Industrial Technology Research Institute
Computer & Communications Research Laboratories

Next Generation Broadband Communications

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April 23 , 2005

AGENDA

- Market Status & Trends
- Technology Trends
  - Metro Networks
  - Access Networks
  - Home Networks
- CCL/ITRI R&D

Where We Are Today

- Number of fixed (wired) telephone users saturated and is now decreasing
- Number of mobile (cellular) telephone users is also nearly saturated
- The number of Broadband users is rapidly increasing
- Network operators are looking for new sources of revenue (new broadband services)
- Next Generation Broadband Networks are expected to be the key for operators to win out in the future

Global Broadband Statistics

North America

29 M subscribers

Cable modem leads

DSL starting to catch up

250 k FTTH subs

Europe

25 M subscribers

DSL leads

Strong growth

450 k FTTH subs

CALA

2.3 M subscribers

DSL leads

Growth picking up

Australasia

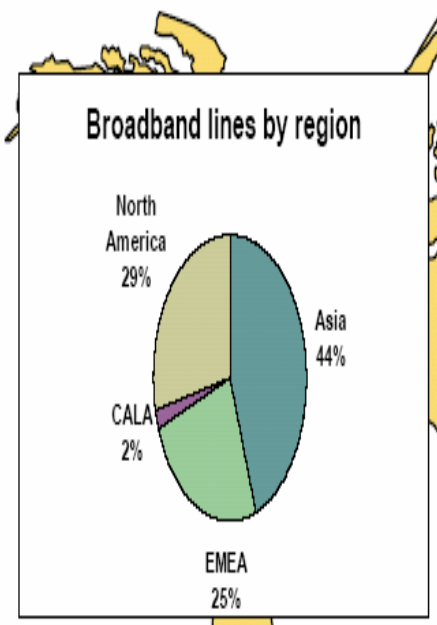
45 M subscribers

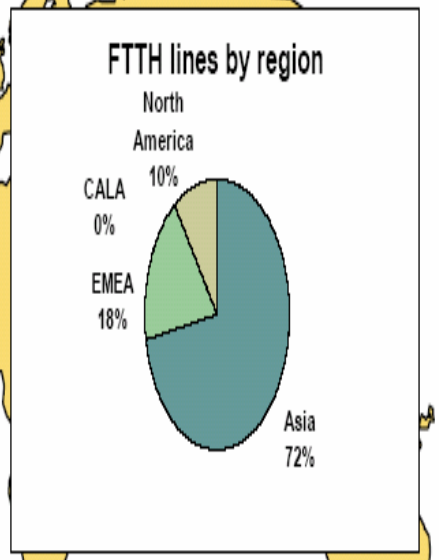
DSL Leads

Deep penetration

1,800 k FTTH subs

Source: RHK, Corning, Point Topic, Render Vanderslice





Source: RHK, Corning, Point Topic, Render Vanderslice

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How Much Bandwidth is Adequate?

1.5Mbps | 12Mbps | 30Mbps | 54Mbps | 100Mbps

- ADSL (up to 8Mbps)
- ADSL2+(up to 24Mbps)
- ADSL2++ (up to 50Mbps)
- VDSL (up to 52Mbps)
- FTTH (up to 100 Mbps)

Contents

Music
Video Streaming
Video Conf.

TV Images

High-Density TV Images

Download Contents

	1.5Mbps	12Mbps	30Mbps	54Mbps	100Mbps
Music CD/60 min.	5 min 8 sec	39 sec	16 sec	9 sec	5 sec
TV Prog. 45 min.	180 min	22.5 min	9 min	5 min	2 min 42 sec
Movies DVD/120 min.	480 min	60 min	24 min	13 min 20 sec	7 min 12 sec

SOURCE：Japan Intelligence Comm.， 2003

Required BW per Subscriber

Services	Bandwidth(down)	Bandwidth(up)
Streaming Video (HD)	Total 60Mb/s	
Live TV	20M/service	
VoD	20M/service	
EoD/GoD	20M/service	20M/service
Internet	10Mb/s	10Mb/s(P-to-P)
Video conference or VoIP	2 ~ 20(HD)Mb/s	2 ~ 20(HD)Mb/s
Remote sensing/control	1Mb/s	1Mb/s
Total Bandwidth	73 ~ 91 Mb/s	33 ~ 53Mb/s

	Average # of TV per home	note
Korea	1.5 (@2002)	2 or more per home : 41%

Source : (KT 2003)

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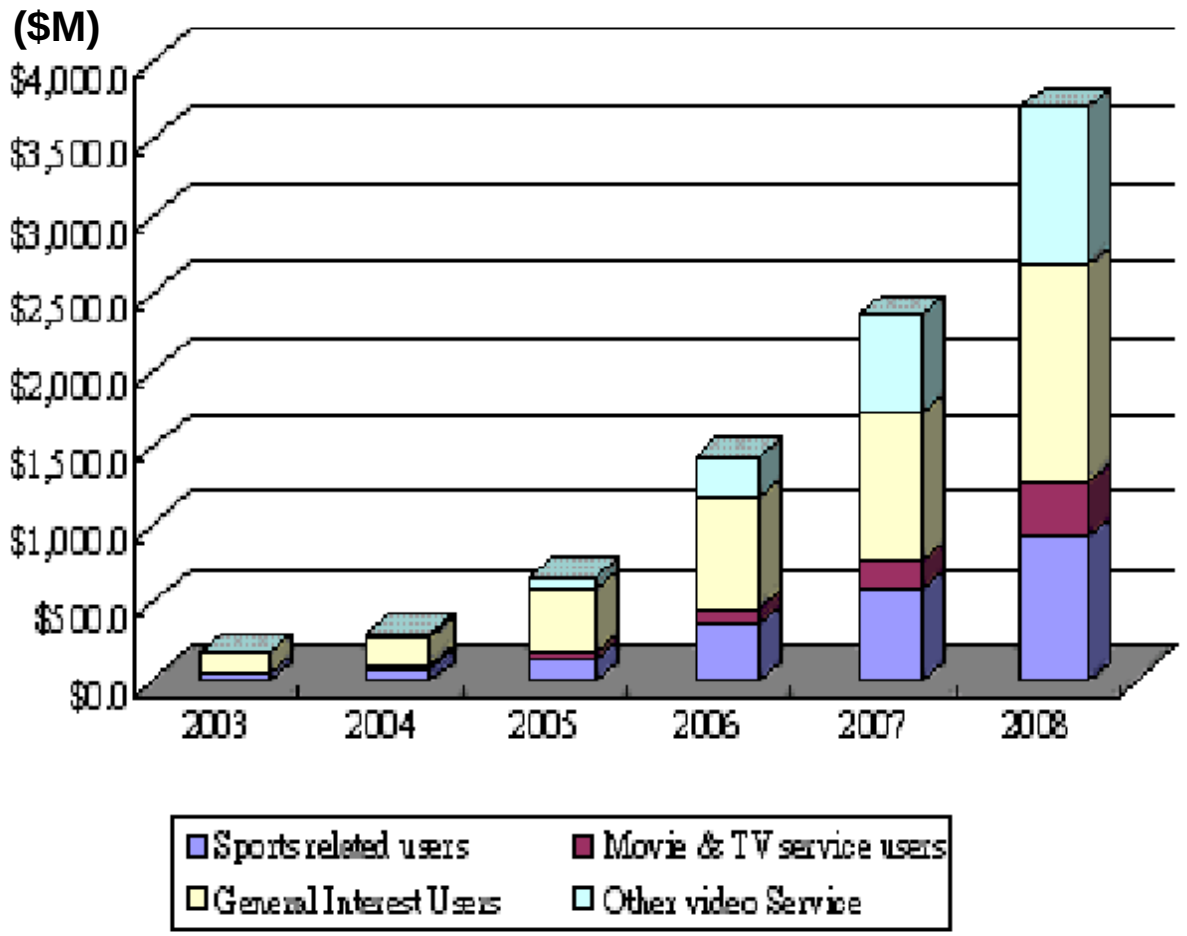
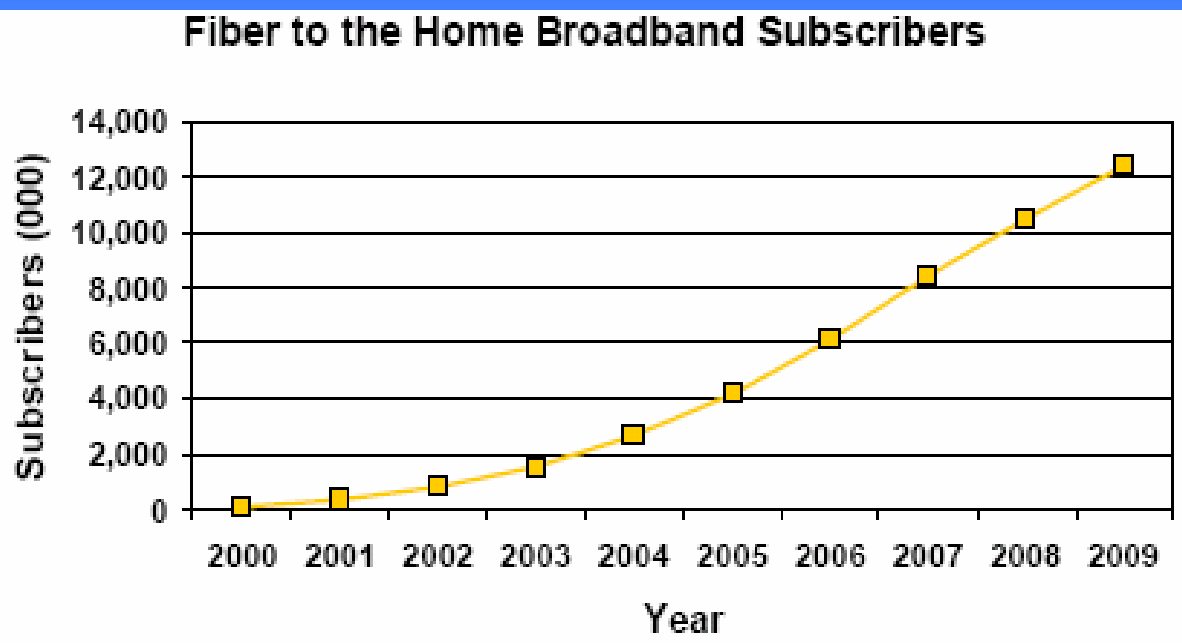
Worldwide Broadband Video Services Market Share & Forecasts



Worldwide FTTH Opportunity



- New/bundled services and revenue streams, reduced churn, reduced operating expenses driving deployment
- Asia continues to lead through national competitiveness
- North America rapid growth starting in 2005 due to Verizon
- European FTTH growth rate will lag over the next few years

Source: Cahners In-Stat Group, RHK, Corning

Worldwide PON Revenue

Worldwide EPON Equipment Revenue by Region Source ($M)

	2003	2004	2005	2006	2007	2008
North America	0.2	0.5	0.7	1.0	1.3	1.6
Europe	1.4	1.8	2.4	3.0	3.3	3.4
Asia	15.0	268.5	520.5	863.3	1078.1	747.8
ROW	0.0	0.1	0.2	0.7	1.2	1.6
Worldwide	16.7	270.8	523.7	868.0	1083.9	754.6

Worldwide BPON Equipment Revenue by Region Source ($M)

	2003	2004	2005	2006	2007	2008
North America	33.8	42.0	60.0	137.5	245.2	296.1
Europe	8.0	11.0	17.0	18.0	20.0	22.8
Asia	43.0	57.4	65.0	24.0	10.6	0.0
ROW	1.0	2.0	2.4	2.5	2.8	3.1
Worldwide	85.8	112.4	144.4	182.0	278.6	322.0

