The Effect of Grid Delivery
using Peering Portal's Streaming Technology
on Video UCC Service

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PANDORA.TV

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Company

History

Oct, 2004	▪ Launched Pandora.tv site
Oct, 2005	▪ Obtained membership of 500,000 and daily visitor of 100,000
Nov, 2005	▪ Established Pandora.tv Japan (www.pandora.tv.jp) ▪ Became the master content provider (MCP) for LG Electronics ▪ Launched mobile Pandora.tv service via KTF
June 2006	▪ Raised 6 billion KRW (US$6.3 million) of funding from a silicon valley VC-led consortium
July 2006	▪ Achieved daily visits of 800,000, daily video streams of 3.5 million, and daily page view of 14.5 million ▪ Content distribution agreements with Yahoo, Naver, Daum, Empas and MSN

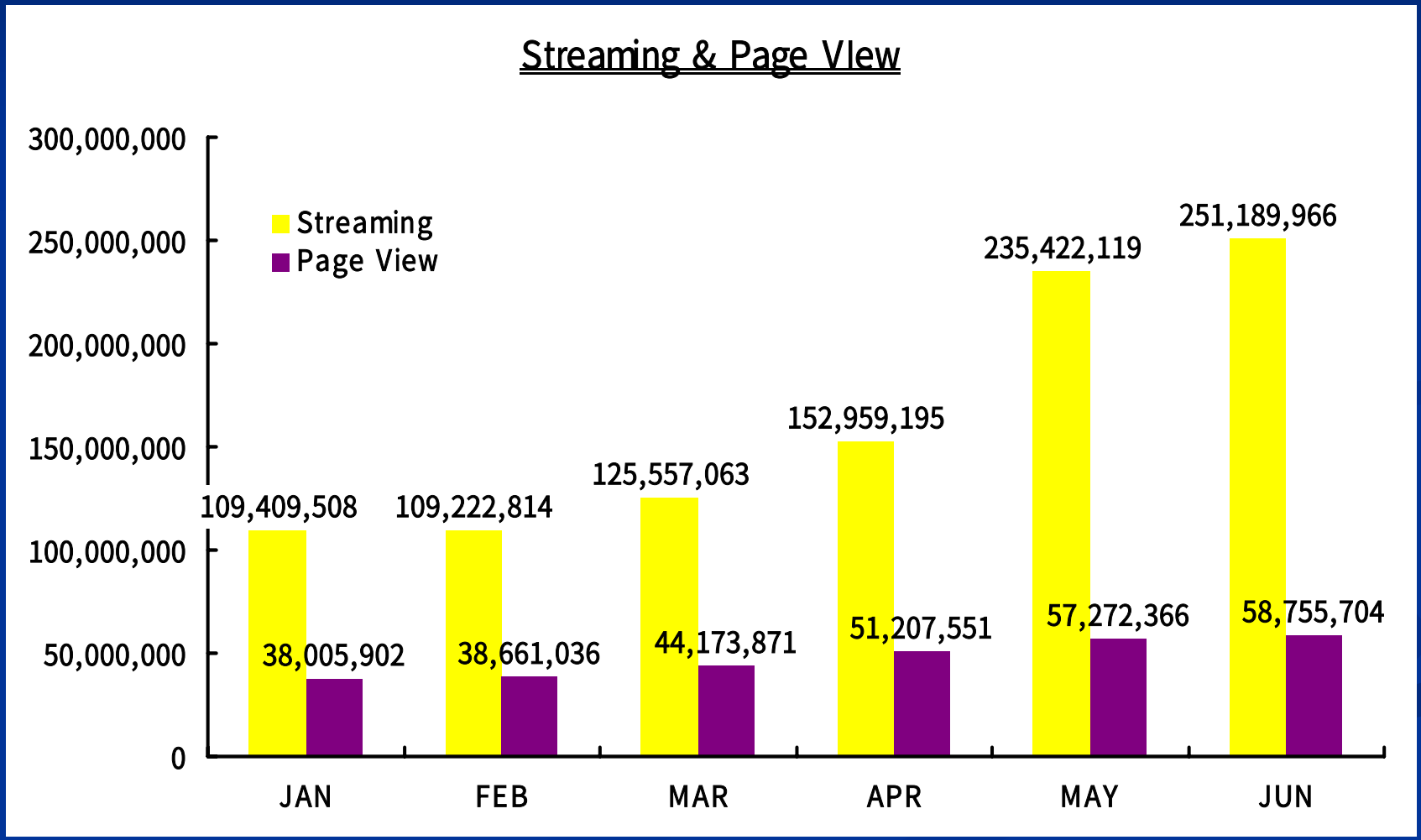
What is PANDORA.TV?

