Advanced Lecture on Internet Applications
8. Internet Home Appliances

Masataka Ohta

mohta@necom830.hpcl.titech.ac.jp

ftp://ftp.hpcl.titech.ac.jp/appli8e.ppt

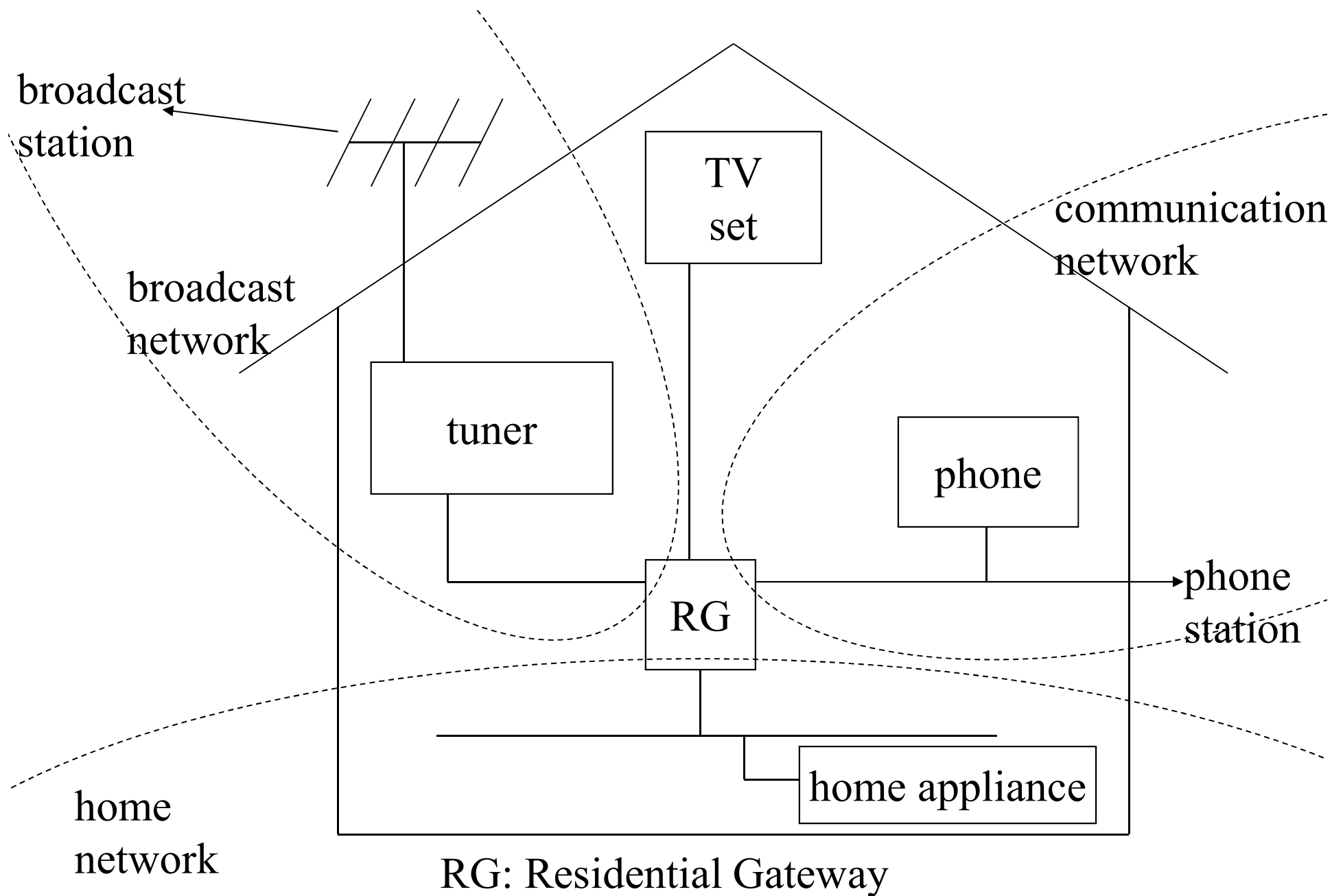# Purpose to have Internet Home Appliances

- communication

- remote control

- remote sensing

- home appliances not suitable for internet
  - refrigerator, electric oven, ...