Source: IDC May, 2004

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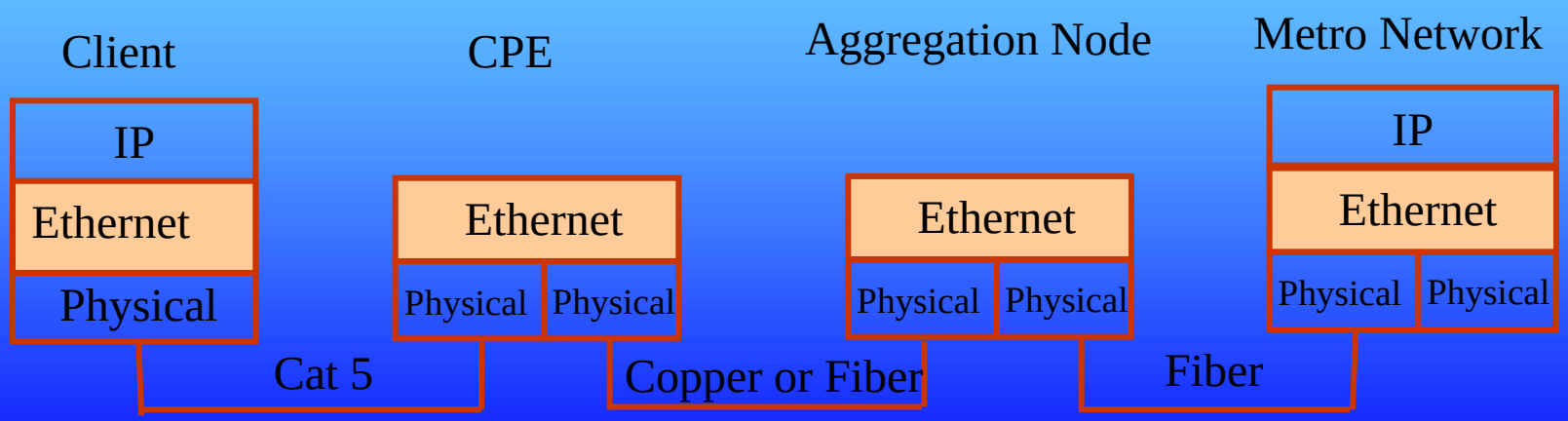
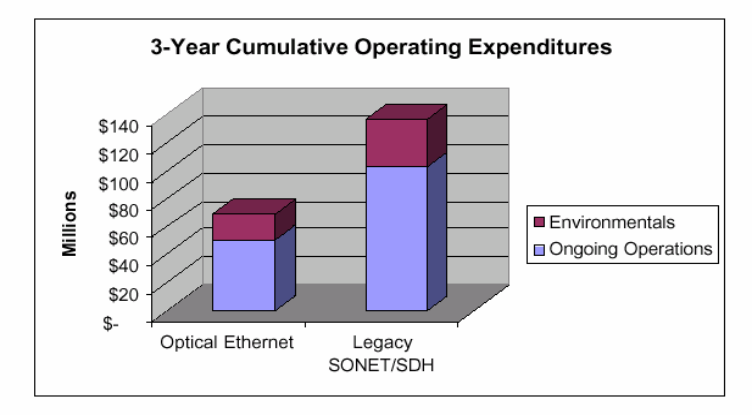
Ethernet-based Fiber Access Solution

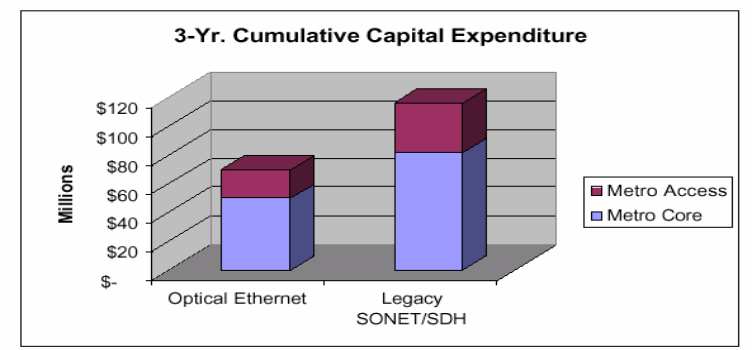
- Ethernet in the First Mile (EFM)
  - IEEE 802.3ah (Standardized in 06/2004)
- Benefits
  - The most efficient infrastructure for data services
  - A simple, globally accepted standard that guarantees interoperability
  - Future-Proof transport for data, video and voice applications

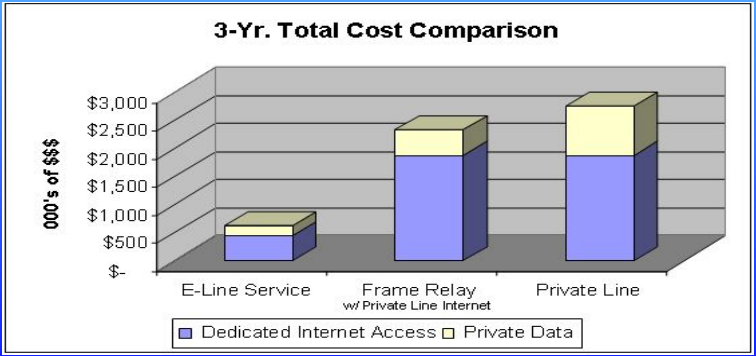


Why Metro Ethernet

- >98% LANs are Ethernet
- More economic for providers compared to legacy SONET/SDH *
  - OpEx: saving 23% in management environment, engineering cost, etc.
  - CapEx: saving 39% in core/access facilities
- More economic services for customers' Internet Access & Private Data (leased-line, VPN, etc.) **
  - 27% of Frame Relay
  - 23% of Private Line





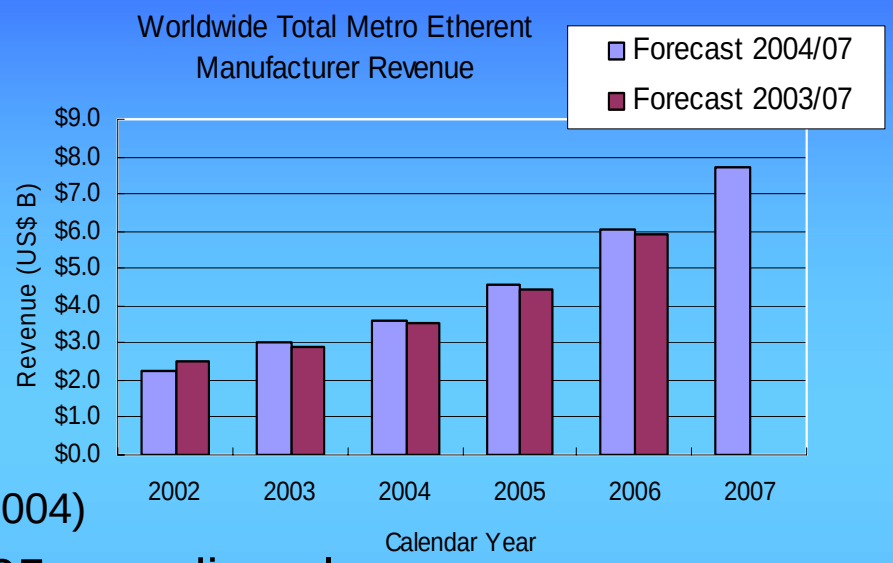


*Network Strategy Partners, Jan.2004: based on 3yrs estimation for 1~2M metro city with 50K~80K business, among which 13800 subscribe to services; 36 service providers in Europe & North America consulted

**Network Strategy Partners, Sept.2002: based on enterprise with one 500+ HQ and four 100~499 branches, private data and Internet access applications

Worldwide Metro Ethernet Market

- Growth (source: Infonetics, 2003/2004)
  - Equipment CAGR: 2003→2007
    - Revenue: 27% ($2.9B→8.0B)
    - Port: 53% (1.1M→5.8M)
  - E-Line/E-LAN Services by 2007
    ~$1.6B, CAGR=35%



- Trends (source: Light Reading survey, 2004)
  - Enterprise/Service provider 2005 spending plans
    - E-LAN: 1st in enterprises (47.7%), 4th in service providers(68.2%)
    - E-Line: 4th in enterprises (34.6%), 2nd in service providers(75.0%)

	Enterprise Users	Service Providers
1	Ethernet private LAN	VOIP
2	VOIP	Ethernet private line
3	IPsec VPNs	Layer 3 IP VPNs
4	Ethernet private line	Ethernet private LAN

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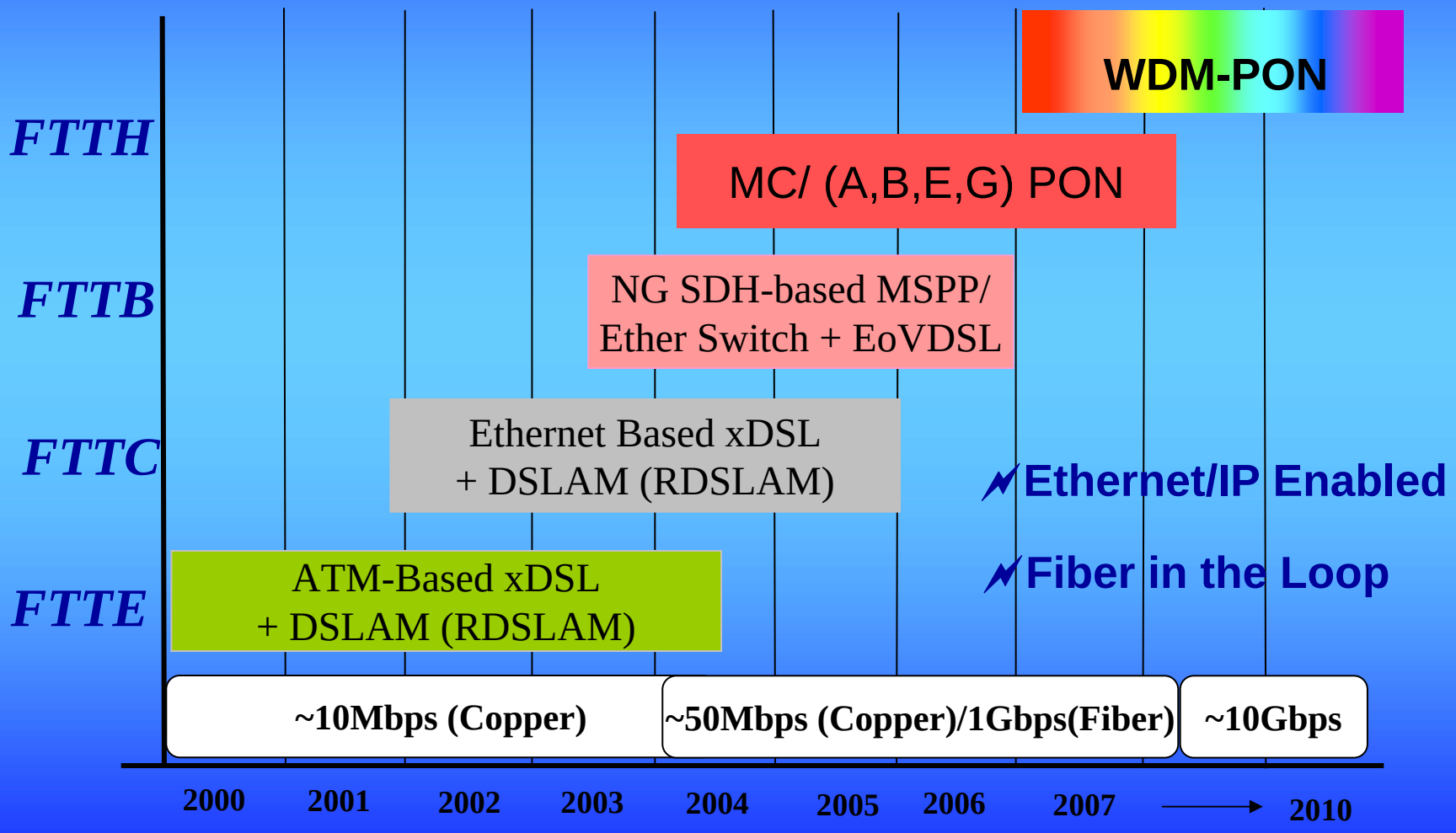
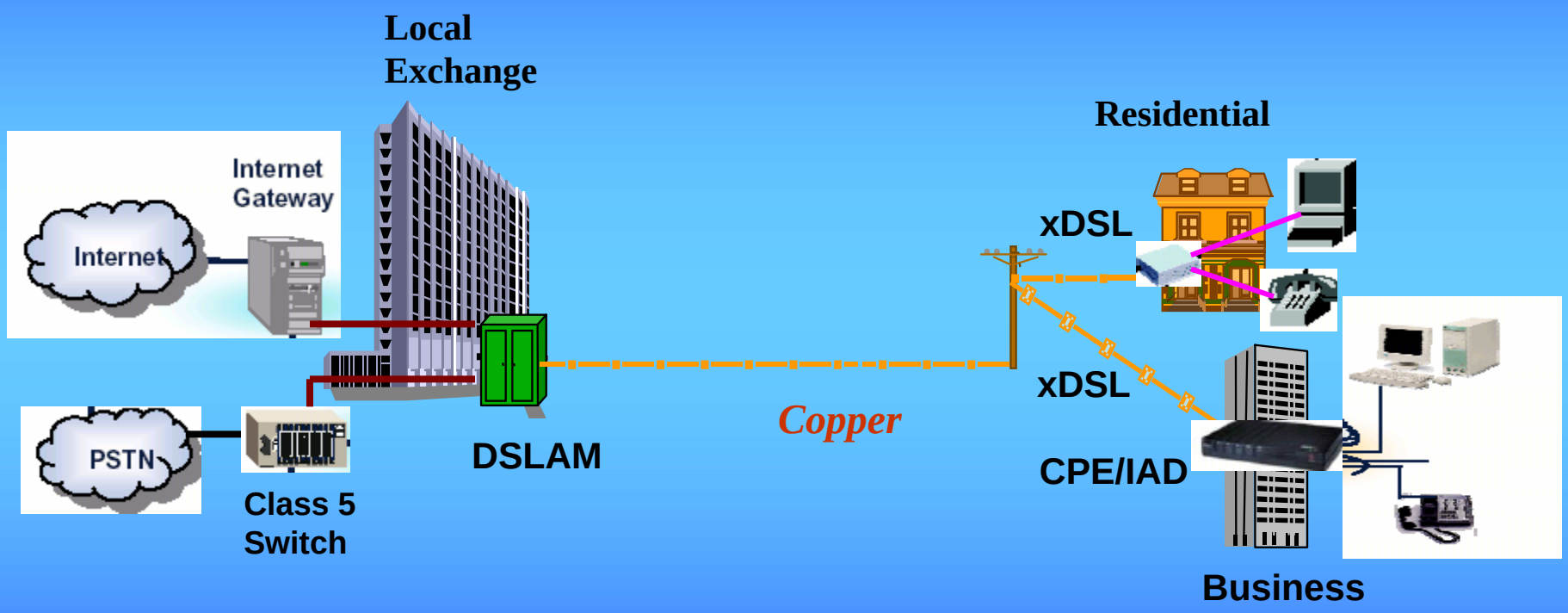
The Evolution of Access Network