- Personal TV Network/Station
  - Offers VOD and live video programs/shows to everyone
- Video-Based Portal
  - Video search capabilities
- New Media
  - Provides videos not found in TV and cable channels
- Video Platform
  - Allows watching and sharing UCC videos

Annual Growth

	June 2005	June 2006	Increase %
Monthly Unique Visit	386K	5,778K	1,397%
Sum of Daily Visitors	576K	10,881K	1,789%
Page Views	13,000K	251,190K	1,832%

Recent Growth



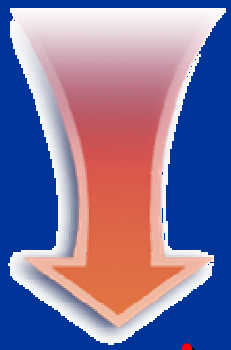
Today's PANDORA.TV

Uploaded Contents	500,000 files
Uploading Contents	4,000 files/day
Storage	40 TBytes
Page View	20 million/day
Unique View	1.5 million/day
Max. Concurrent Users	30,000

Missions

Missions for Global Service

- Cost saving
- High quality service
- Various additional features



- **Grid Delivery using Pcube Stream™**

※Pcube Stream™ or P³ Stream™ is the trade mark of Peering Portal

Cost Problem

- Example of network cost
  - Max. concurrent users: 30,000
  - Bit-rate: 600Kbps
  - Total bandwidth: 18Gbps (30,000*600Kbps)
  - Network cost: $180,000/Month
    (Unit price in Korea: $10,000/Gbps.month)
- Server/network cost is proportional to the number of concurrent users & bit-rate
- Traditional streaming such as MS WMT and Adobe Flash CANNOT solve the cost problem

Service Quality Problem

- Server or network bottlenecks cause inconvenience
  - Freezing
  - Long latency
- Traditional streaming such as MS WMT or Adobe Flash CANNOT overcome bottlenecks

Need for Distinctive Features

- Video UCC service market is becoming the “Red Ocean”
  - Network effect in UCC services
  - Distinctive features are essential for continuous growth
- Traditional streaming such as MS WMT or Adobe Flash can hardly offer differentiations from competitors

Why Pcube Stream™?

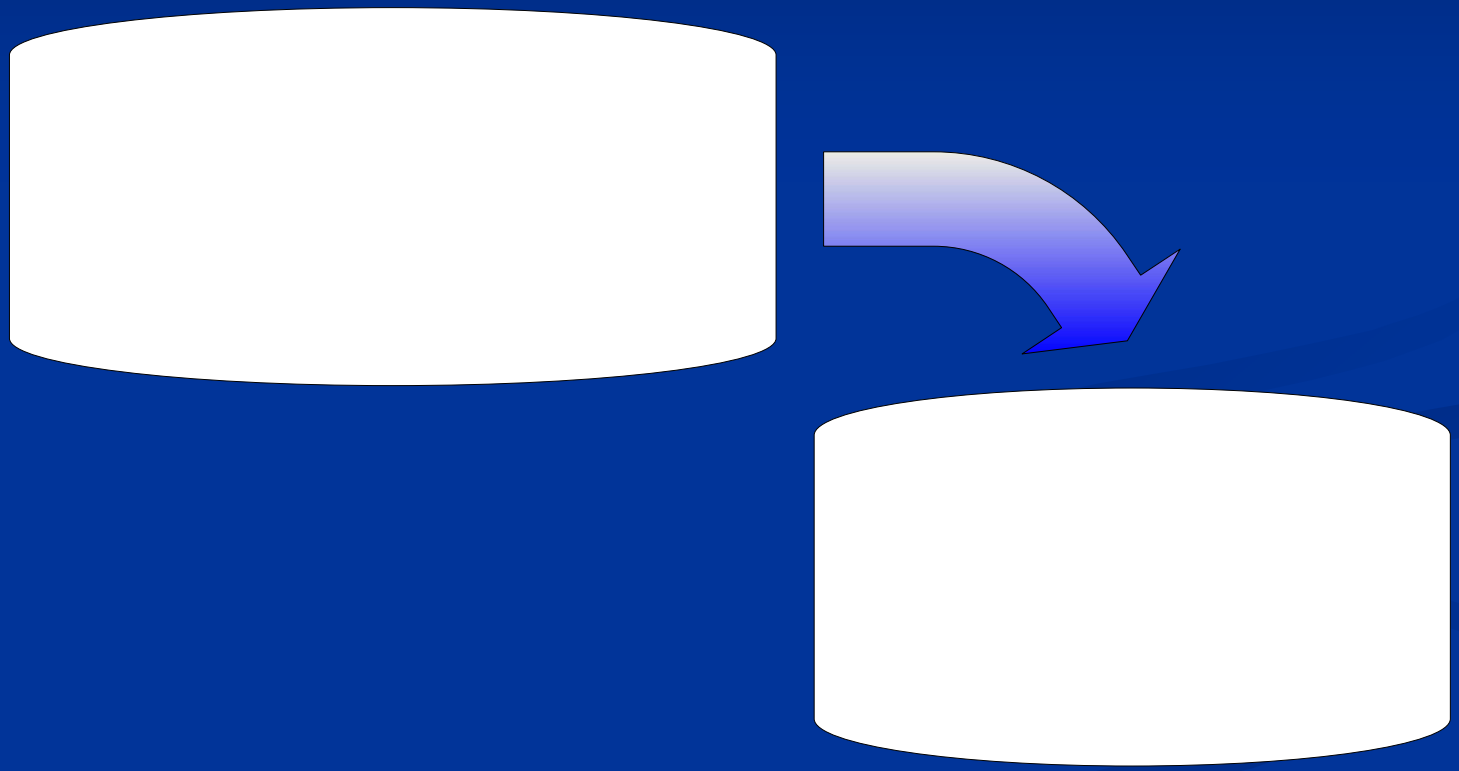
Why Pcube Stream™?