- home appliances suitable for internet
  - communication devices (phone, FAX, game machine, camera), AV devices, air conditioner, bath heater, gas cooker, lock, meter, ...

Broadband Contents for Home?

- many home appliances require broadband
  - CD: 1.5Mbps
  - DV: 28Mbps
  - HD DV: 100Mbps
- information is not merely downloaded to home
  - home appliances generate broadband contents

Broadcast centric View on Home Appliances

- TV set is the terminal
  - behaving as the king of home appliances
- TV set is connected to BS/CATV networks through STB (Set Top Box) or RGW (Residential GW)
- RGW unify home information network
- home appliances are controlled from TV set

broadcast station

broadcast network

TV set

communication network

tuner

phone

RG

phone station

home appliance

home network

RG: Residential Gateway

unification of communication/broadcast/home network?

broadcast		phone		data comm	
broadcast network		phone network		dedicated line	

networks before the Internet

	e-mail news	www	etc
	data comm		
phone	iMODE	internet	
broadcast	phone network		dedicated line
broadcast network			
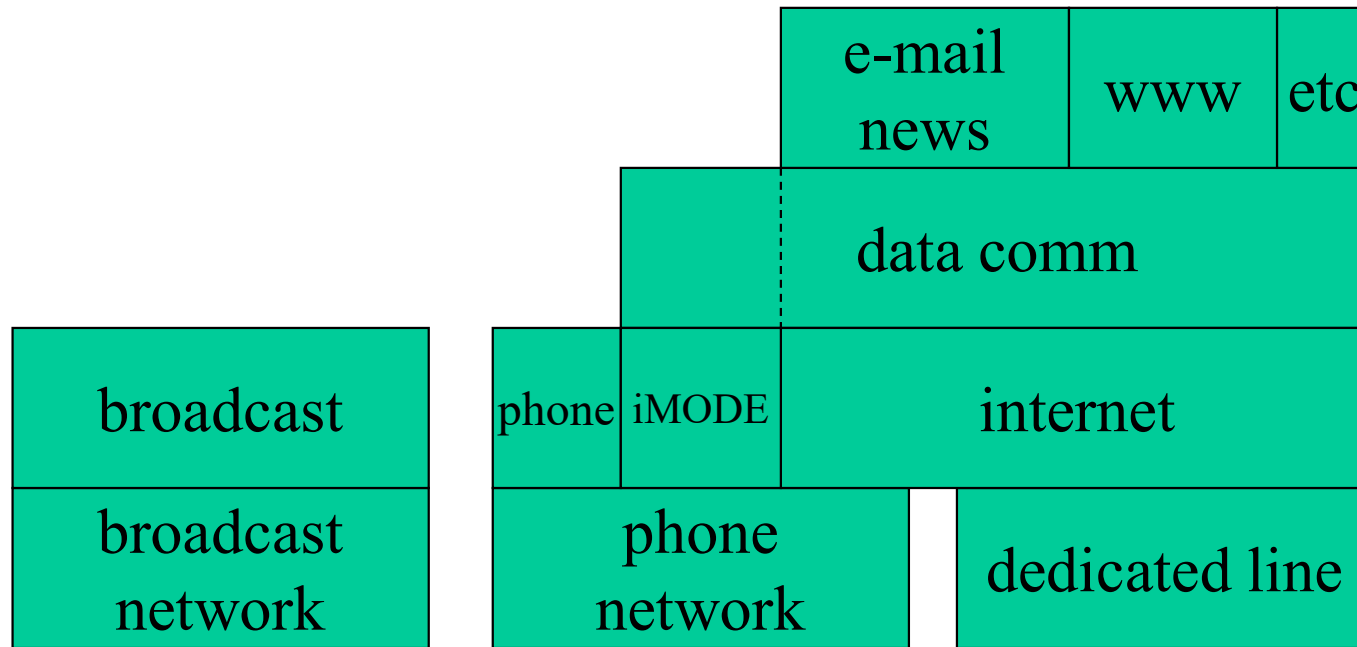
networks with the Internet

broadcast	phone	e-mail news	www	etc
streaming		data comm (batch)		
internet				
dedicated line (including wireless)				

network in the future

Internetionalization, Digitization and Electronization

Internet

IT Revolution!