source： ITRI/CCL, 2004/5

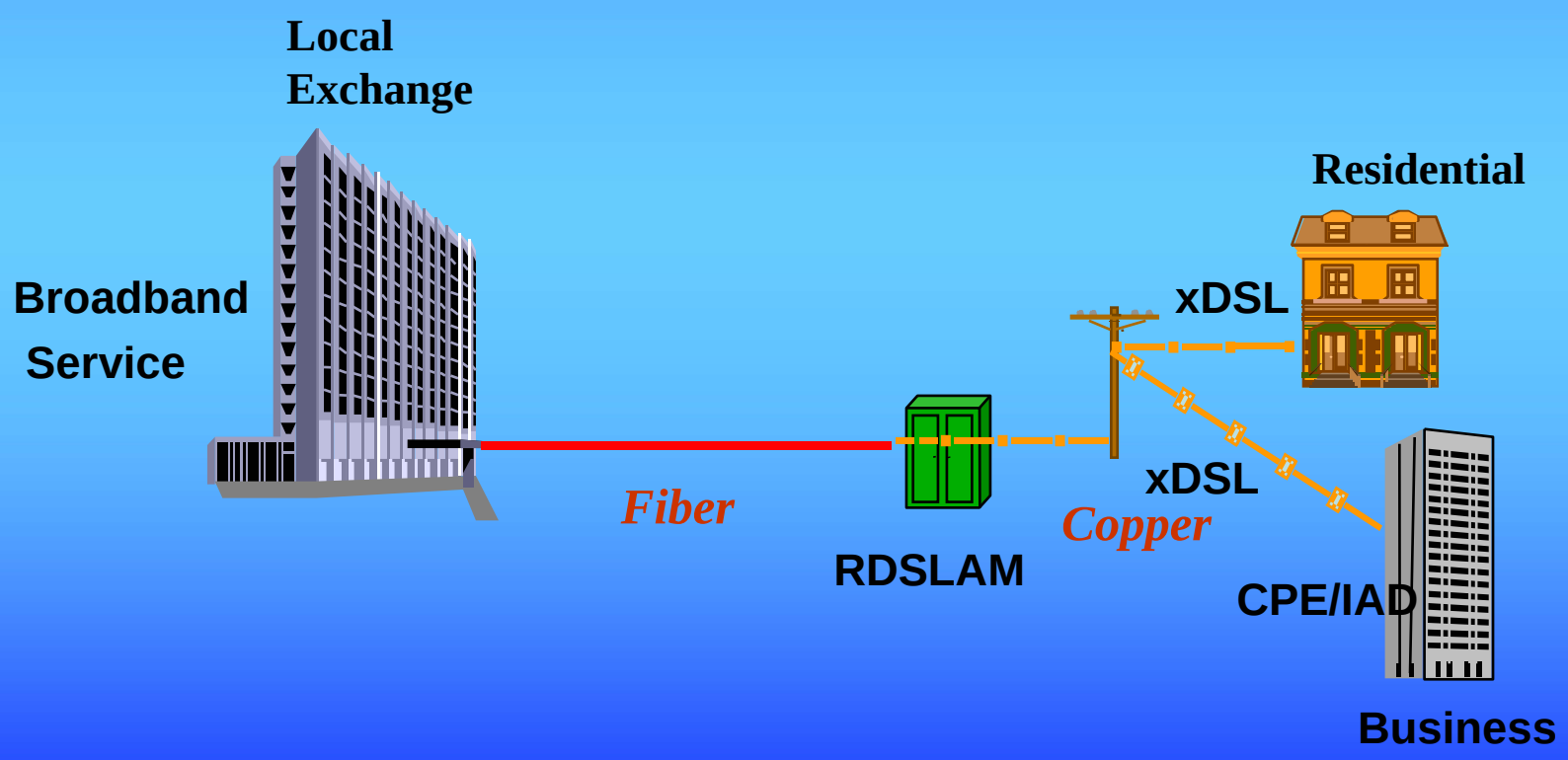
Existing DSL-based Broadband Access



Advantages :

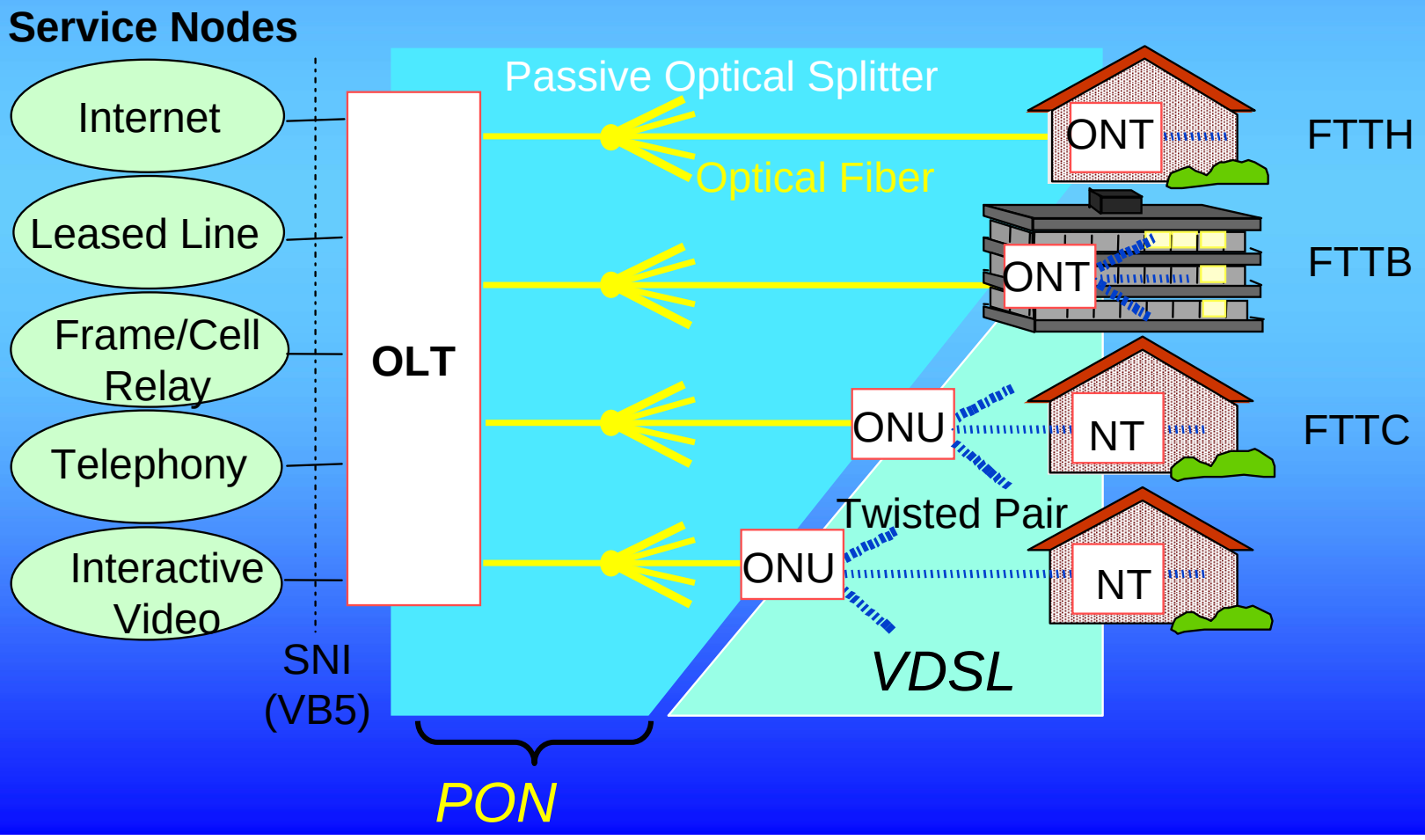
- Utilize widespread copper infrastructure
- Support data and legacy voice service simultaneously
- Avoid the PSTN switch congestion problem

Trend: Fiber Closer to End Users

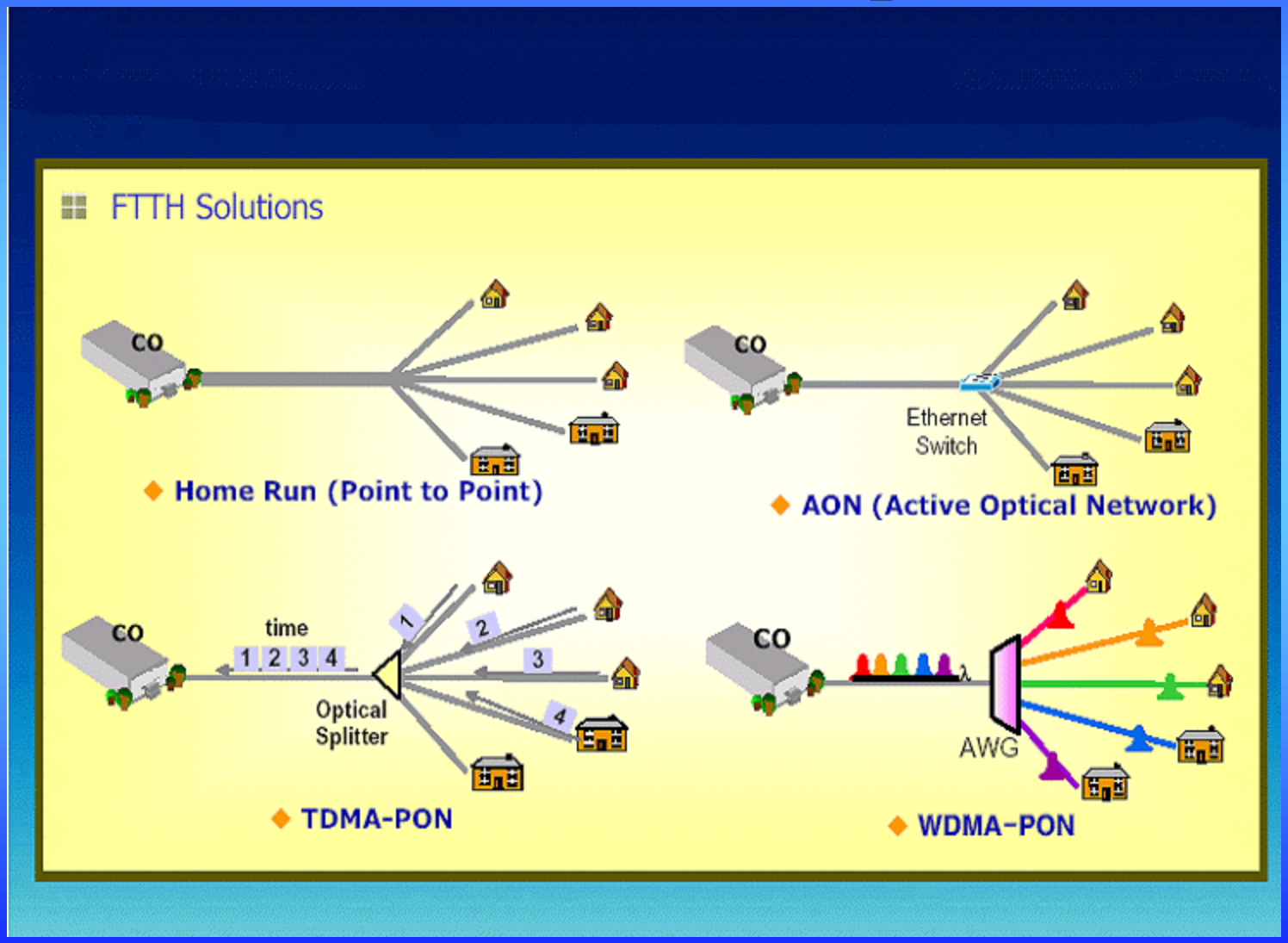


What is FTTx ?