- Uniqueness
  - The only streaming solution using Grid Delivery
- Many references
  - More than 40 streaming services including AoD/BGM/VoD/IPTV are using Pcube Stream™
  - Result proven by many service companies
- Proved by users
  - More than 50 million client modules installed

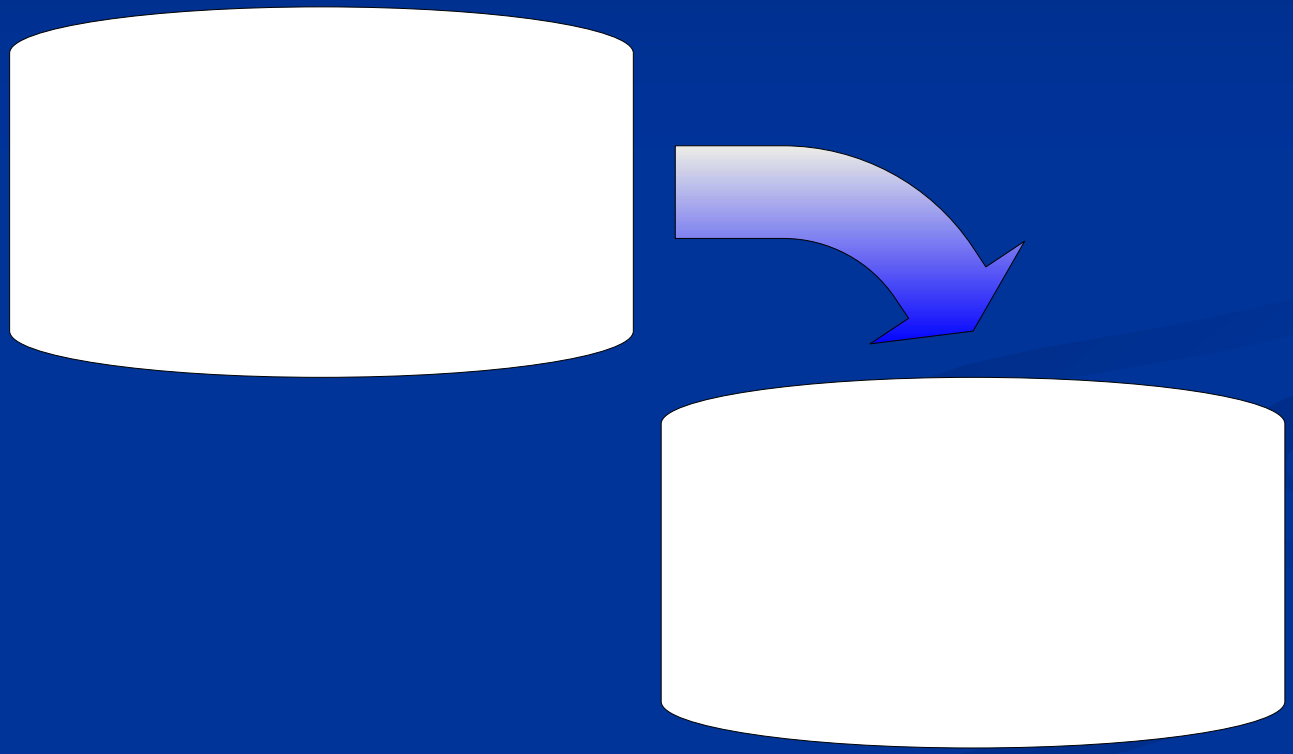
Case Study - AoD Service

Number of contents: 350,0

Case Study - BGM Service



Case Study - VoD Service

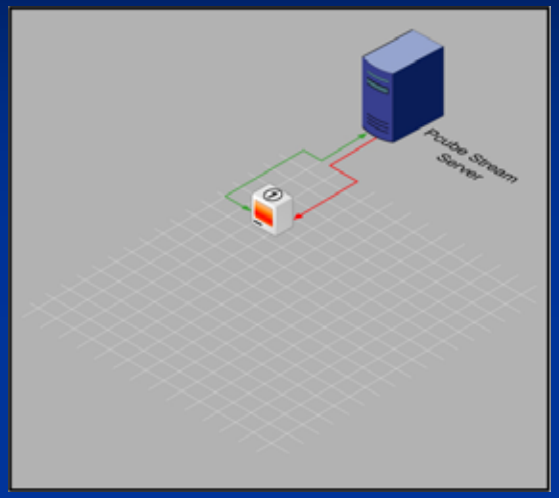


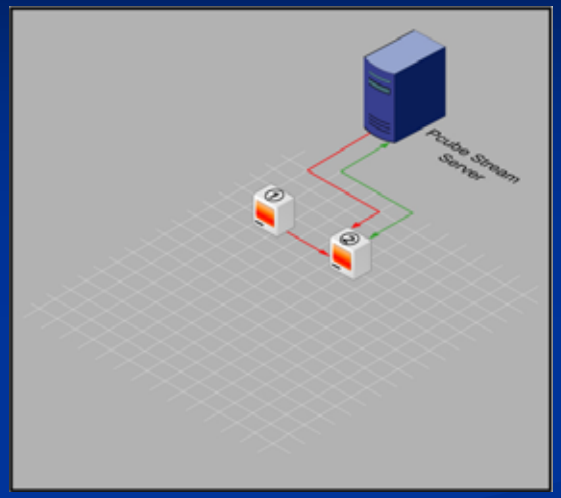
Cost Saving Forecast

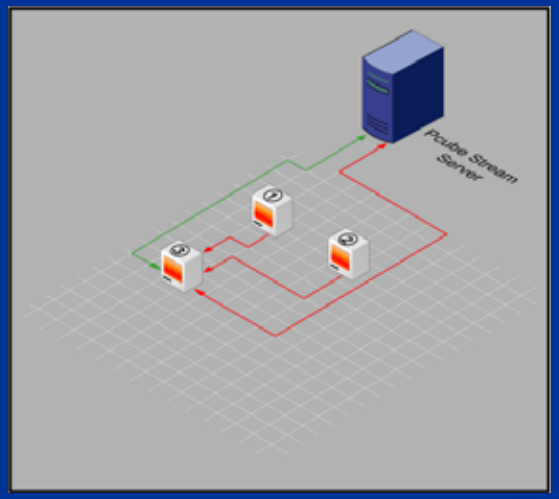
Network bandwidth before applying P3	Reduced bandwidth and network cost saving		
	70% reduction	80% reduction	90% reduction
1Gbps	700Mbps $7,000/month	800Mbps $8,000/month	900Mbps $9,000/month
5Gbps	3.5Gbps $35,000/month	4Gbps $40,000/month	4.5Gbps $45,000/month
10Gbps	7Gbps $70,000/month	8Gbps $80,000/month	9Gbps $90,000/month
20Gbps	14Gbps $140,000/month	16Gbps $160,000/month	18Gbps $180,000/month

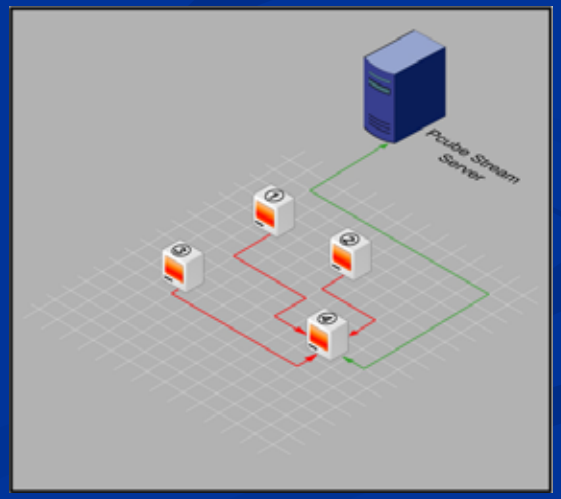
※ Unit price in Korea: $10,000/Gbps.month