Digital (ISDN, digital broadcast, telegram, e-mail, i-mode)

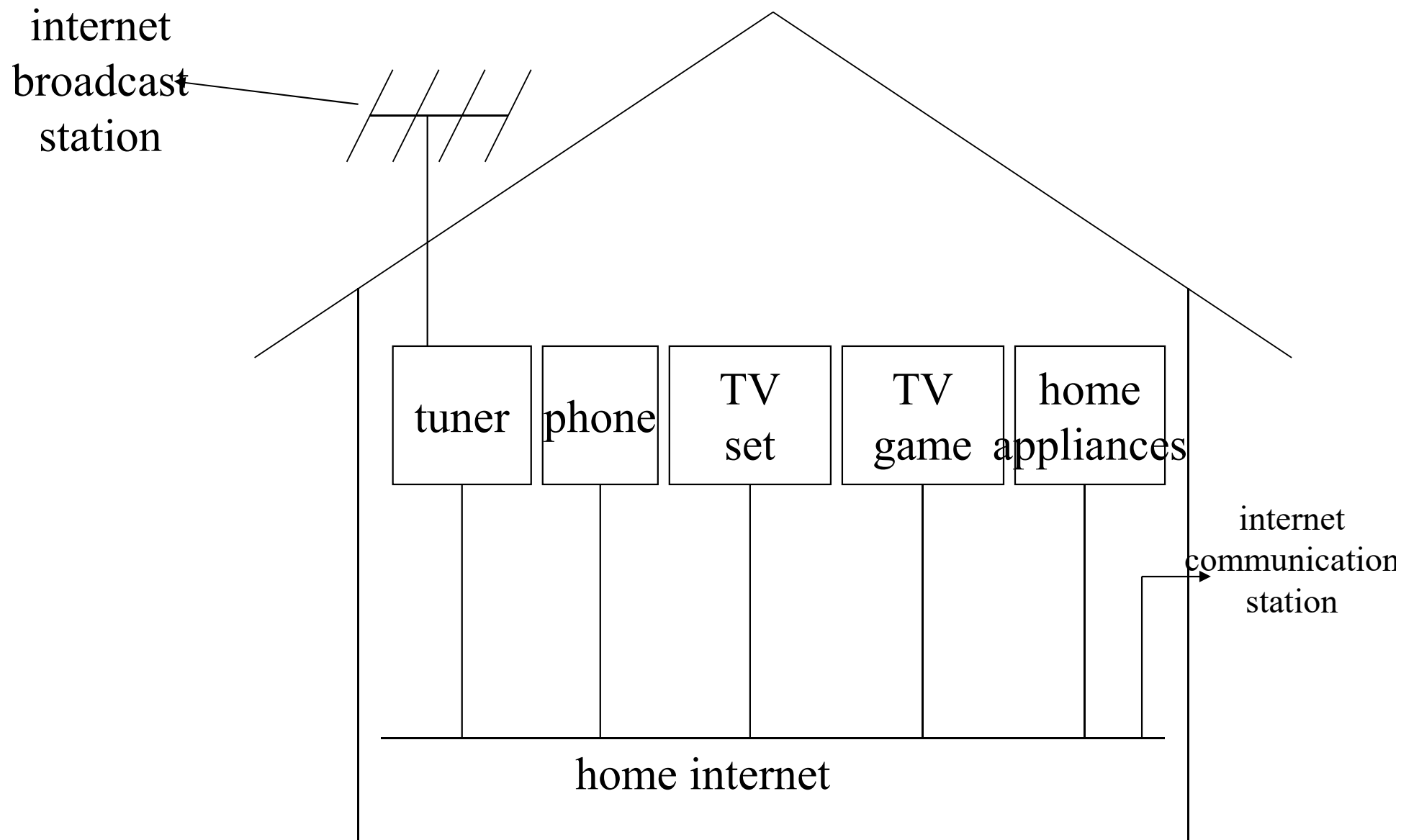Electric (phone, broadcast, FAX, e-commerce?, e-government?)
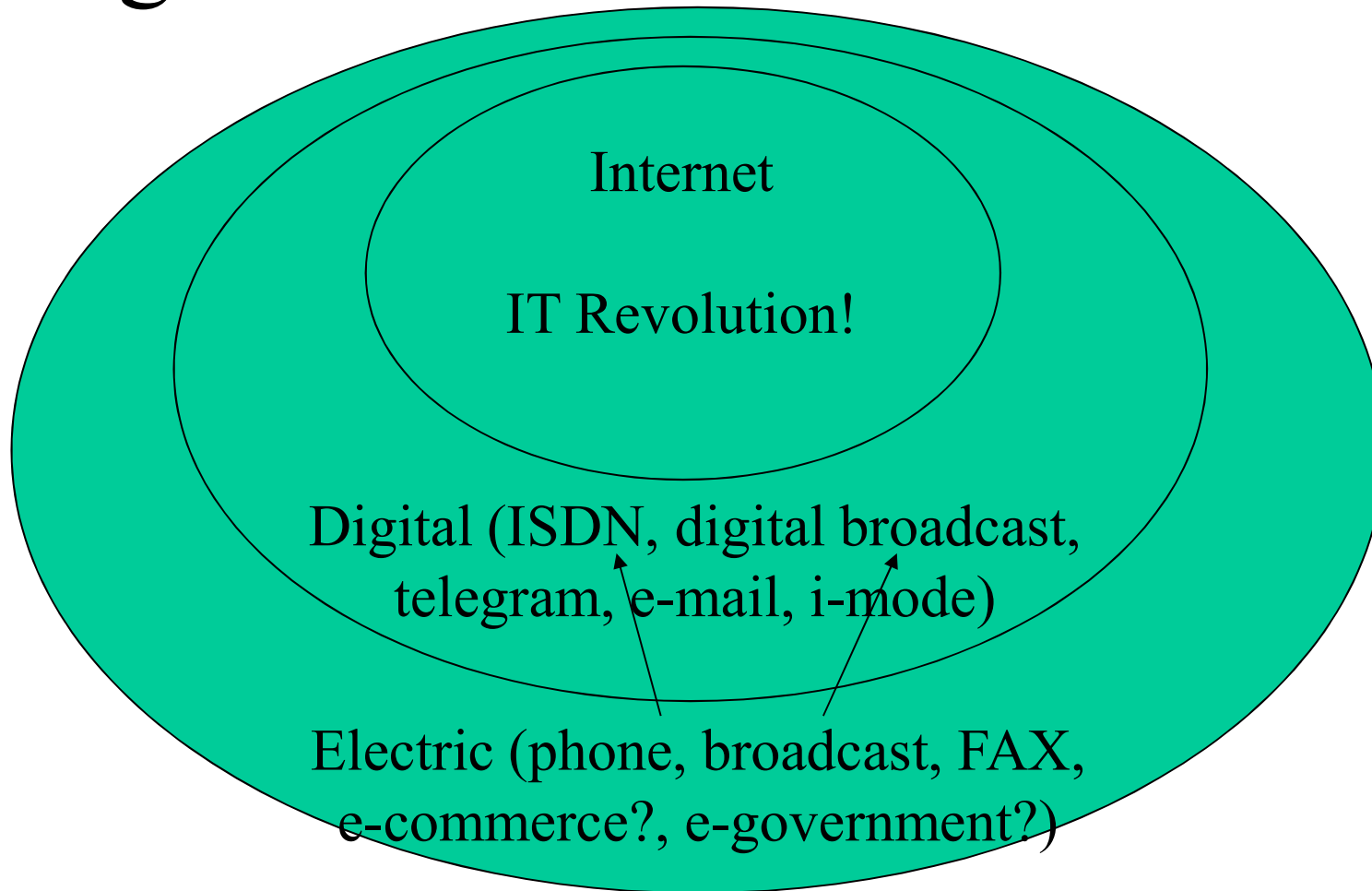
Digitization of Broadcast

