The Radically Changing Device Development Landscape for Service Providers

Sree Kotay, Comcast, LCA14, Macau
Agenda

• Intro
  Sree Kotay:
  SVP Eng&Ops Technology&Product, Chief Software Architect
  Comcast Corp

• A little bit of context
• Problem statement
• Technical solutions
• How Linaro fits
A little background…

Comcast Corporation
Uniquely positioned to lead in entertainment, information and technology

<table>
<thead>
<tr>
<th>COMCAST</th>
<th>NBCUniversal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable Communications</td>
<td>Cable Networks</td>
</tr>
<tr>
<td>% of Total Revenue: 64%</td>
<td>14%</td>
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<tr>
<td>% of Total OCF: 77%</td>
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<tr>
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<th>Broadcast</th>
<th>Film</th>
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<tr>
<td>1%</td>
<td>2%</td>
<td>4%</td>
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</tr>
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**XFINITY TV**
**XFINITY Internet**
**XFINITY Voice**
**XFINITY Home**

**COMCAST BUSINESS**
**COMCAST SPOTLIGHT**

**Digital and Other**

The Platform
plaxo
Ovations
Global Spectrum

DailyCandy
hulu
ivillage

Note: Revenue mix based on LTM results as of 3Q13 and is before corporate overhead and inter-company eliminations.

*Minority interest and/or non-controlling interest.
“if you care about the software, you should care about the hardware.”
"When I go into my living room and turn on the TV, I feel like I have gone backwards in time by 20 to 30 years," Apple CEO Tim Cook
What we wanted to build:

- New interactive experiences
- Easy to change
- Embrace the web
- Aggregator of info, entertainment & communication
What we needed to build to do that....

**Evolution of Cable Ops & Infrastructure**
- Ingest content, serve user interface
- Billing and entitlements
- Care

**Cloud Computing**
- Faster product
- Apps store
- Easier to support more devices at scale

**IP Video End to End**
- Serve any device, source any content
- Leverage personal media
- Off-footprint reach

**New Device Ecosystem**
- Lower cost, commoditized devices
- Flexible storage architecture
- Managed configuration

**User Experience**
- New interactive experiences
- Easy to change
- Embrace the web
- Aggregator of info, entertainment & communication

**New Device Ecosystem**
But really not that complicated…

Be relevant to every screen in the home

Make the big screen relevant and innovative.
Key investment domains

- Application platform
- IP video platform
- CPE platform

project xcalibur
<table>
<thead>
<tr>
<th>Time</th>
<th>Channel</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:00p</td>
<td>69 FOOD</td>
<td>Essence of Emeril</td>
</tr>
<tr>
<td>7:30p</td>
<td>70 HGTV</td>
<td>Designed to Sell</td>
</tr>
<tr>
<td>8:00p</td>
<td>71 DIS</td>
<td>Mary Poppins</td>
</tr>
<tr>
<td></td>
<td>82 ESPN2</td>
<td>ESPNEWS Gametime</td>
</tr>
</tbody>
</table>

**Yesterday**:

- Essence of Emeril, (2006), Family recipes are featured. Included...
<table>
<thead>
<tr>
<th>Time</th>
<th>Channel</th>
<th>Program</th>
<th>Time</th>
<th>Channel</th>
<th>Program</th>
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<td>412</td>
<td>Lombardi</td>
<td>3:00p</td>
<td></td>
<td>Diary of a Wimpy Kid: Rodrick Rules</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>3:30p</td>
<td></td>
<td>Pom Wonderful Presents: T ...</td>
</tr>
<tr>
<td>3:30p</td>
<td>413</td>
<td>The Ides of March</td>
<td>4:00p</td>
<td></td>
<td>Enlightened</td>
</tr>
<tr>
<td></td>
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<td></td>
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<td>414</td>
<td>Get Low</td>
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<td></td>
<td></td>
<td>415</td>
<td>Celebrity Apprentice</td>
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<td></td>
<td></td>
<td>Restless</td>
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<td></td>
<td></td>
<td>416</td>
<td>Addicted to H ...</td>
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<td></td>
<td></td>
<td></td>
<td>UCLA Dynasty</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The Prankster</td>
</tr>
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</table>

### The Ides of March

(2011) Ryan Gosling, George Clooney, Philip Seymour Hoffman...