- FTTH : Fiber To The Home
- FTTB : Fiber To The Building
- FTTC : Fiber To The Curb

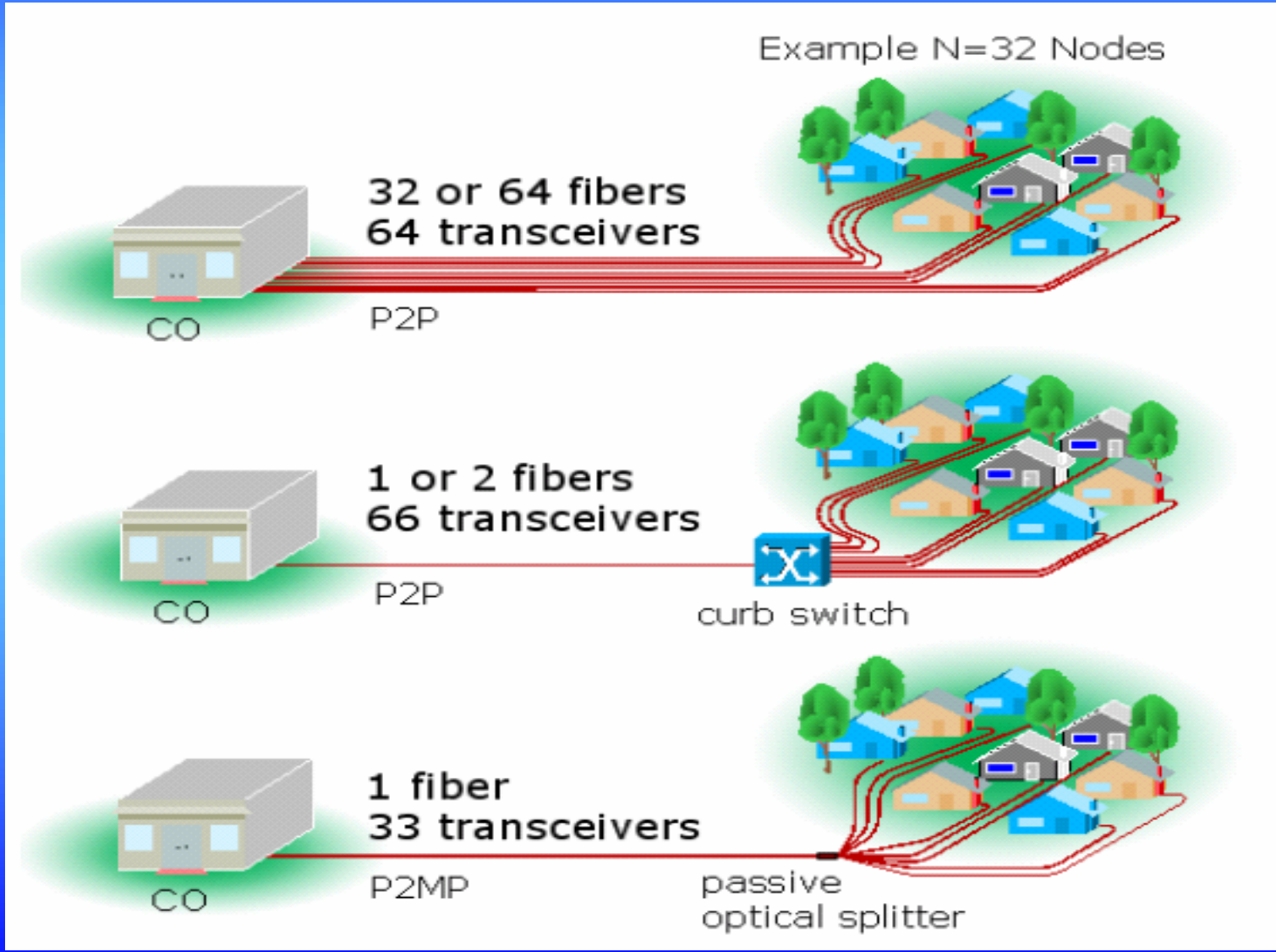


FTTH Techniques

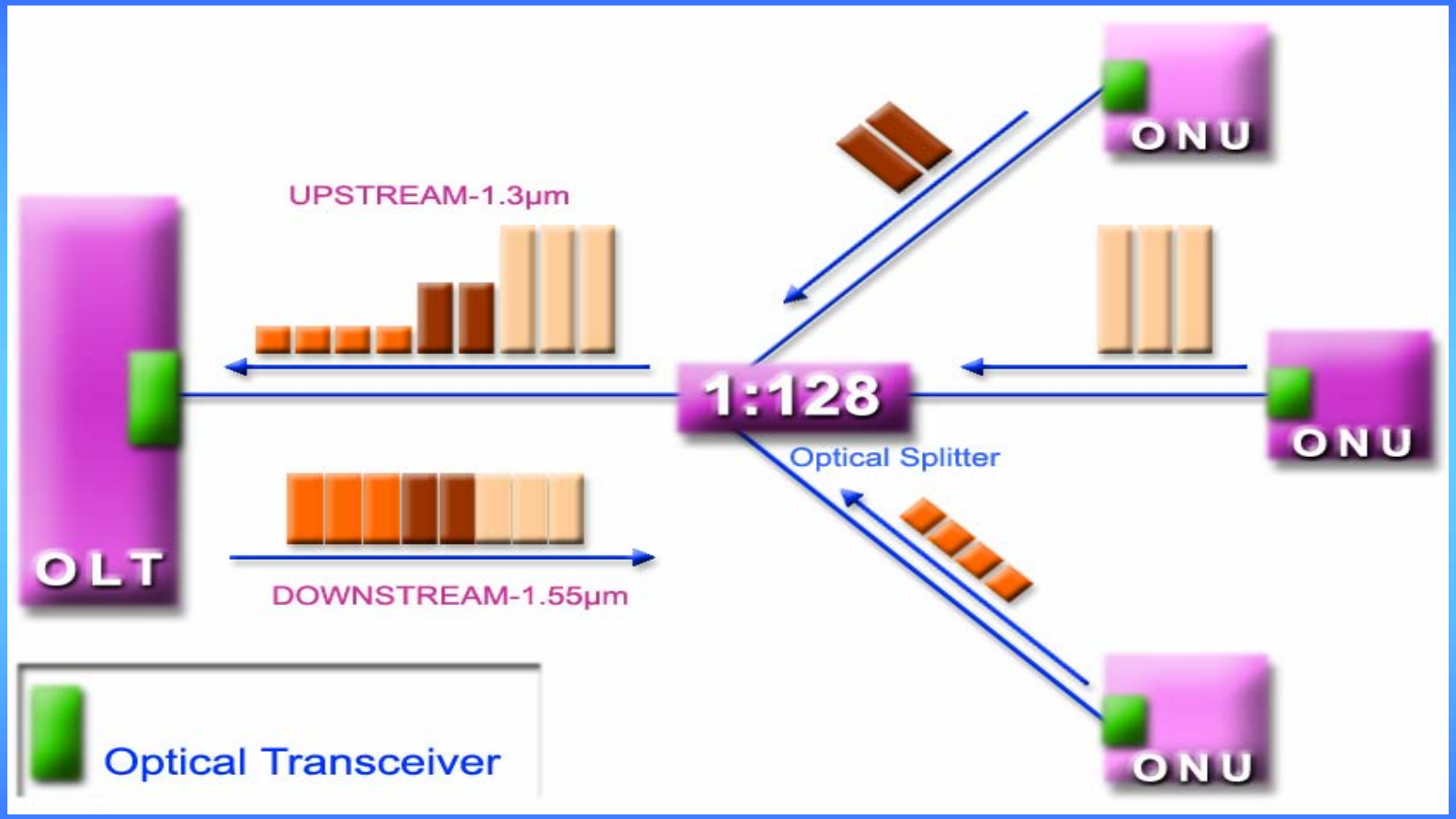


Source : (KT 2003)

Why PON?


Example N=32 Nodes
32 or 64 fibers
64 transceivers
CO
P2P
1 or 2 fibers
66 transceivers
CO
P2P
curb switch
1 fiber
33 transceivers
CO
P2MP
passive
optical splitter

TDMA PON-based FTTH



APON/BPON (G.983)
GPON (G.984)
EPON (IEEE 802.3ah)

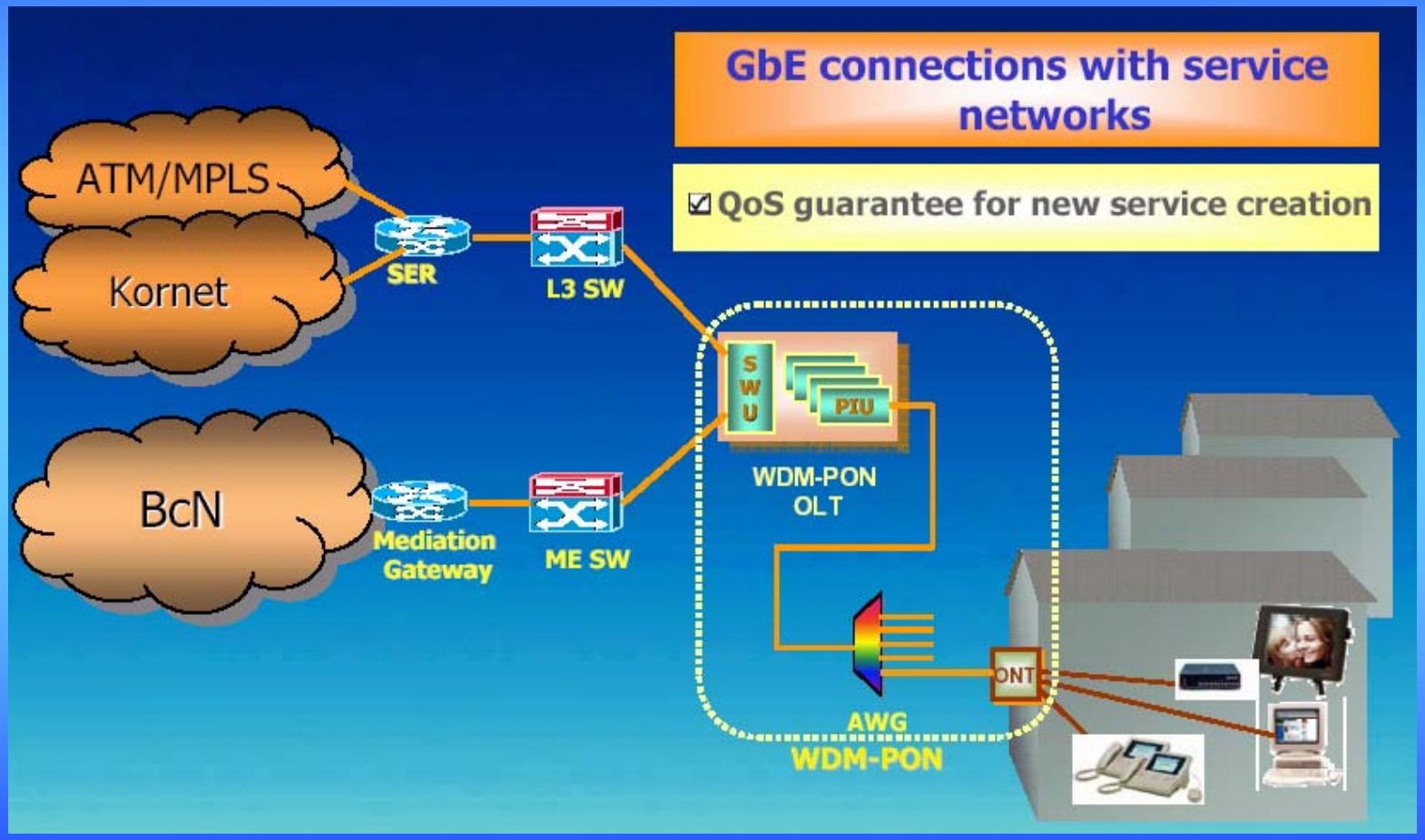
TDMA PON relies on complicated Burst Mode Transceivers and DBA mechanisms