How Pcube Stream™ works

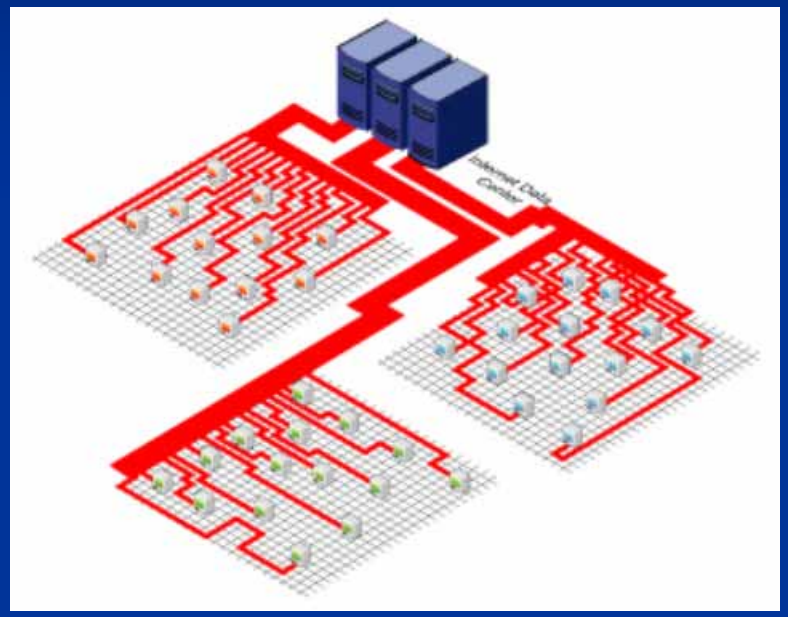


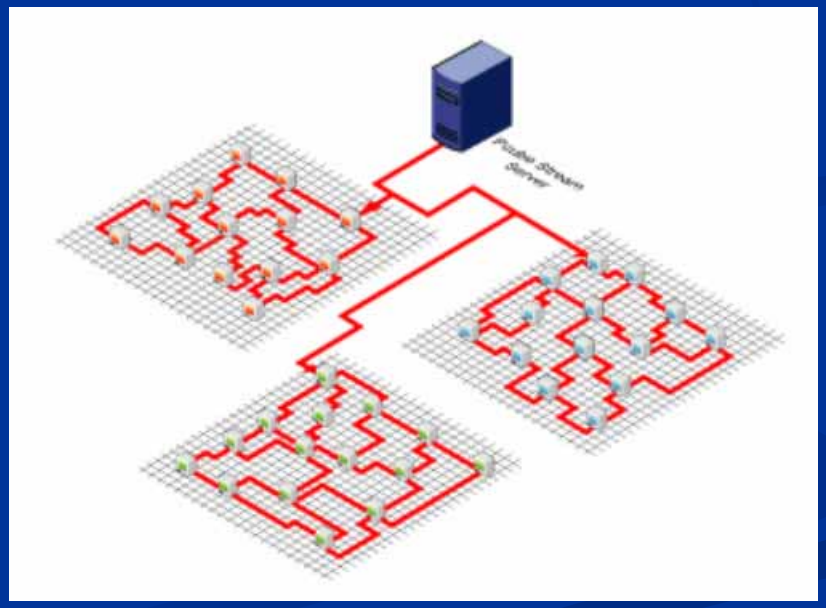






Traditional VS. Grid Delivery





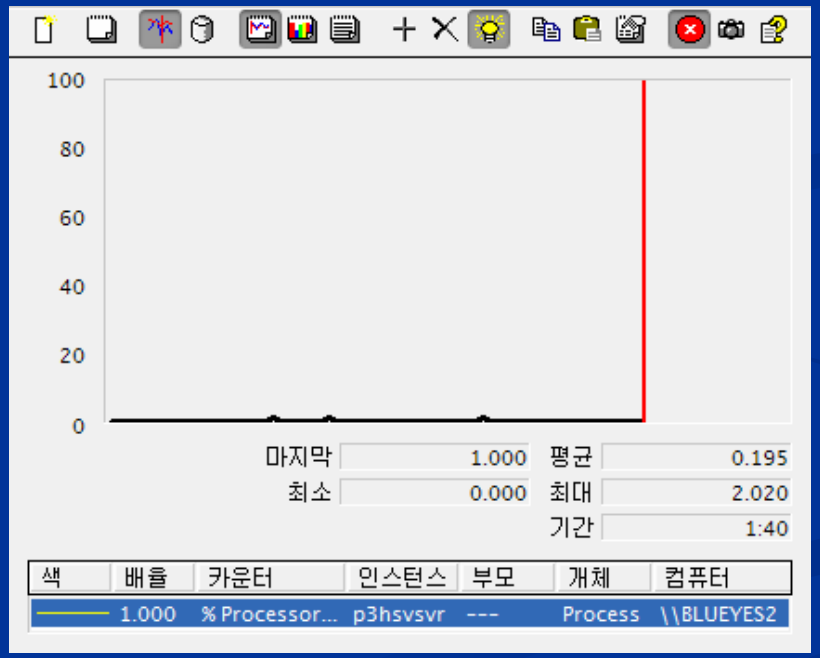
Other features of Pcube Stream™

- Low usage of users' resource
  - Minimized resource usage
- Service provider's control over contents
  - Instant prevention of unwanted contents that are already cached
- Strong security
  - Protection from unauthorized use without DRM
  - Support 3'rd party DRM
- Easy to apply
  - Easy adaptation to streaming service

Experiments on Pcube Stream™

Experiment – CPU load

- Additional CPU load of client PC
  - When segments are served to other clients
  - Less than 1% per segment



Experiment – Buffering Latency

- Pentium II 350MHz, 64MB RAM, 192Kbps media
- Windows 98

	1	2	3	4	5
mms	6.38	6.04	6.23	6.02	5.89
Pcube	3.91	5.89	5.02	4.49	4.31

- Windows 2000

	1	2	3	4	5
mms	6.13	5.89	6.11	6.04	6.08
Pcube	3.88	5.65	4.93	5.03	4.38

Experiment – CPU load

- Overall CPU load of client PC
  - When an audio stream is being played
  - Pentium II 350MHz, 64MB RAM, 192Kbps media
- Windows 98
  - Before playing: 0~4%
  - mms play: 15~19%
  - Pcube play: 13~19%
- Windows 2000
  - Before playing: 1~2%
  - mms play: 9~15%
  - Pcube play: 9~15%