In this thought-provoking drama, an idealistic campaign press secretary (Ryan Gosling) works to help a politician (George Clooney) become the Democrat ...
Game of Thrones S3 | Ep7 "The Bear and the Maiden Fair"

Tywin counsels Joffrey; Melisandre shares a secret with Gendry; Daenerys exchanges gifts with a slave lord near Yunkai; Brienne battles a formidable adversary...

65 minutes
HBO On Demand
TVMA 60 66

Record  Bookmark  More Info

Latest Episodes of Game of Thrones
Since 2H 2012:
- Screensaver/Dayview
- Editorial Promotions
- Voicemail & Text messaging
- Photos, Stocks, Horoscopes, et al.
- Send-To-TV
- Electronic-Sell-Through
- Cloud-DVR

In addition to:
- X1 voice remote
- National launch
- AR-DVR
- DLNA, Powersave, new CC requirements
- Numerous user enhancements to flow
- Numerous bug fixes
- X2 FCS
And more…

(...and some R&D projects....)

WEB-RTC

EA Gaming

3rd Party Web Apps

Android Apps
Why do all this?

DOES EXPERIENCE MATTER?

Or will people just buy anyway?
25% lift in VOD hours
20% lift in VOD revenue
11% more minutes per view

65% use apps

90% use “Recents”
56% use full-screen “Search”

25% reduction (voluntary) churn

7.6 hours of TV
~2X over-index on EST
40% lift in Channel usage
1.8B pageviews (Nov’13)

x1 by the numbers
*early data / early days
“Xfinity X1: How Comcast roped me back in to cable”

“…the X1 is worth getting over other subscription services“

“Kudos to @Comcast: New X1 platform is best cable UI I've used to date (by a wide margin) and ordering/installation was surprisingly painless”
– Jeff Weiner, CEO LinkedIn
“I keep hearing rumors that Apple is working on something like this...
....If Apple is going to be able to do a lot better, I’ll be pretty shocked.

This is a HUGE improvement in my enjoyment of TV every evening.”

-- Robert Scoble
CEO Reed Hastings and CFO David Wells gave a shout-out to Comcast for its X1 interface, which they said "is an impressive and leading example of [competition]." – Netflix 2012 Earnings report – Jan, 2013

“…I have a X1 (Comcast box) at home. It's got apps and I listen to Pandora on it…I think personally, I would like to be able to watch Netflix and that will keep me on the Comcast X1, which is a great product…” – Netflix Q3 2013 Earnings call – Oct, 2013
Let’s rewind a bit…

Application platform
IP video platform
CPE platform
x1 platform
viper
rdk

project xcalibur
# Application Models: Problem Decomposition

Lower you are on the chart, the more specific you have to be about client requirements.

<table>
<thead>
<tr>
<th>Remote Display</th>
<th>Remoted Video</th>
<th>Bandwidth</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g. Active Video (AKA ICTV)</td>
<td>Remoted Video</td>
<td>Latency</td>
</tr>
<tr>
<td>OnLive</td>
<td></td>
<td>Compute Power</td>
</tr>
<tr>
<td>Raven</td>
<td></td>
<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Remote DOM</th>
<th>DOM model</th>
<th>Latency</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g. HME</td>
<td>Resource oriented</td>
<td>Tool Chain/Developer Community</td>
</tr>
<tr>
<td>Flash Remoting</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Generic Client</th>
<th>“Content” application</th>
<th>“Thickness” of client</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g. Flash</td>
<td>Cache based</td>
<td>STB performance</td>
</tr>
<tr>
<td>HTML Browser</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Full Client</th>
<th>Installable application</th>
<th>Installation and deployment</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g. Guide</td>
<td>Native or VM based</td>
<td>Pace of innovation</td>
</tr>
<tr>
<td>Outlook</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Linaro**