Key features of optical access systems

	MC	B-PON	G-PON	GE-PON
Standards	ITU-T *G.985* IEEE *100BASE-BX*	FSAN/ ITU-T *G.983 series*	FSAN/ ITU-T *G.984 series*	IEEE 802.3ah *1000BASE-PX*
Transmission frame	Ethernet	ATM	GEM	Ethernet
Transmission speed（bit/s）	125M (100M after decoding)	156M、622M、1.2G（down）	1.2G、2.4G、156M（up）, 622M（up）	1.25G (1G after decoding)
Wavelength (um)	1.3/1.5	1.3/1.5	1.3/1.5	1.3/1.5
WDM for video services	NA	Available	Available	Available
BW control for upstream	NA	DBA	DBA	DBA
Services	IP service	Full services（Tel, IP, TDM）	Full services（Tel, IP, TDM）	IP service

Source : NTT Access Network Service Systems Laboratories

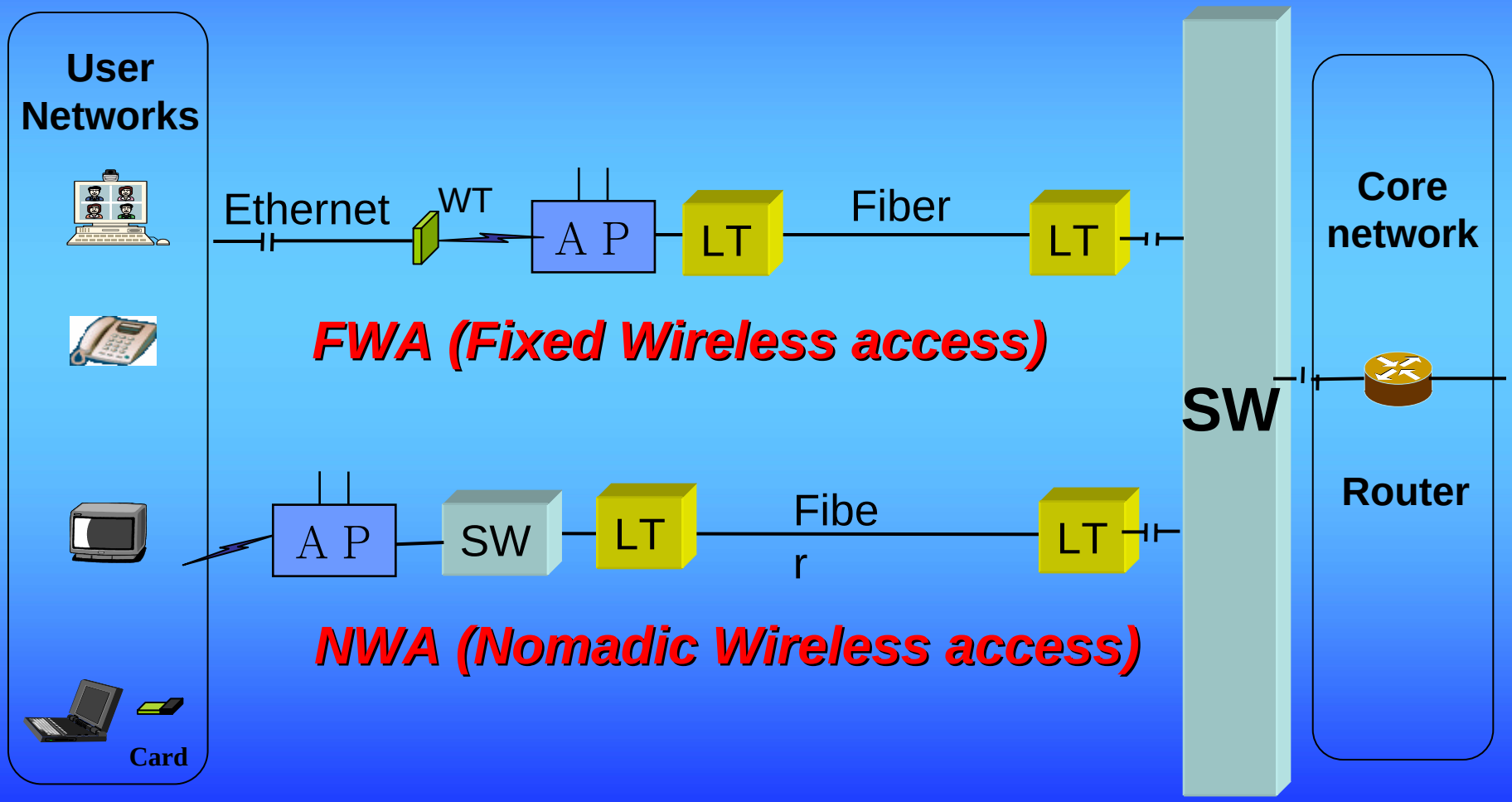
WDMA-PON based FTTH



Source : (KT 2003)

Ongoing WDMA-PON Trials in Korea

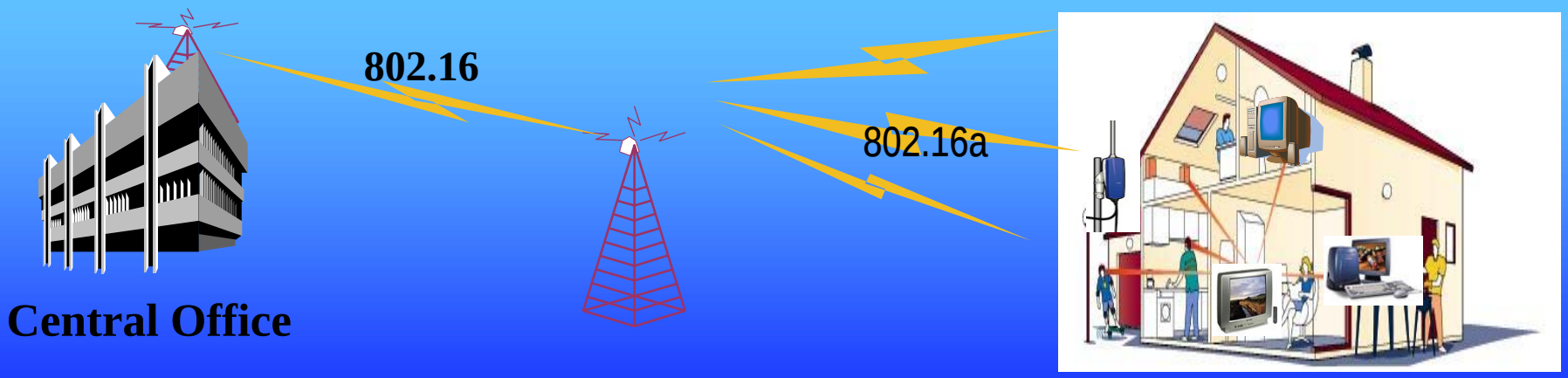
Hybrid of optical & wireless systems



Source : NTT Access Network Service Systems Laboratories

WiMax

- It is a Broadband Wireless Standard being defined by IEEE 802.16 Task Force
- It is a bi-directional transmission mechanism with reach distance over 30 miles and bandwidth up to 75 Mbps
- 802.16 is originally designed for a point-to-point line-of-sight transmission. 802.16a is for non line-of-sight point-to-multipoint transmission. 802.16e is for mobile transmission.



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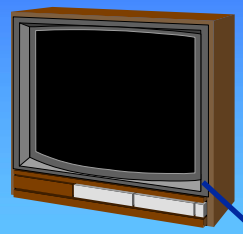
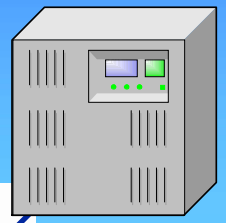
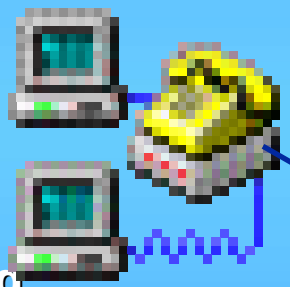
The Promise of Broadband Home

Digital radio and TV everywhere in the home





Big jukeboxes of music, movies, TV and games



Personal voice and video conferencing

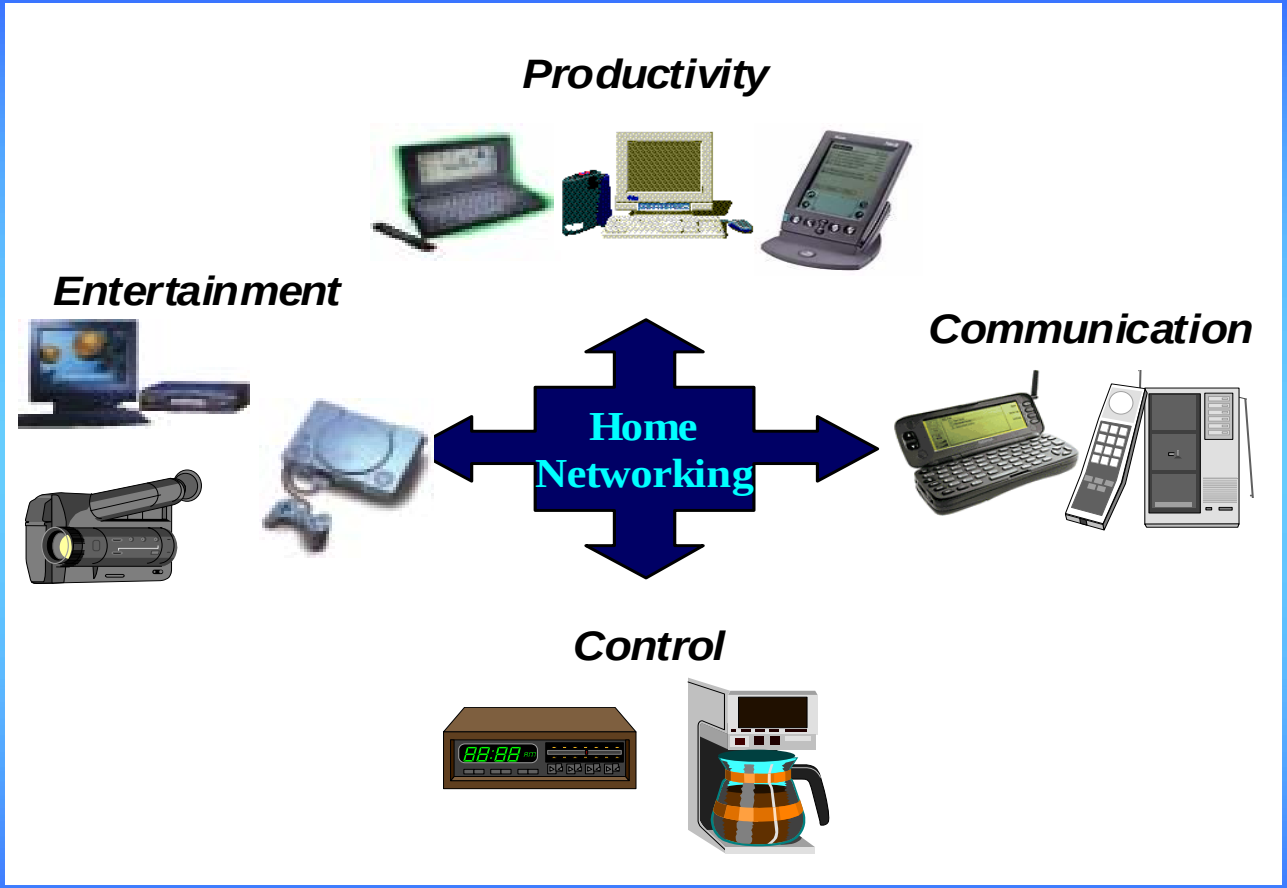
Share photos and videos with friends and family