- digitization of phone is ISDN (Integrated Services Digital Network)
  - only good for phone (too narrow)
  - phone service better provided by internet
- digitization of broadcast is ISDB (Integrated Services Digital Broadcasting)
  - only good for broadcasting (BML etc.)
  - broadcast service better provided by internet

Internetionalized Broadcast

- unification of information, communication and broadcast networks by internet
- for the unification, internetionalization of broadcast data is necessary
  - e2e principle
- use IP packets over broadcast radio wave
  - IP multicast packets

internet
broadcast
station

tuner | phone | TV set | TV game | home appliances

internet communication station

home internet

internetionalized home network

Power Line Communication

- can send data over power lines in or to households
- no/negligible initial cost
- not very high speed, because its for power
  - may use ADSL-like technology, but...
  - various devices are dynamically attached to PL
    - a lot of impedance mismatches
    - can be very noisy
    - speed limit dynamically change

Internet and PLC

- internet
  - consists from small datalink networks connected by routers
  - various datalink networks can be connected
  - no QoS guarantee, yet
- PLC for internet
  - speed guarantee not necessary
  - high speed not necessary (should use fiber)
  - should concentrate on cost

Power Meter Reading

- should be automated
- use PHS (Personal Handy-phone Service, inexpensive mobile phone service once popular provided by power companies)?
  - to prevent PHS disappear?
    - only to waste radio bandwidth
- meter reading through internet is free
  - for power, water and gas

What Actually Happened

- expensive PLC with extremely high peak speed
  - using very wide band agaist oppositions from radio amatures
  - even more expensive than high speed Wifi
  - not deployed at all
- "smart meter" with dedicated bandwidth

broadcast	phone	e-mail news	www	etc
streaming		data comm (batch)		
internet				
dedicated line (including wireless)				

network in the future

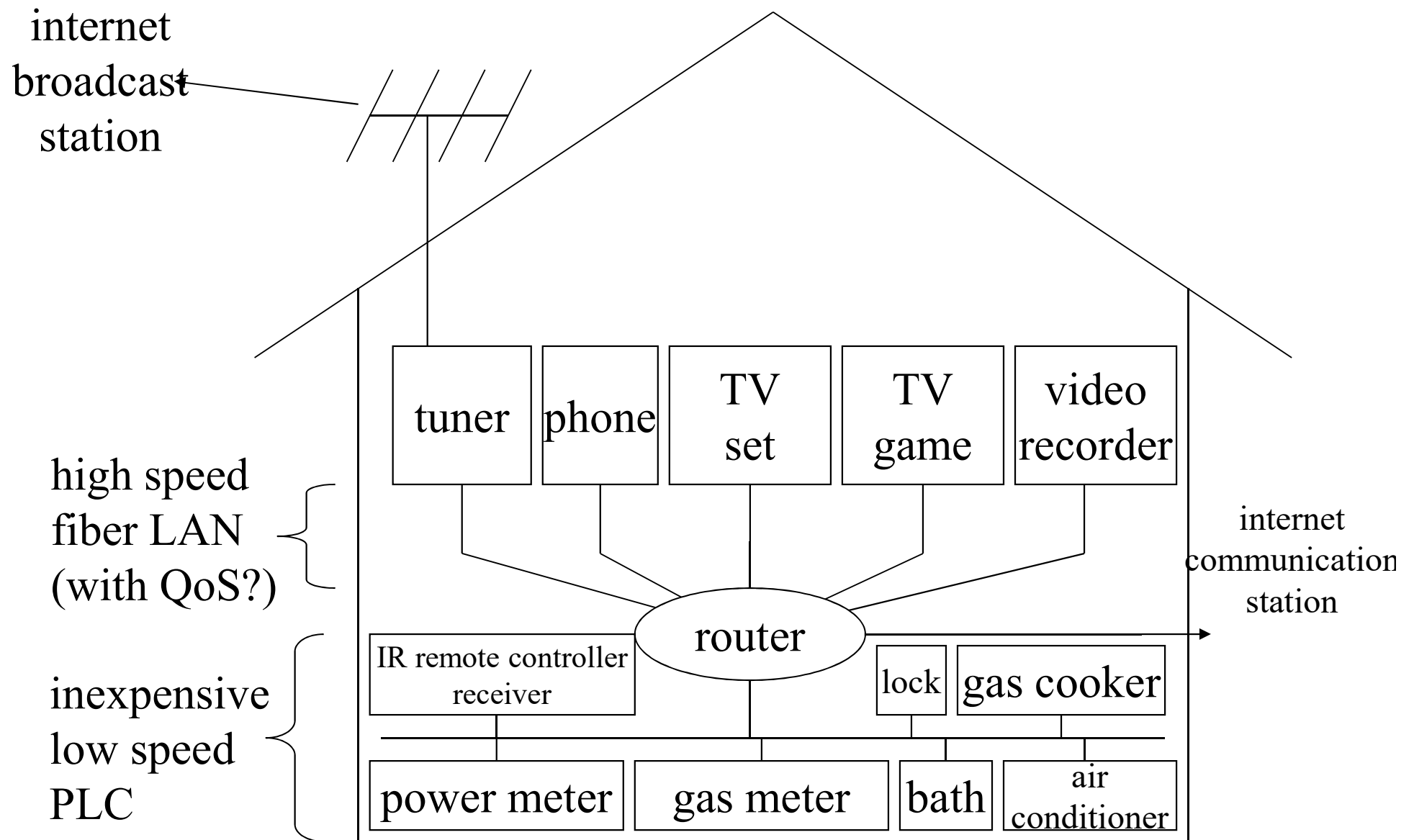| power meter reading	broadcast	phone	e-mail news	www	etc
	streaming		data comm (batch)		
	internet				
	dedicated line (including wireless)				