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Comparison to AJAX

“The key difference between Server-side Dual-DOM and Client-side Dual-DOM is that, with Server-side Dual-DOM, the Ajax DOM and most user interface logic is managed on the server. In this scenario, the primary job of the client Ajax engine is to reflect back to the server any interaction state changes, deferring data handling, UI state management and UI update logic to the server.”

http://www.openajax.org/member/wiki/WP2_-_Successful_Deployment_of_Ajax_and_OpenAjax
Sample messaging

Connection setup

XRE Receiver

Connect Event
{
    name: "CONNECT",
    deviceCaps: { ... },
    applicationName: "apps/myApp",
    minimumVersion: "1.2.3",
    eventIndex: 0,
    timestamp: XXX
}

XRE Host

Connect Command
{
    command: "CONNECT",
    version: "1.2.3",
    sessionGUID: "{xxxxxxxx-xxxx-...}",
    commandIndex: 0,
    timestamp: XXX
}

New view message

{
    command: "NEW",
    id: 2051,
    klass: "XREView",
    params: { bounds: [600, 600] }
}
commandIndex: 56,
timestamp: 12393187203234
XRE: More about it

• XRE is a **methodology** NOT a **technology** (or standard)
• AJAX pattern: JSON over HTTP (or at least port 80)
  o If the web works, UI and content should work
• Strict W3C DOM*
  o Plus animation (client side)
  o Plus 4x4 matrix composed tree
  o No CSS, NoI, No scripting (client-side)
• Ease of implementation in a variety of client technologies:
  o Flash, HTML, Java, C, Silverlight/C#, etc.
  o Ease of HW accelerability
• Requires factoring business logic into web services
  o Cacheability
  o Data Integrity
Video: Client Platform strategy – no industry standardization

4 client technology tiers required for COAM service delivery*
- Application implements user interface
- Video Player implements video business logic (ads, blackouts, etc)
- Container/Protocol implements adaptive logic and video playback (trick, etc)
- Security implements content protection

*Not all combinations are valid!

Service | App | Runtime | Video Player | Container/Protocol | Security
---|---|---|---|---|---
*Netflix* | HTML (CE) Native (iOS) | Custom Qt/Webkit (CE) Native Obj-C (iOS) | Custom per device/Native C++ | PIFF/Smooth HLS (iOS) | Playready

*Vudu* | HTML (iOS) Native C++(CE) | Browser (iOS) Native C++(CE) | Custom per device/Native C++ (CE) Javascript (iOS) | Custom HLS (iOS) | Custom? AES (iOS)

*Hulu* | HTML | Browser Engine | Flash (Online) | RTMP (Online) | RTPME (Online)

*VIPER-Xbox* | C# | Silverlight | Silverlight | PIFF/Smooth | Playready

*VIPER-Samsung* | HTML | Browser Engine | Flash | HDS | Access

Security models are “TLS to the glass”
Separating discovery from delivery means:
- IP apps can leverage QAM video
- IP video can be delivered to many applications
Xcalibur: Cloud Compute Platform

Client platforms

- Elasticity
- Utility
- Velocity
Xcalibur: Cloud Compute Platform

Client platforms

~20 Local Encode (ONLY) + nDVR (storage)

NDC

RDC

Video

Application

• Virtualization
• Persistence
• Metrics
Shared source development for devices

RDK: *(noun formal)*

- a royalty free *bundled distribution* of *shared source* components
- selected for utility in delivering MPVD services by *reducing the abstraction* between custom and COAM
NOT

A presentation engine

An application framework A (traditional) HAL
Obligatory Block Diagram

But that looks just like .... Android? CDI? HPK? Etc.??
A different mindset....