Work from home as easily as in the office

Untethered access

Control VCRs, AC, lights from anywhere

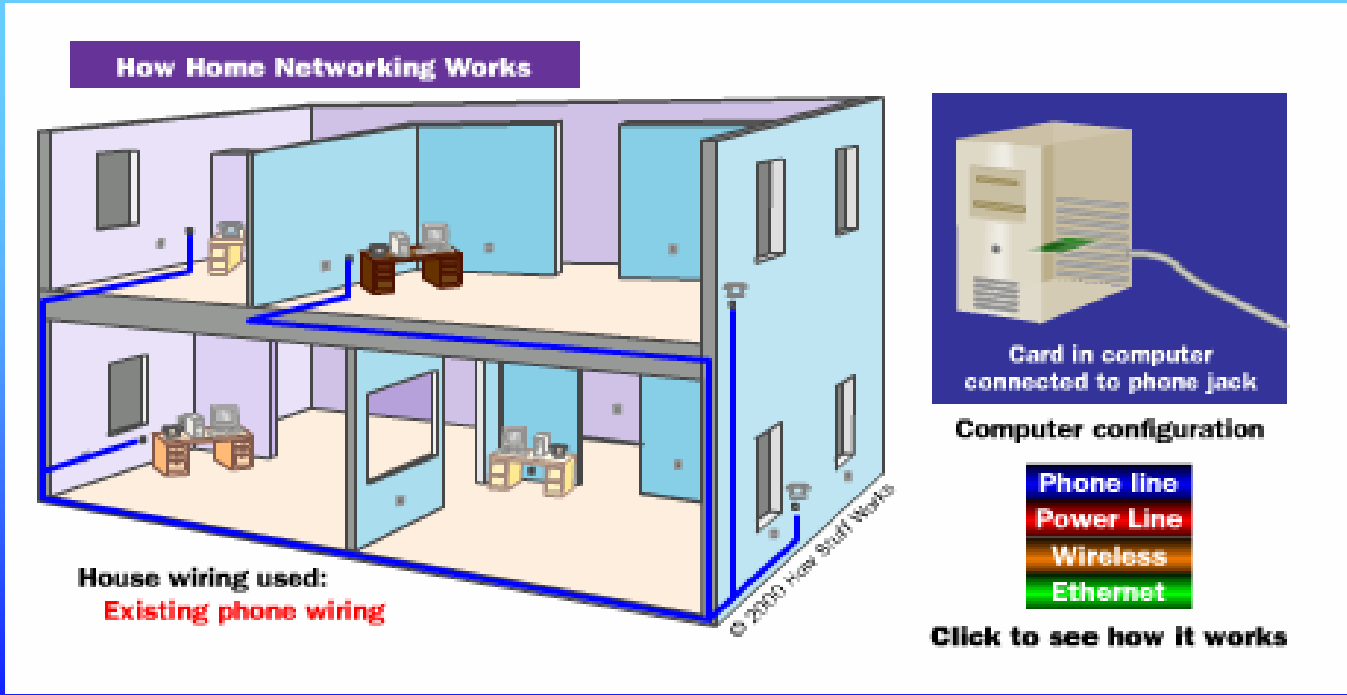
Facilitating Multi-Service Integration



Source: Cahners In-Stat Group

Enabling Technologies

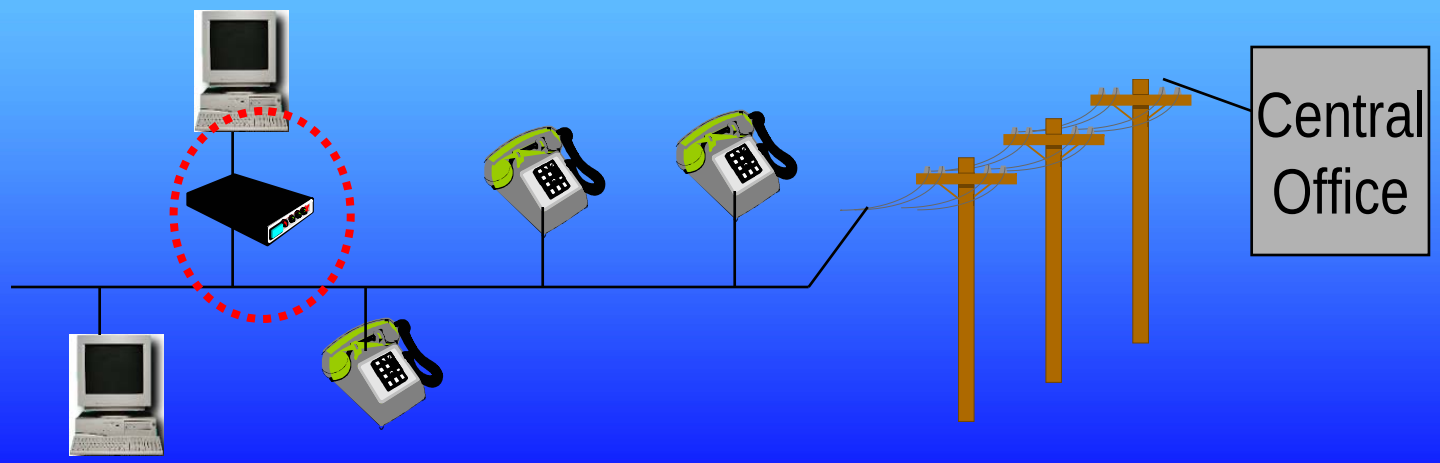
- **Ethernet**
- HomePNA (phone line)
- HomePlug (power line carrier)
- Wireless (HomeRF, IEEE 802.11, IrDA, Bluetooth, UWB)



HomePNA

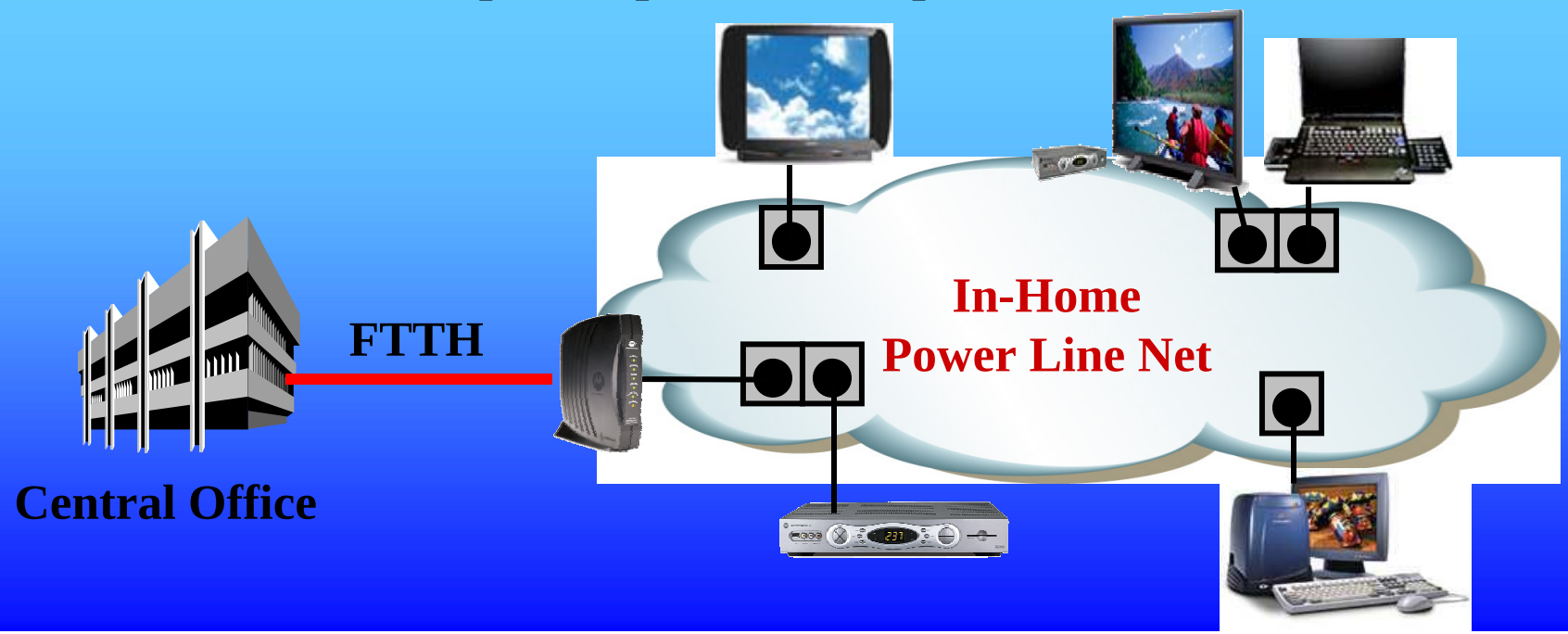
- Promoter Members

- Standard's version updated
  - HomePNA 1.0: adopted Tut Systems at 1 Mbps
  - HomePNA 2.0: adopted Epigram's "iLine10" at 10 Mbps
  - HomePNA 3.0 specification was released in June 2003
    - Up to 128Mbps(240Mbps optional) with QoS support



HomePlug AV

- It is a standard defined by HomePlug Powerline Alliance with the goal of sharing multimedia contents among home networking devices with in-home power lines
- The standard is expected to be ratified by June 2005 and will support the transmission speed up to 200Mbps



Wireless Home

	IEEE802.11g	Bluetooth	UWB
Freq.	2.4GHz	2.402~2.48GHz	3.1~10.6GHz
Transmission Rates	54Mbps	<=1Mbps	>=480Mbps
Distance	10~100m	10m	<=10m
Power	>=1W	1~100mW	<1mW
Application Supported	WLAN	PC peripheral , short distance	Short distance multi-media
Product Types	NB、PC、Pocket PC , etc.	NB 、 handset , etc.	Digital TV Set 、 DVD , etc.
Price	High	Low	Low
Key Vendors	Cisco 、 Lucent , etc.	Nokia 、 Motorola 、 Ericsson , etc.	TI 、 Motorola 、 Intel , etc.

Source：TRI ，2004/02

Ad-Hoc Network

- Ad hoc Network is an autonomous system of mobile nodes connected by wireless links. Each node operates not only as an end-system, but also as a router to forward packets. The nodes are free to move about and organize themselves into a network..

- IEEE now forms 802.11s study group to investigate the feasibility of the Ad hoc Network using 802.11 technology. It could be a potential technology for the interior connectivity in the home network

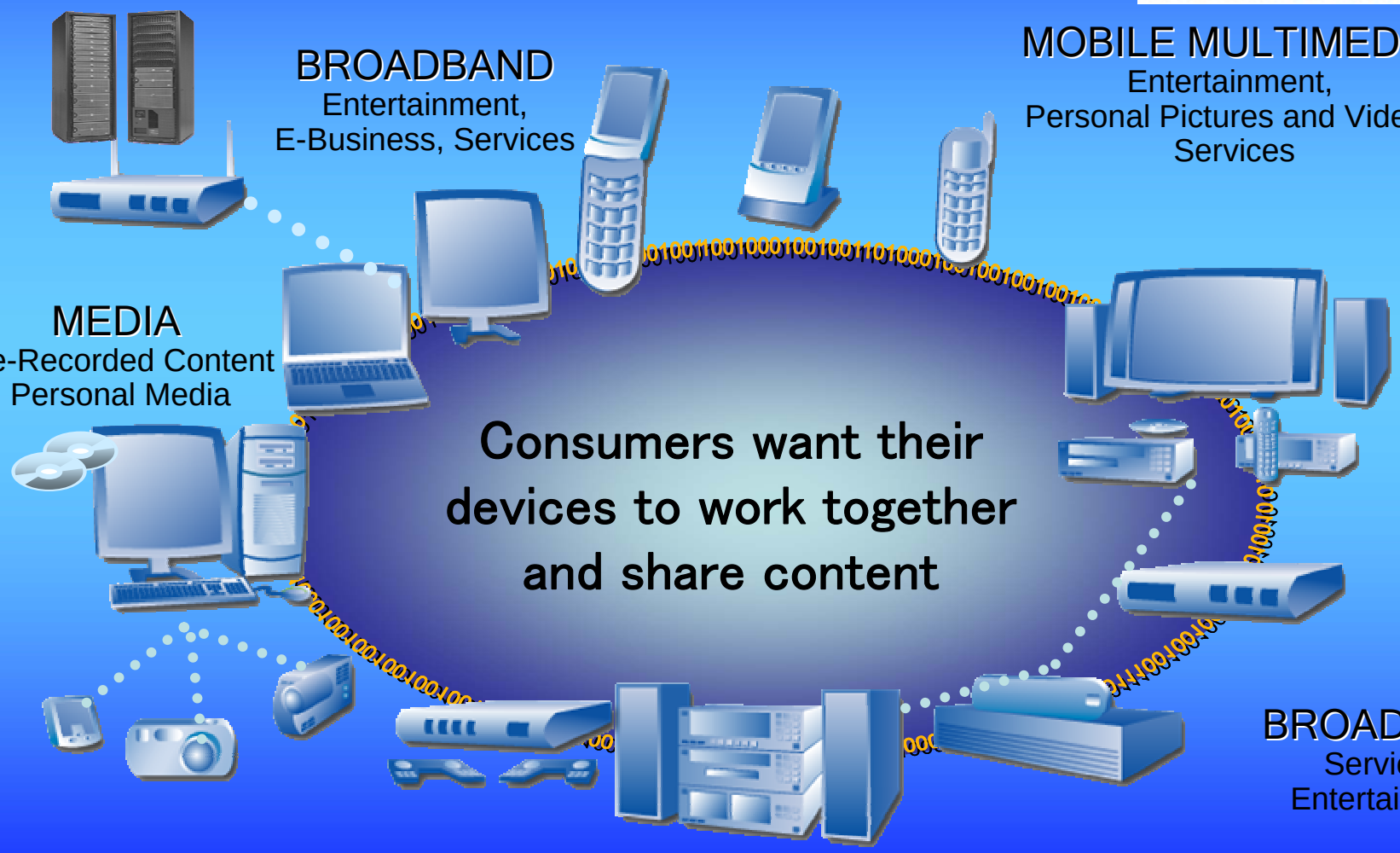
Related Standards Bodies to Home Networking