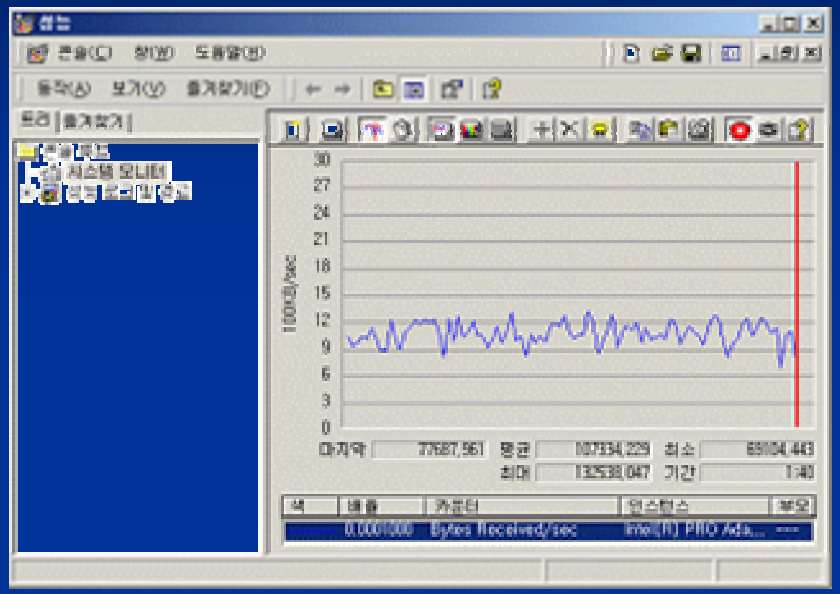
Experiment – Transfer Speed

(Unit: Bytes/sec)

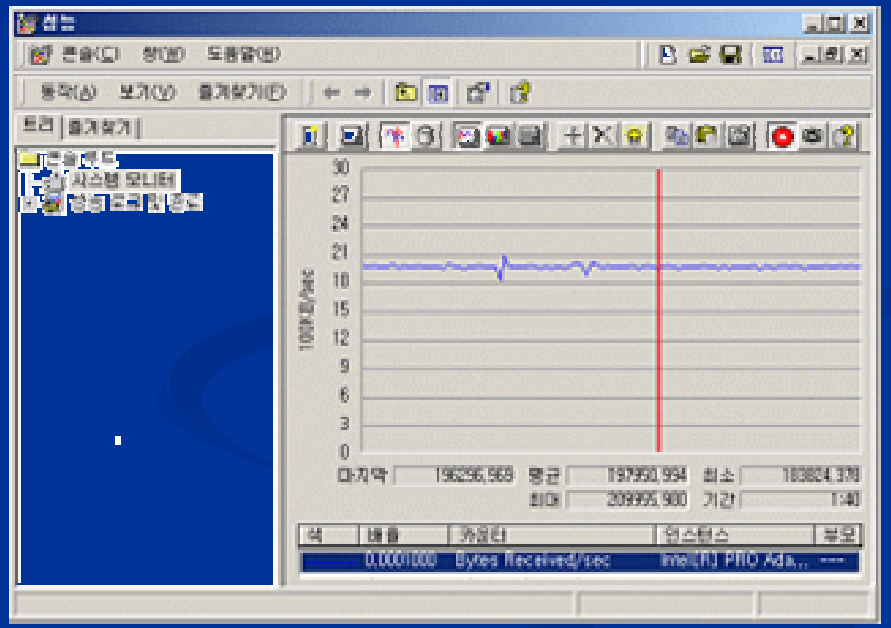
Internet Service	Speed check(1)	ftp result(2)	Pcube(3)	Increase rate (%)	
KT Megapass Multi IP	192,500	48,398	223,544	16.1	461.9
Thurunet Cable	310,900	168,338	489,599	57.5	290.8
Hanaro Cable	116,600	107,334	197,950	69.8	184.4
Hanaro ADSL	132,200	18,121	163,924	24.0	904.6

(1) Using NCA (National Computerization Agency) tool
(2) From FTP server located at Thrunet Back-bone
(3) 6 PCs on a couple of external DSL