Different in that it:

• is a leaky abstraction – not a new API
• is shared source – transparent and self-service
• leverages community progress
# The last 12 months

## 2013

<table>
<thead>
<tr>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>VPOP / CVP1</td>
<td>Multihub mDVR</td>
<td>QT 5.0</td>
<td>Qt 5.1</td>
</tr>
<tr>
<td>Power Mgmt</td>
<td>RCDL/DCM</td>
<td>Service Manager</td>
<td>TDK</td>
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<tr>
<td>Service Flow Routing</td>
<td>TR69</td>
<td>RMF Preview</td>
<td>RDK Emulator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WebKit Media Player</td>
<td>IP Video / AVE</td>
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</tbody>
</table>

### Device Deployment

<p>| | | | |</p>
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<tbody>
<tr>
<td>3rd Device</td>
<td>4th Device</td>
<td>1M+ Devices</td>
<td>5th Device</td>
</tr>
<tr>
<td>Deployment</td>
<td>Deployment</td>
<td>Deployment</td>
<td>Deployment</td>
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</table>

Linaro Connect
## The next 12 months

### 2014

<table>
<thead>
<tr>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
</tr>
</thead>
</table>
| - RDK 2.0 (OCAP-less)  
- DVB Preview  
- IPv6 Support  
- HDMI-CEC | - CVP2  
- Yocto/OE RootFS  
- WebGL  
- Advanced Power Mgmt  
- Wifi support | - Blink  
- **OpenMax-IL** support  
- WebRTC | - Linaro RDK  
- Crypto API  
- RDK/B |

You are here
RDK @ comcast

- ‘develop in the open’
- two hats
  - community owner
  - deployment customer
- hierarchical and distributed
Source code mgmt. looks different

- Trunk based development: Branch for release
- Continuous Integration
- Sprints are when you ship
- Build vs. Buy is a false dichotomy
“it is better to fix problems than to prevent them”
- ed catmull
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<th>Brand New</th>
<th>Mature</th>
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<tr>
<td>2007 Aug 21</td>
<td>2012 Dec 18</td>
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<tr>
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<td>2013 Jan 28</td>
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<tr>
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<tr>
<td>2007 Nov 12</td>
<td>2013 Feb 19</td>
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<tr>
<td>2008 Jan 1</td>
<td>2013 Mar 19</td>
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<tr>
<td>iOS 1.1.4</td>
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<tr>
<td>2008 Feb 26</td>
<td>2013 May 2</td>
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<tr>
<td>iOS 1.1.5</td>
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<tr>
<td>2008 Jul 15</td>
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<tr>
<td>iOS 2.0.0</td>
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<td>2008 Aug 4</td>
<td>2013 Sept 19</td>
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<td>...</td>
<td>iOS 7.0.2</td>
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<tr>
<td>Every 2-3 weeks</td>
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<td>...</td>
<td>...</td>
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<td>...</td>
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<tr>
<td>...</td>
<td>2013 Aug 15</td>
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<td>iOS 7.0.2</td>
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<tr>
<td>2013 Sept 19</td>
<td>2013 Sept 26</td>
</tr>
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<td>...</td>
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Same Period: Jun ‘07-Sep ‘13

A25.2  2007 Jan
A28    2009 Feb
A30    2012 Aug
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<td>9/19/2013</td>
</tr>
<tr>
<td>1.3.0</td>
<td>9/30/2013</td>
</tr>
</tbody>
</table>

... (covers XG1 releases only)
quick summary

- intentionally leaky abstraction – not a new API surface
- shared source – sharing knowledge is better than hiding hardware
- community counts – vote with code!!!
- know how **devops** works: don’t branch until you’re ready
- open = “transparent” & “self-service”, while closed = “wait-in-line”
- its been good for comcast – it might be good for you, too
Why do all this?

PLATFORM CONTROL MATTERS. a lot. the alternative is marginalization.
principles

- develop in the open
- regular robust releases
- no anti-fragmentation*
- royalty-free
- community contribution
- product velocity
community

• contributions back
• you can have private components
• backwards compatibility required*
• we don’t have all the answers
• security is a shared problem
• grants? bug bounties?
An XKCD for everything...

How people feel when they say "I don't own a TV" by year:

- Smug
- Neutral
- Embarrassed
More about Linaro Connect: http://connect.linaro.org
More about Linaro: http://www.linaro.org/about/
More about Linaro engineering: http://www.linaro.org/engineering/
Linaro members: www.linaro.org/members