STANDARD BODY	FOUNDING COMPANIES	COMMENT	TECHNOLOGY
Universal Plug & Play	Microsoft	Service discovery and enumeration	TCP/IP
Jini	Sun	Service lookup discovery	JAVA
DLNA	HP, Intel, Microsoft Nokia, Panasonic, Philips, Samsung, Sony	Service discovery, Media Format, DRM	Framework
Home API	Compaq, Honeywell, Intel, Microsoft, Mitsubishi ,Philips	Windows based	API
OSGi	Ericsson, IBM, NCI, Nortel, Oracle, Sun, Alcatel, Motorola, Lucent, Enron, EDF, Philips, EDF, Cable & Wireless, Sybase and Toshiba	residential gateway /SOHO/ROBO	JAVA
Home PNA	3Com, AMD, AT&T Wireless, Compaq, Epigram, HP, IBM, Intel, Lucent, Rockwell , Tut Systems	LAN	Phone Line
HomeRF	Compaq, Compaq, HP, IBM, Intel, Microsoft, Motorola, PIC, Proxim, Symbionics	WLAN + DECT	RF
Bluetooth	Ericsson, IBM, Intel, Nokia, Toshiba Over 400 companies	IrDA + voice	RF
VESA	365 member companies	Multimedia	1394
HAVi	GRUNDIG, Hitachi, Matsushita, Philips., Sharp, Sony, Thomson and Toshiba	Audio-Video, API	1394, JAVA

Source: HomeRF WG

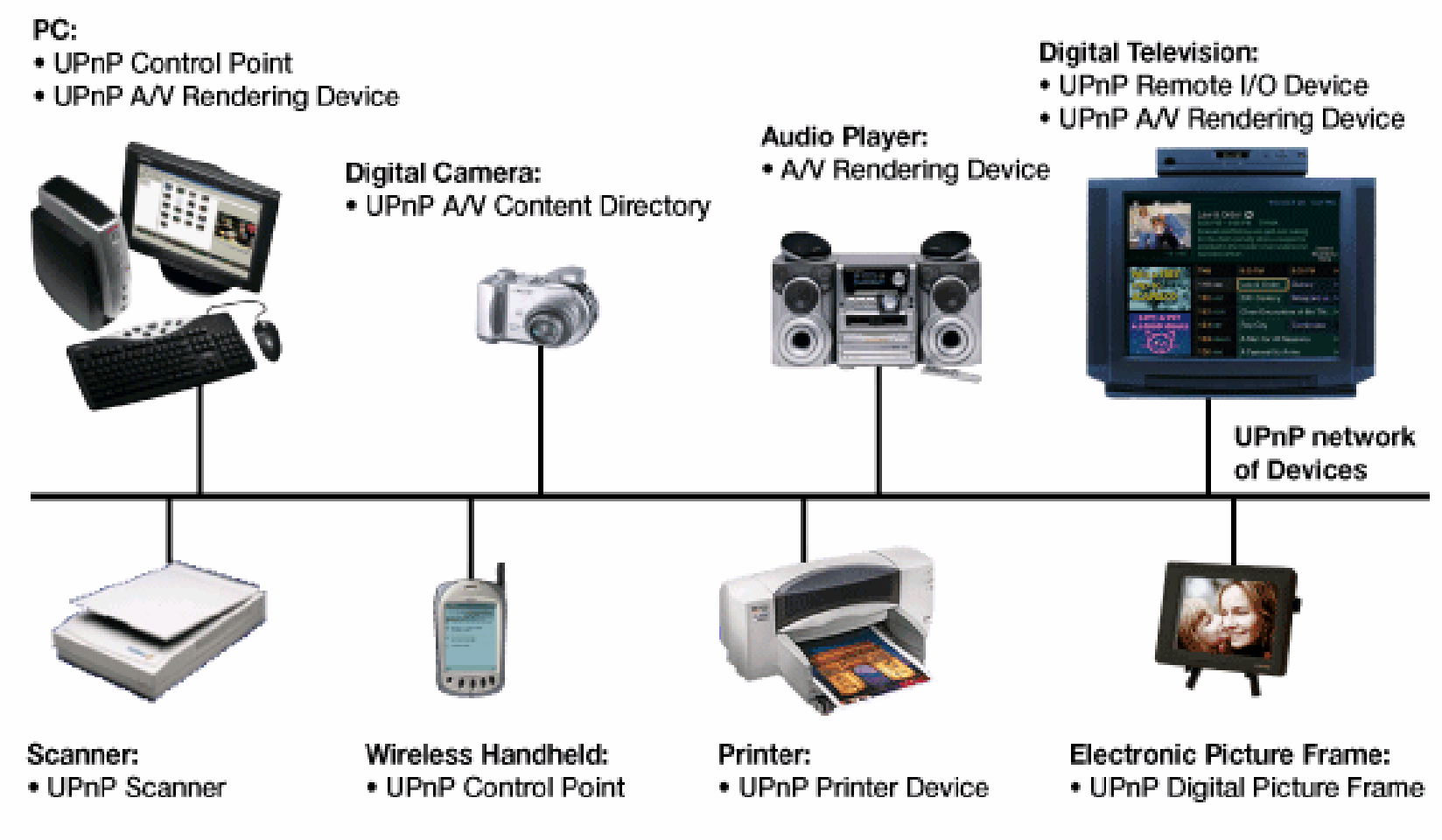
The DLNA Vision

DLNA
Digital Living Network Alliance



Source: Intel

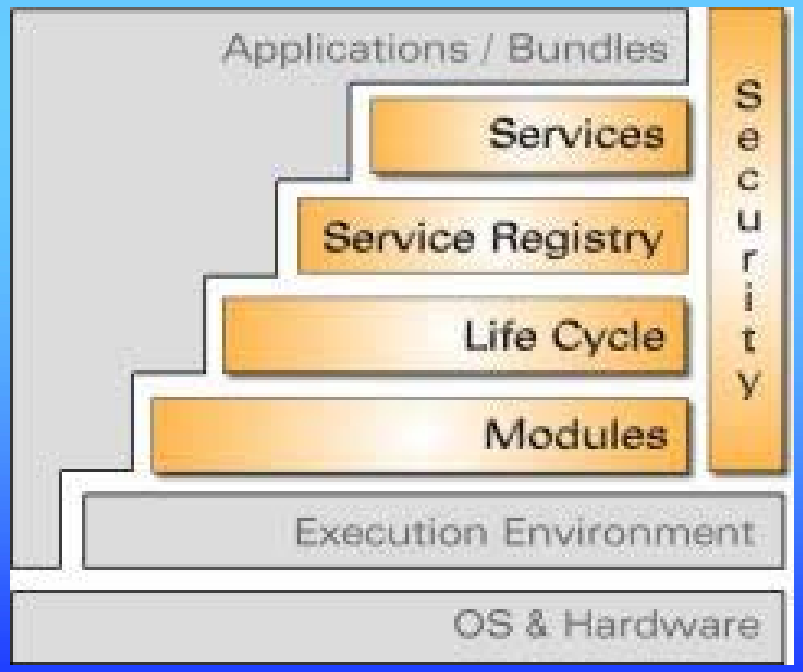
UPnP
Digital Home Platform

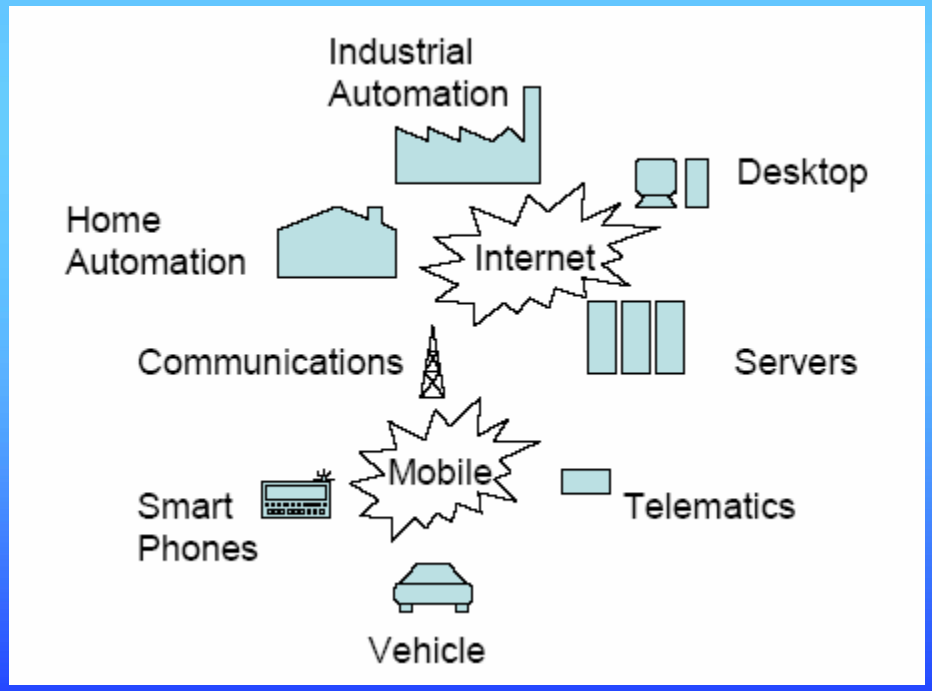


Source: http://developer.intel.com/update/contents/it06031.htm#overview

OSGi (Open Service Gateway initiative)

- The OSGi Alliance is an open forum. Its mission is to specify, create, advance, and promote an open service platform for the delivery and management of multiple applications and services to all types of networked devices in home, vehicle, mobile and other environments.





Source: OSGi Alliance

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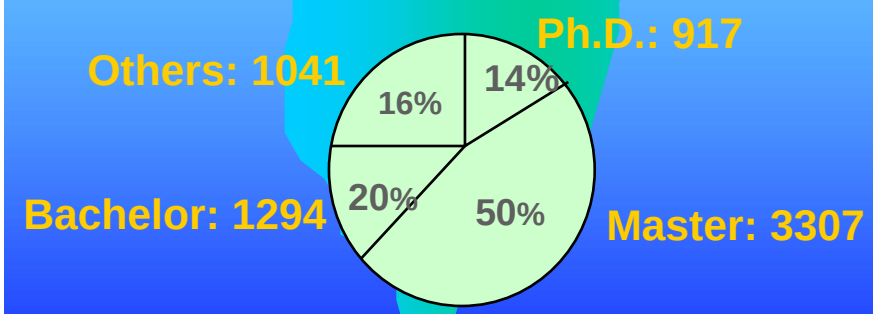
ITRI Profile

Industrial Technology Research Institute

- **Founded in 1973 by the government**
- **A non-profit R&D organization**
- **Meet the technological needs of Taiwan industries**
- **A total of 6,559 employees**



Update: February 2005

7 Major Laboratories

- **Computer & Communications Research Laboratories (CCL)**
- **Mechanical Industry Research Lab.**
- **Union Chemical Laboratories**
- **Energy & Resources Laboratories**
- **Material Research Laboratories**
- **Opto-Electronics & Systems Lab**
- **Electronics Research and Service Organization**

6 Research Centers

- **Center for Measurement Standards**
- **Biomedical Engineering Center**
- **Center for Industrial Safety and**
- **Center for Aviation & Space**
- **SoC Technology Center**
- **Nano Technology Research Center**