Experiment – Transfer Stability



Traditional transfer from a server

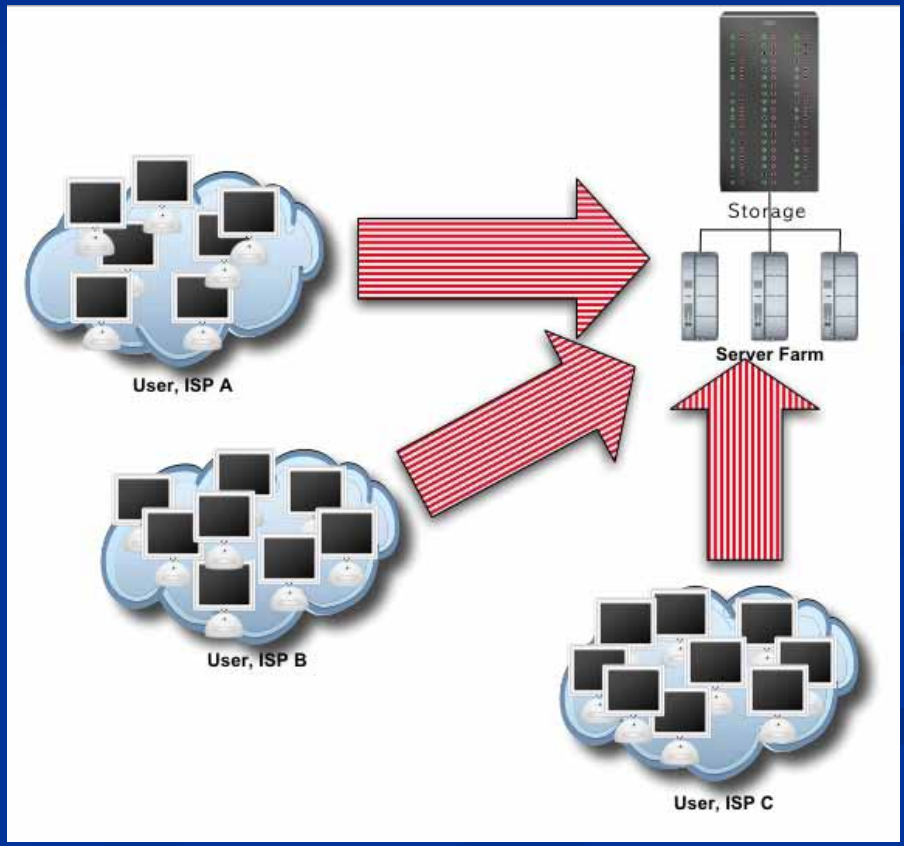


Pcube (Parallel Harvest)

