



Technologies That Matter, Convergence or Conspiracy?

Keith Cambron

President & CEO, AT&T Labs



How have networks changed, and how do we design and operate them?

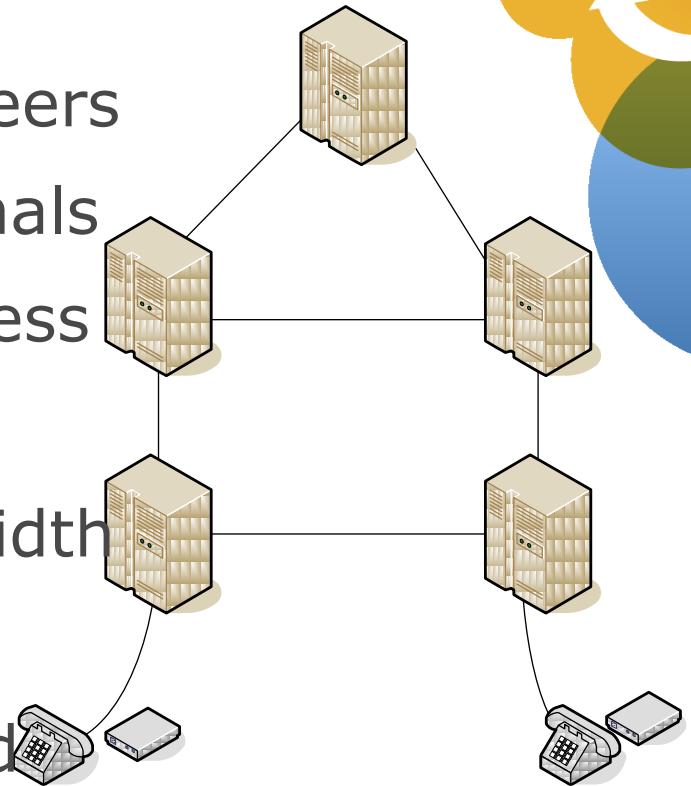
Networks – before 1990

- Shaped by the PSTN providers & standards
- Largely voice, ISDN introduced in mid 1980s.
- One *converged* network for voice and data
- Predictable port growth, about 3% per year
- Predictable traffic patterns
 - 3 ccs residence or 8% occupancy in the busy hour
 - 5 ccs business or 14% occupancy in the busy hour



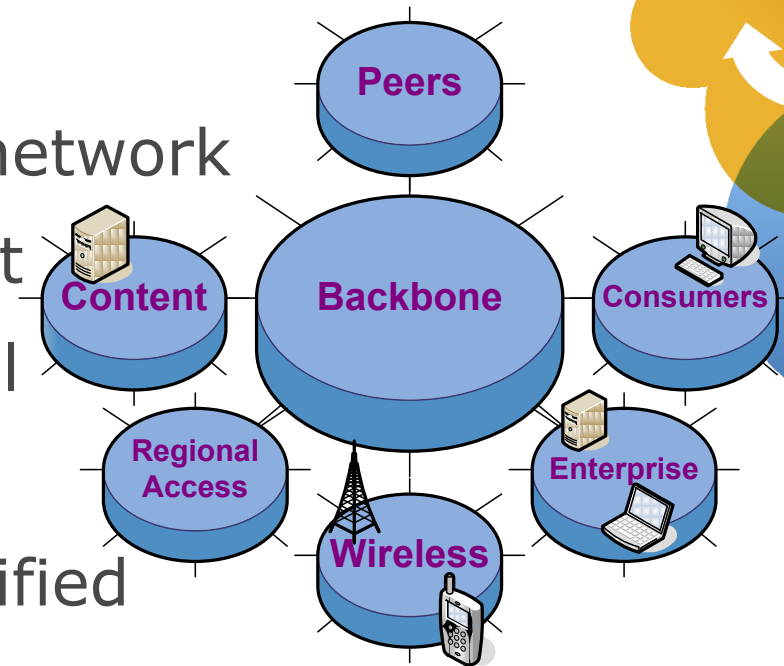
Networks – before 1990 ...

- Hierarchical networks
- Static routing set by PSTN engineers
- Clear division, networks & terminals
- Backbone traffic throttled by access
- All traffic is unicast
- All sessions used 64 kbps bandwidth
- Common channel signaling
- Sessions are blocked, not queued
- Blocking occurs at origination



Networks – after 2010

- **Mesh** - network of networks
- **Dynamic routing** set by the network
- Blurred boundary, apps & net
- No explicit congestion control
- Traffic is **unicast & multicast**
- Session bandwidth is unspecified
- Sessions fail at the weakest point
- No end to end service management
- Lack of global standards for services



A Foundational Change

- converge - to tend to a common result, conclusion, etc.
- conspire –
 - (1) to act or work together toward the same result or goal.
 - (2) to agree together, esp. secretly, to do something wrong, evil, or illegal.