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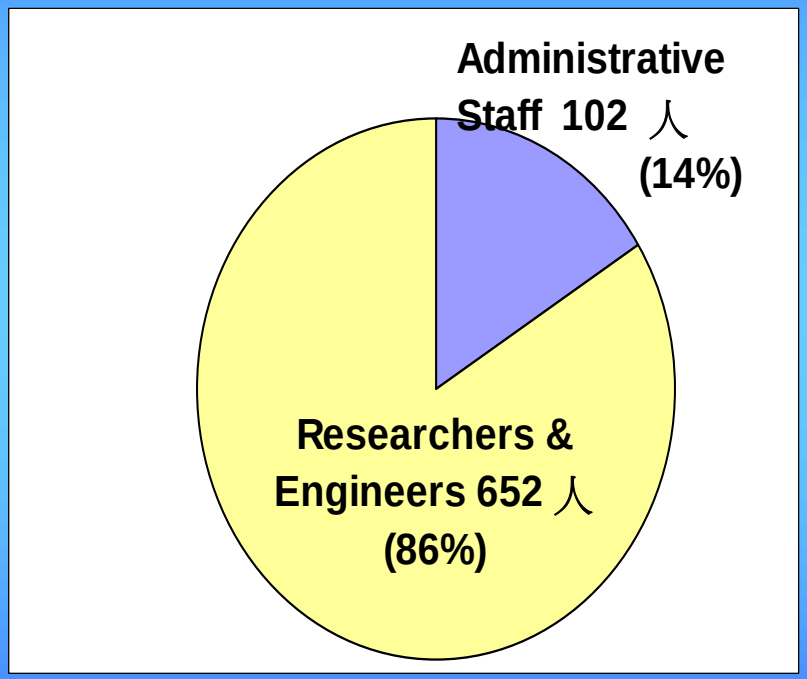
CCL Organization

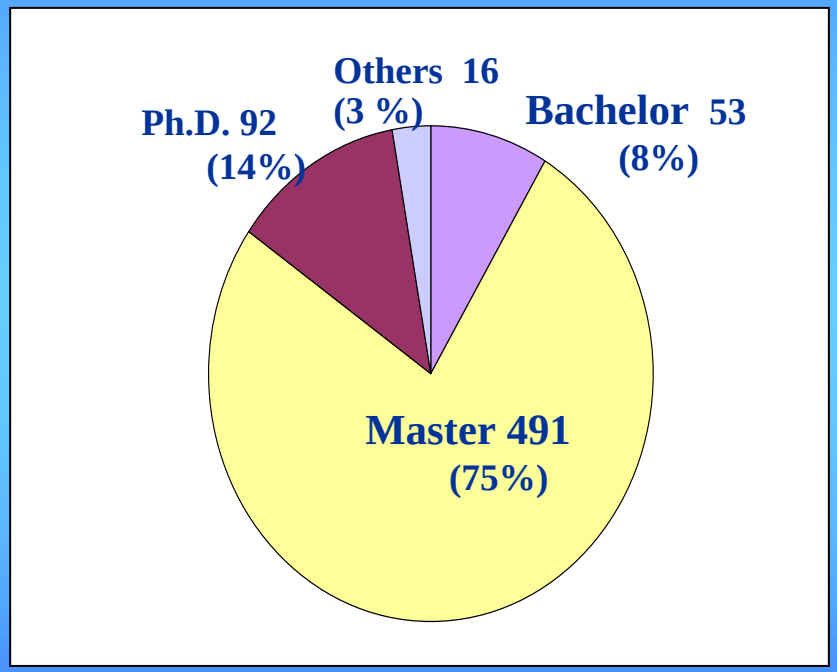
General Director's Office

- Advanced Technology Center
- Internet Software Technology Division
- Internet Platform Technology Division
- Wireless Communication Technology Division
- Communication System Division
- IP Network Technology Division
- Digital Video & Optical Communications Technology Division
- Network and Communications Technology Center

- Administration & Industrial Safety Division
- PRs & International Collaborations Office
- Strategy & Planning Division
- Technology Transfer & Services Division
- Quality Assurance Department

CCL Personnel Profile





Total Number : 754

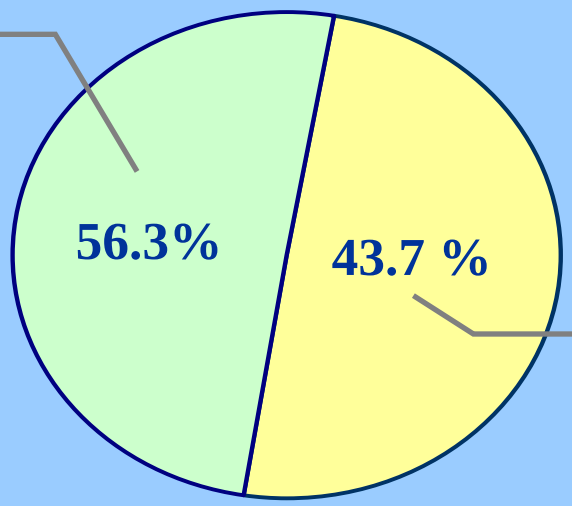
Researchers & Engineers : 652

March 2, 2005

CCL Financial Profile (2004)

Total Number: NTD 2,301 million (~USD 74 Million)

Government
(MOEA Projects)
NTD1,224 Million
~USD 39.4 Million



Industry
(Services and Contracts)
NTD 1077Million
~USD 34.7 Million

CCL R&D Focus

Wireless Comm.

- SoMLC：System on Multi Layer Circuit
- WCDMA Common IP
- Re-configurable Radio Access
- B3G Radio Access
- MIMO Technology
- B3G Interworking
- NG Service Enabling Technologies
- Mobile Multimedia Comm.Technologies
- B3G Networking
- B3G Service Enabling
- SIP IP Telecom

Broadband Comm.

- FTTx Access Technology
- Network Security & IP-VPN
- Metro Ethernet Networking
- NG-SDH Technology
- Networked Video
- IP-based SAN

Intelligent Env.

- Smart Pervasive Device
- Human-Machine interaction
- E-Learning
- Internet Security
- Pervasive Computing & Sensor Networking

DTV & Video Technologies

- MHP
- DTV chipset
- DAB chipset
- MPEG-21/IPMP
- DVB-H

CCL Technology Development

S-3C Concept

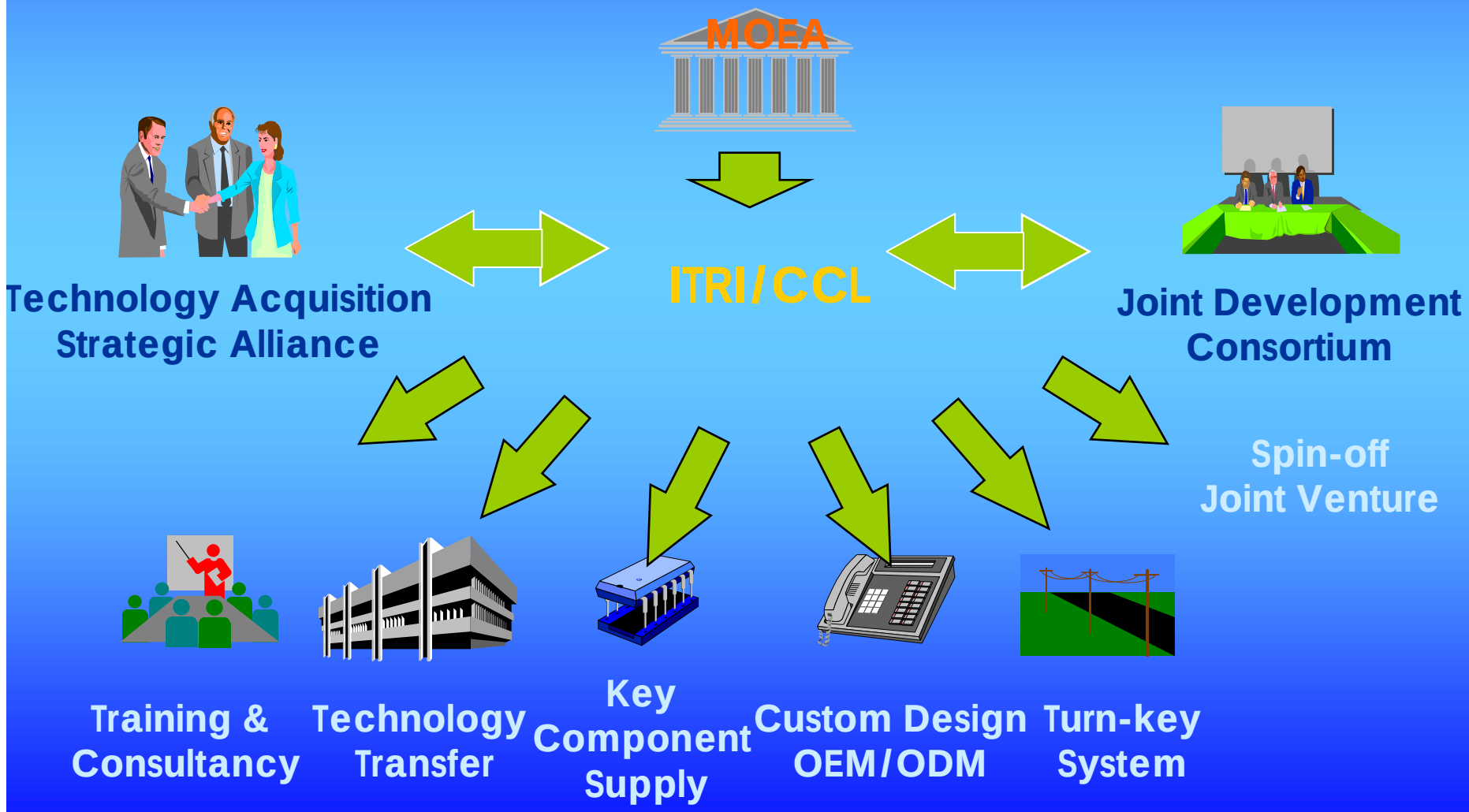
Service

Computer
ommunications
onsumer Electronics

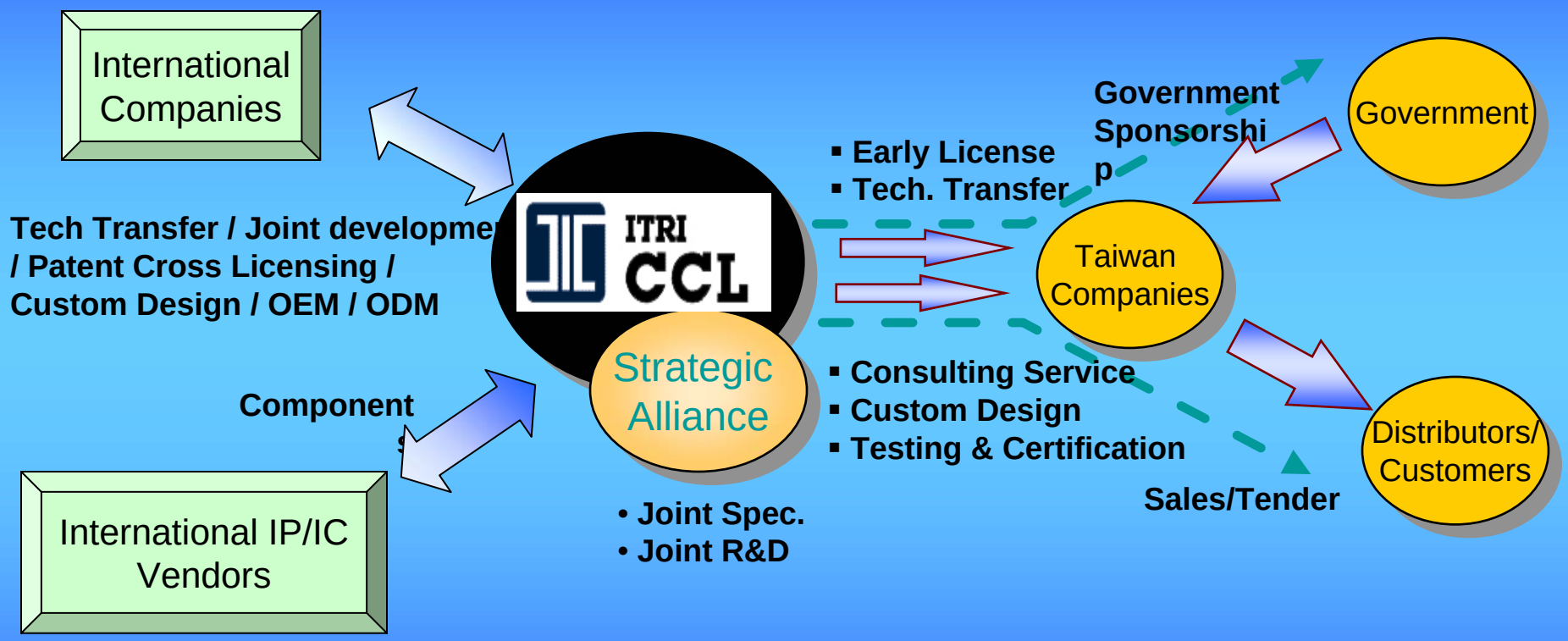
Solution

Software

Technology Diffusion Model



Generic Business Model



Thank you !