The Software in Software Radio

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Software Radio

- **Hardware Radio**
  - Separate devices for different functions

- **Software Radio**
  - One device for different functions
Talk Outline

- Vanu, Inc background
- Software Radio technology
- Market opportunities
- New business opportunities
- Is Software Radio a disruptive technology?
Company History

**History**
- Founded September ‘98
- Spin-off from MIT SpectrumWare project
- 20 employees

**Strengths**
- 6 years experience implementing software radios
- Software engineering, DSP, system design

**Mission**

To be the Software Provider to the Software Radio Industry.
Why use a Software Radio?

- **Faster technology tracking**
  - Software-only upgrades to new standards

- **Simplifies user experience**
  - One device for all your wireless needs

- **Mitigates Risk**
  - Can change standard after production

- **Universal Roaming**
  - Between services, standards, providers, countries
Definition of Terms

- **Software Defined Radio (SDR)**
  - Software controls and configures any aspect of the radio

- **Software Radio (SWR)**
  - Software controls, configures and implements all signal processing functions
SWR is a software problem

- **Manage Software Complexity**
  - Example: Harris Military Radio Family
    - 25 standards, 3 million lines of code

- **Lesson:**
  - Traditional DSP programming approaches will not scale

- **Solution:**
  - Bring CS software engineering to embedded DSP
    - high level languages, objected oriented design
    - software re-use, modularity, portability
Software Radio Phase Space

Vanu, Inc. Architecture

RDL: Radio Description Language

Control
- RDL Applications
- RDL Interpreter

Signal Processing
- Signal Processing Modules
- Sprockit™ Middleware

LINUX
- Operating System
- Device drivers
  - network
  - user I/O
  - timers

RF-to-Digital
Antenna

Network
User I/O
Timers
Control Interfaces
Implementation Diagram

Software Application

Radio Description Language

Sprockit™

IF Proc.
Modem Proc.
Link Proc.
Protocol Proc.
User Interface

Operating System

Device drivers

Motherboard
RF-to-Digital
Antenna
Market Opportunities

- **Fixed/Vehicular**
  - Telematics, Fixed wireless CPE, Test and monitoring equipment

- **Wireless Infrastructure**
  - **Requires: scalability and reliability**
  - Cellular / PCS, LMDS, MMDS, Wireless local loop, etc.
  - Shared infrastructure
    - cellular, wireless networks, fixed wireless, public safety

- **Handheld**
  - **Requires: Low power, small form factor**
  - Cellphones
  - PDAs
New Business Opportunities

- Shared Infrastructure
- Virtual service providers
- Horizontalization of wireless device industry
Shared Infrastructure

- **One set of infrastructure hardware**
  - Tower, power, network, signal processing

- **Reduce buildout costs by sharing**
  - Est. $10B / carrier for 3G buildout in U.S.
  - Recent activity in Europe to share infrastructure
    - driven by cost of 3G licenses

- **Support multiple customers**
  - Different bands, different standards, different services
    - cellular, PCS, wireless data networks, fleet management, private wireless networks, public safety
    - anyone that uses wireless is a potential customer
Virtual Service Provider

- **Split network operation and service provision**
  - They are fundamentally different businesses

- **Better customer service**
  - Pay one bill, not ten
  - Better coverage and service offerings

Diagram:

- AT&T
- RIM
- BT
- Orange
- Cingular
- Skytel

Virtual Service Provider

Wireless PDA customer
Horizontalization

- **Wireless device industry is moving towards a model more like the PC industry.**
- **Software Radio will take it further:**
  - Component suppliers
    - processors, A/D converters, antennas, memory, “motherboards”
  - Software suppliers
    - operating systems, middleware, radio applications
  - System integrators / retailers
    *Who will be the Dell of wireless devices?*
Vanu, Inc. Business Model

- **Our Primary Business**
  - Software for Software Radios

- **Our Expertise**
  - Software radio and signal processing software
  - Software radio system design

- **Our Products**
  - System design consulting
    - build prototypes and reference architectures
  - Software licensing
    - middleware, radio applications
Is Software Radio Disruptive?

Performance trajectory of present technology driven by sustaining technological improvements

New Performance trajectory

Performance that customers can absorb or utilize

Source: Clayton Christenson
Summary

- **Software Radio is an emerging technology**
  - Well suited for vehicular markets
  - Advanced development aimed at infrastructure market
    - scalability and reliability
  - Major limitation for handhelds: battery life
    - limits to niche wireless markets today
    - will be overcome with advances in low power processors
  - FCC examining certification issues
    - proceeding: 00-47

- **Market Implications**
  - Enable new business opportunities
  - Complete the vertical to horizontal industry shift