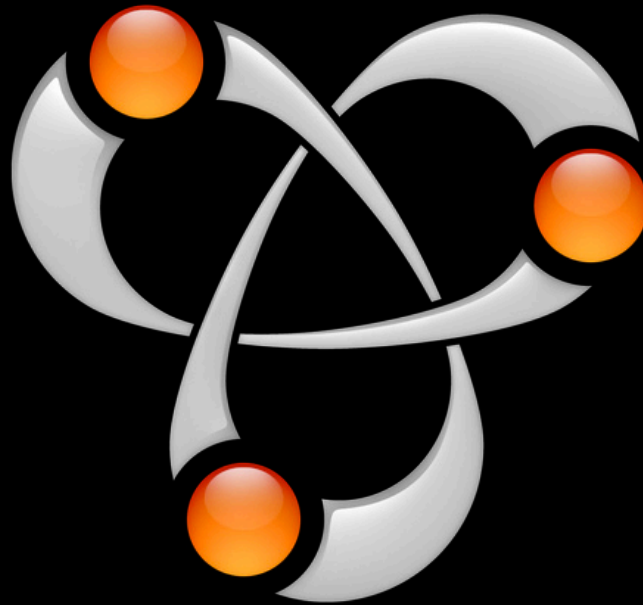
- Pass stored { Name, Type, Domain }
- Don't pass "local" or empty string for domain
- Set interface index to zero to search on all interfaces

Do Not Ignore Port Number

- Do not assume well-known port
- Wide-area Bonjour does automatic NAT port mapping
 - Increasingly, services will not be reachable on expected “well-known” port
 - `DNSServiceResolve()` tells you the port
 - Use it!
 - Example: Terminal “New Remote Connection...”

License Bonjour Logo

No license fee



Run Conformance Test

<http://developer.apple.com/bonjour/>

Finds common mistakes in:

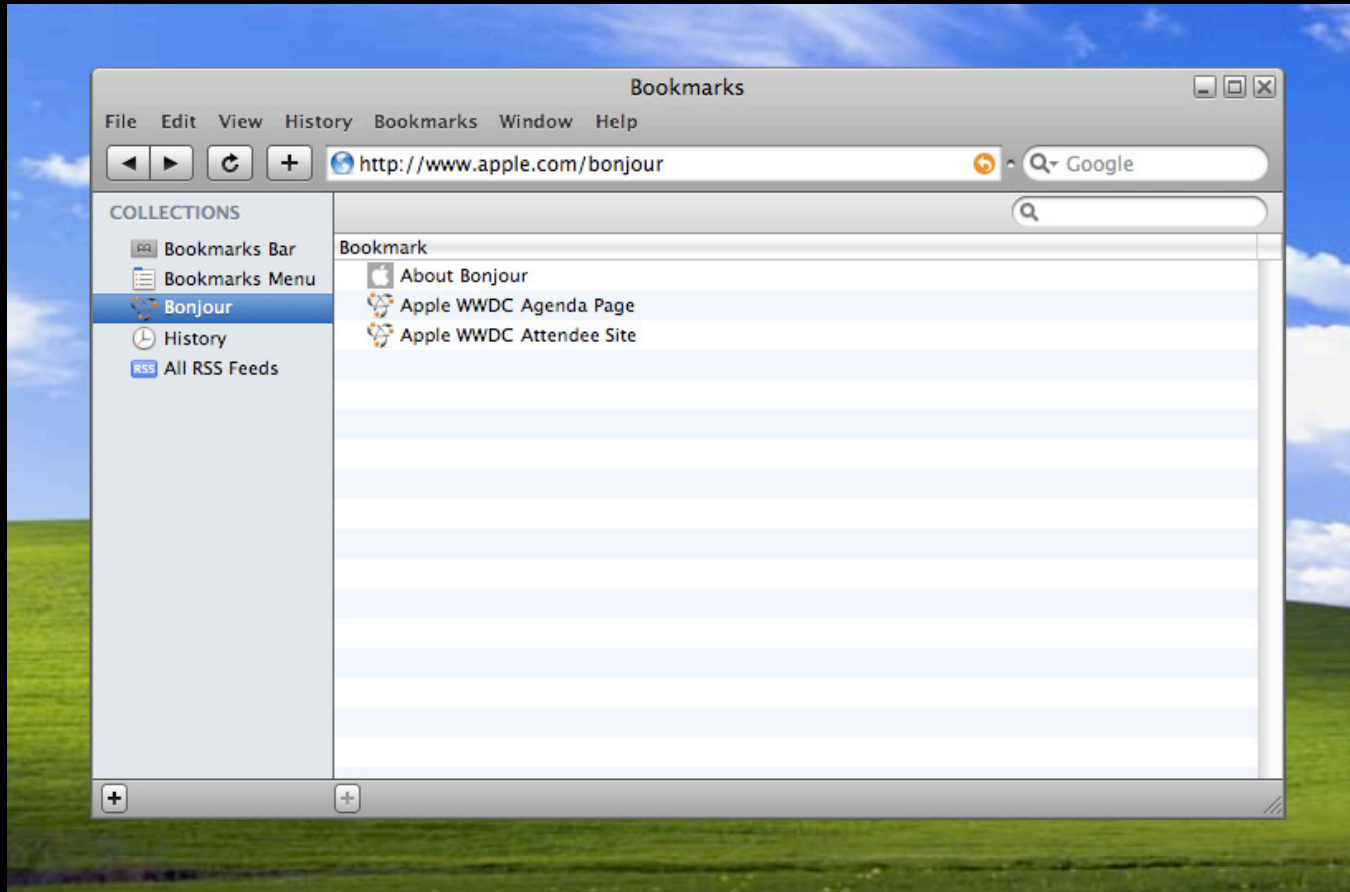
IPv4 Link-Local Addressing
Multicast DNS
DNS Service Discovery