Results

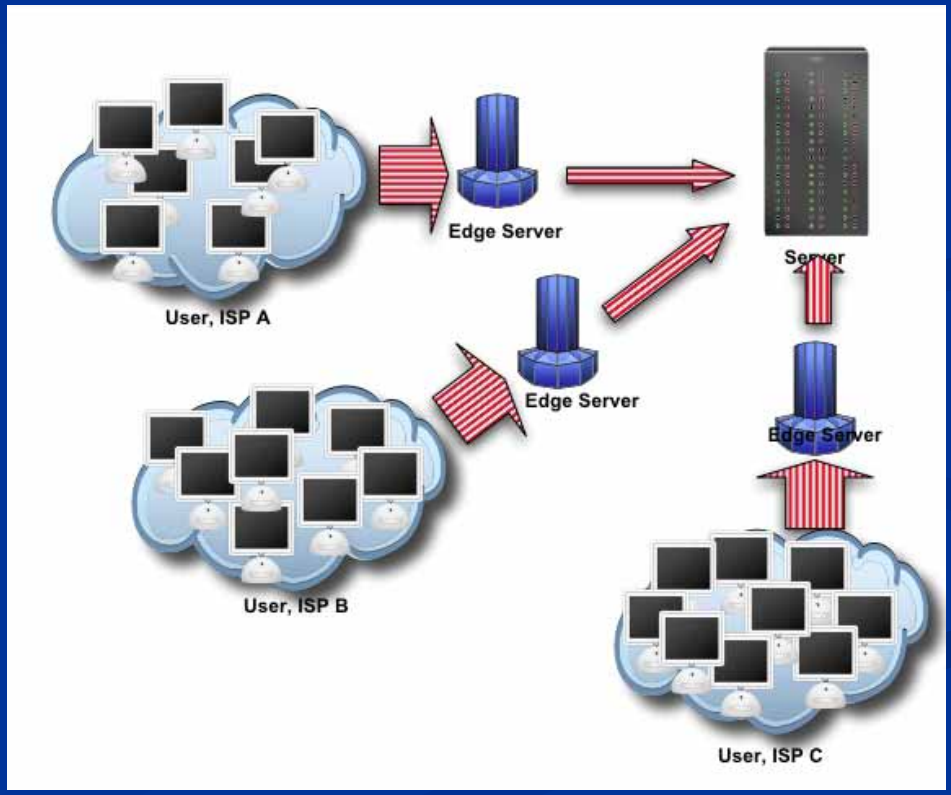
Service Architecture - IDC

- HUGE investment in servers & network
- The source of problems remain



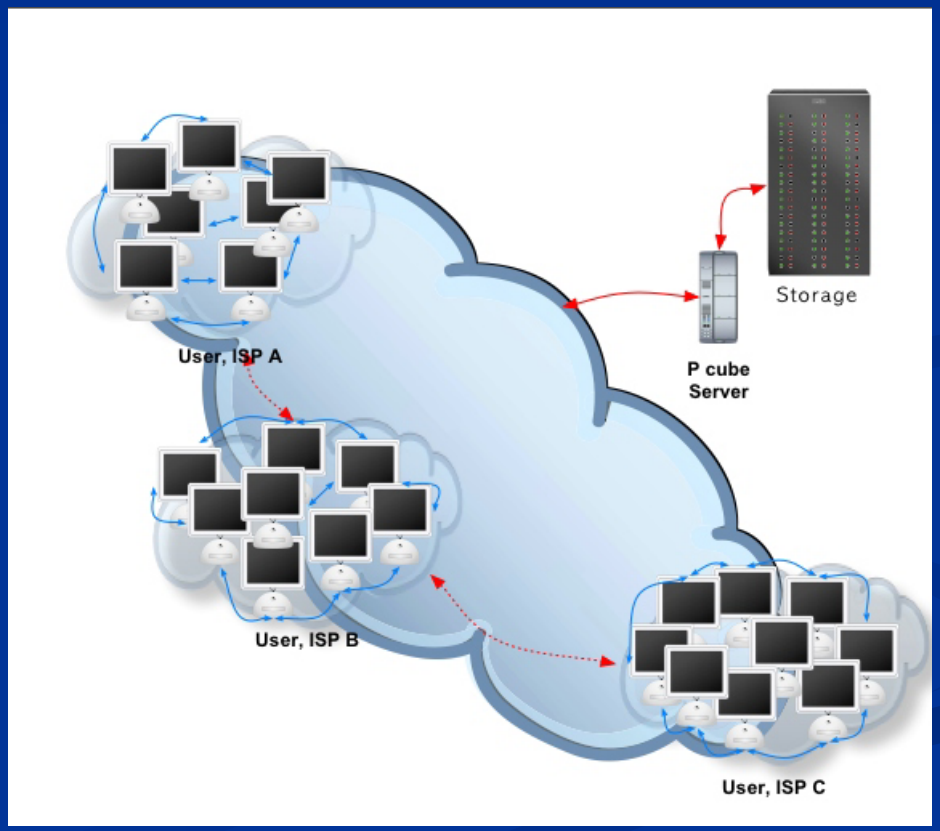
Service Architecture - CDN

- HIGHEST cost
- Underutilization of servers and network

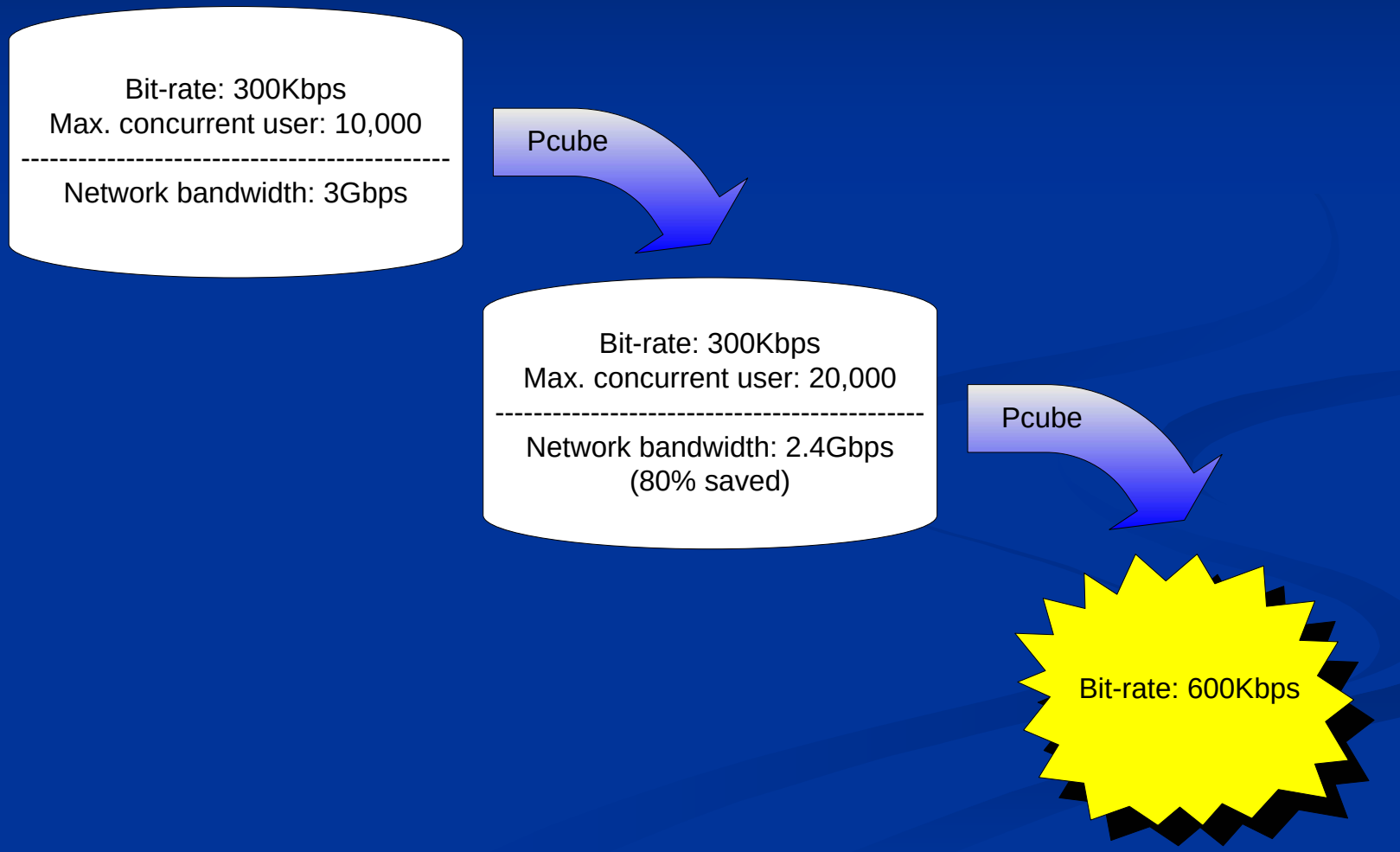


Service Architecture – Grid Delivery

- Optimal data source
- Shortest route
- Minimum cost



Brief Result of Pcube Stream™



Effect of Pcube Stream™

- Network saving
  - PANDORA.TV can save up to 12.6Gbps network each month
- High quality service
  - Bit-rate increased to 600Kbps, and will be 1Mbps in near future
- Various additional services
  - PANDORA.TV is planning for new services

Thank You!

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