Then - Network providers introduced services on **converged** networks to optimize capital deployment. Networks were predictable and centrally managed. Service management and network management were synonymous.

Now – Devices, applications and access technology **conspire** to shift demand and services in dramatic fashion, testing the ability of networks to respond. Often there is no clear owner of service management.



Technologies that Matter

“The Conspirators”

- **Access Technologies** – opening the gates
- **Devices** – exploding consumption
- **Applications** – content dominates the Internet
- **Mobility** – cutting the cord



Access Technologies

Opening the Gates

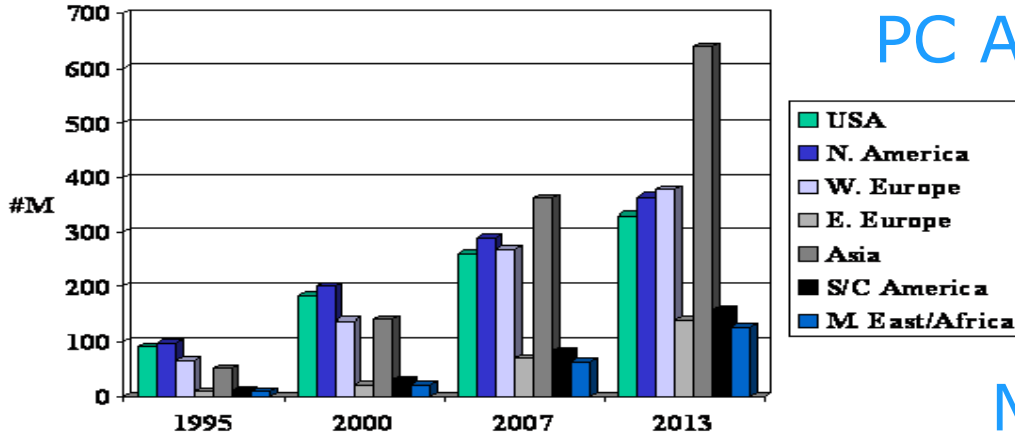
- **Copper** – ADSL1 (1990) 6 mbps, VDSL2 (2006) 25 mbps
- **PON** – BPON (2005) .6 Gbps, XPON (2012) 10 Gbps
- **DWDM** – Access (2006) 1 Gbps, (2010) 40 Gbps
- **Mobility** – GSM/EDGE (2003) .1bit/Hz, LTE/OFDM (2011) 2.4 bits/Hz

Access bandwidth is growing at 40% CAGR



Devices

Exploding Consumption

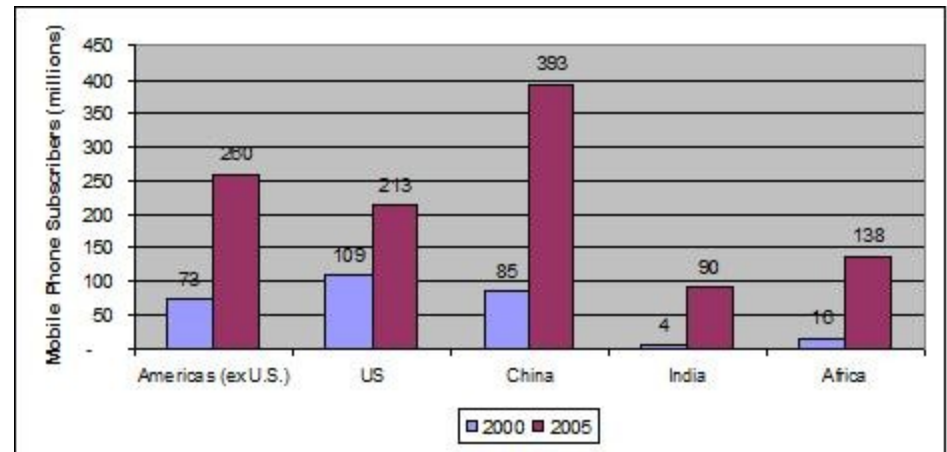


Computer Industry Almanac

Device adoption is maturing in US, but growing at 15 - 30% CAGR globally.

Device bandwidth consumption is growing at ~ 40% CAGR for smart devices.