License Bonjour for Windows

No license fee



Safari for Windows with Bonjour



Summary

- Browse when requested by user, not constantly
- Resolve when requested by user, not every service you find
- Embrace asynchronous networking
- Pay attention to iOS 4 Multitasking issues
- Use Bonjour logo on your packaging and marketing materials

More Information

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Paul Danbold

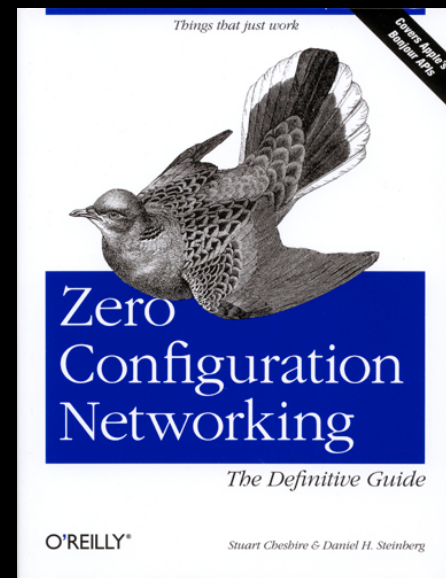
Core OS Technology Evangelist
danbold@apple.com

Documentation

Bonjour Developer Web Page
BonjourWeb & WiTap Sample Code
<http://developer.apple.com/bonjour>

Apple Developer Forums

<http://devforums.apple.com>



Related Sessions

Core OS Networking	Pacific Heights Tuesday 9:00AM
Adopting Multitasking on iPhone OS, Part 1	Marina Friday 9:00AM
Adopting Multitasking on iPhone OS, Part 2	Marina Friday 10:15AM
Network Apps for iPhone OS, Part 1	Pacific Heights Wednesday 2:00PM
Network Apps for iPhone OS, Part 2	Marina Wednesday 3:15PM

Labs

Networking Lab 1

Core OS Lab A
Tuesday 4:30PM

Networking Lab 2

Core OS Lab B
Thursday 9:00AM

Networking Lab 3

Core OS Lab B
Friday 9:00AM

Q&A