Mobile Phone Adoption

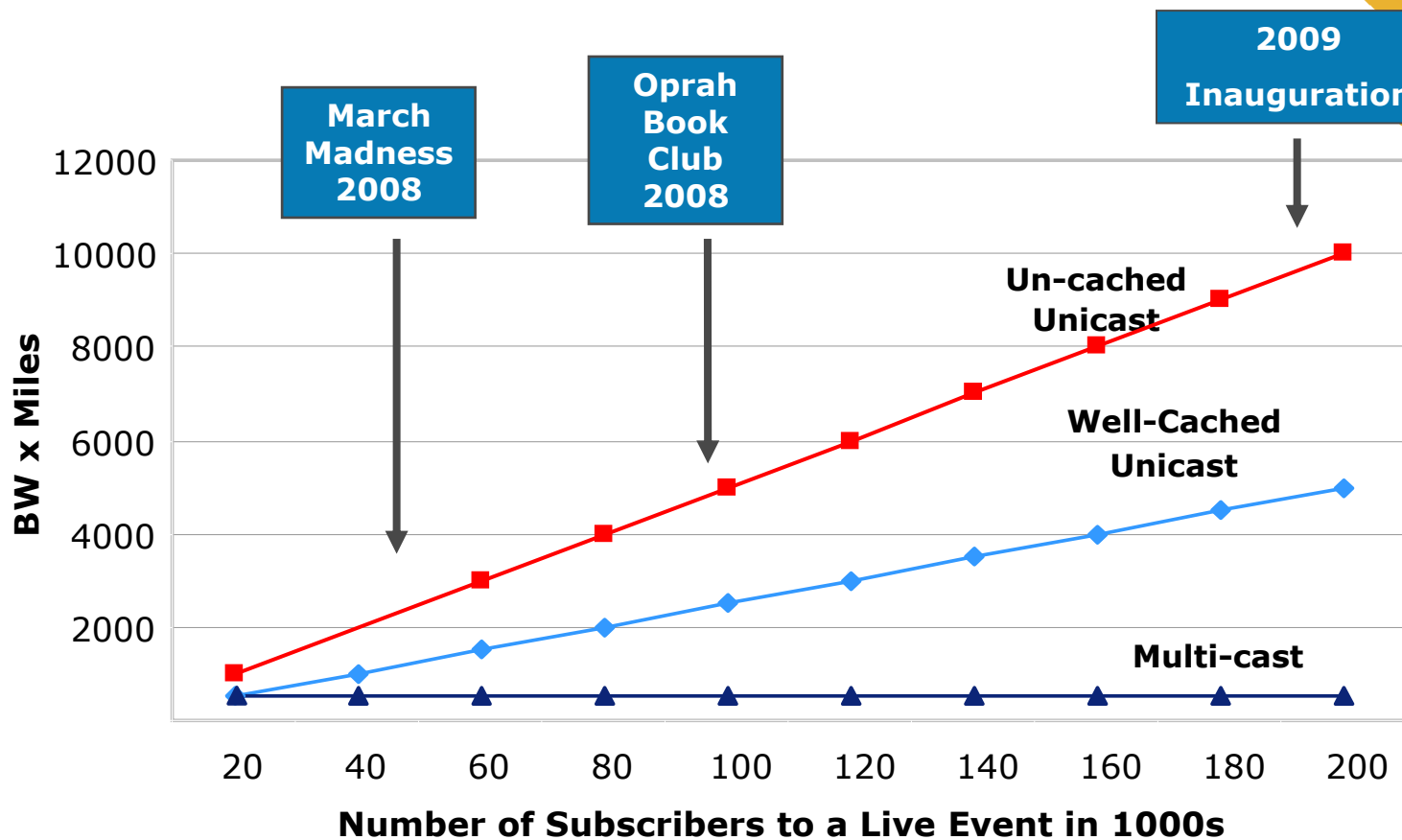


WikiInvest.com



Applications

Content Dominates the Internet



Video accounts for 35% of backbone traffic, and is growing at 75% CAGR



Mobility

Cutting the cord



- iPad, iTablets – dramatic increases in screens
- Multi-tasking – Pandora
- Mobile LANs – tethering and vans
- Venues – replays at the stadium
- IPV6 – interworking and routing tables



Network Technologies

Responding, Adapting



- **Optics** – 100 GigE, OTN, wavelength services
- **Dynamic Routing** – App aware networks
- **Mobility** – LTE, WiFi, DAS, IPV6
- **Video** – tiered multi-cast, tiered caching
- **IPV6** – dual stack, 6rd, CG NAT
- **Service Management** - ?