network in the future (?)

Internet Home Appliance and Energy Saving

- PLC (Echo Net)
  - funded from IPA for energy saving
- to reduce power peak in summer
  - power companies control home appliances?
    - not merely for meter reading?
  - power companies stop air conditioners when its extremely hot?
    - no one will buy such equipment

Internet Home Appliance and Proper Energy Saving

- power companies do not control HA

- should depends on economy

- extremely high power charge at peak
  - must tell the charge in real time
    - it's free over the internet

- needs fine control/reading of power meter
  - easy for internetionalized power meter

internet
broadcast
station

internet
communication
station

high speed
fiber LAN
(with QoS?)

inexpensive
low speed
PLC

| tuner | phone | TV set | TV game | video recorder |

router

IR remote controller receiver

lock | gas cooker

power meter | gas meter | bath | air conditioner

ideal internetionalized home network and appliances

High Speed Home Network

- IEEE1394
  - high speed (100Mbps~400Mbps)
  - can guarantee QoS
  - can protect copyright?

- optical Ethernet
  - high speed (100Mbps~10Gbps)
  - can guarantee QoS (802.1p)

JAVA (Script)

- embedded in HTML downloaded from server

- interpreted by client side

- client GUI can
  - initiate JAVA applet
    - may cause protocol actions
      - JAVA applet downloaded from server understand protocol
      - client do not have to understand protocol?

JAVA Applet

- even if client does not know protocols recognized by server
  - JAVA applet interpreted by browsers
    - can communication with server
- because human beings are involved through GUI
  - human beings know protocols used for text/graphical representations in web pages
    - ■: stop, ▶: play, ▶: record etc.

Standardization of JAVA API

- even if protocols are not standardized
  - if JAVA API is standardized
    - can control clients by JAVA code sent from server

- easier than standardizing protocols?
  - for people not familiar with networking, maybe
  - protocol standardization makes applets unnecessary
  - unconditional execution of programs from server may cause security problems
    - carefully designed protocols are better

Protocols to Control Home Appliances

- dedicated protocol should be defined
- initially, primarily for AV equipments
- RTSP
  - protocol for streaming
- CRCP
  - general purpose

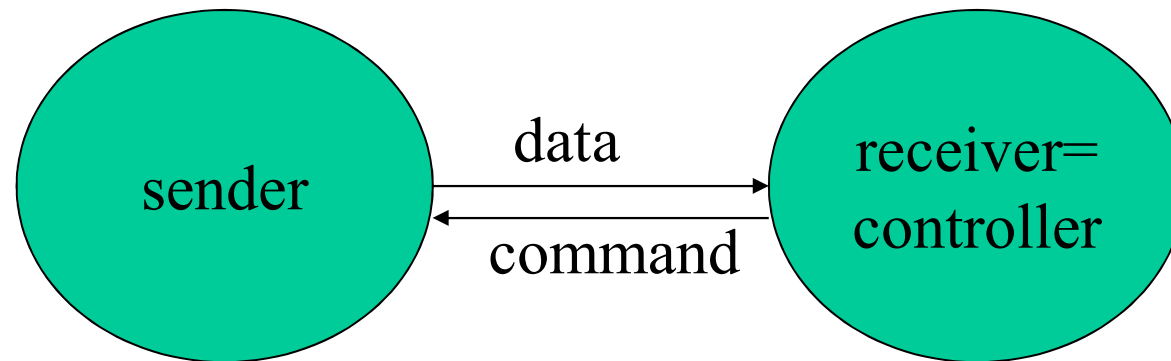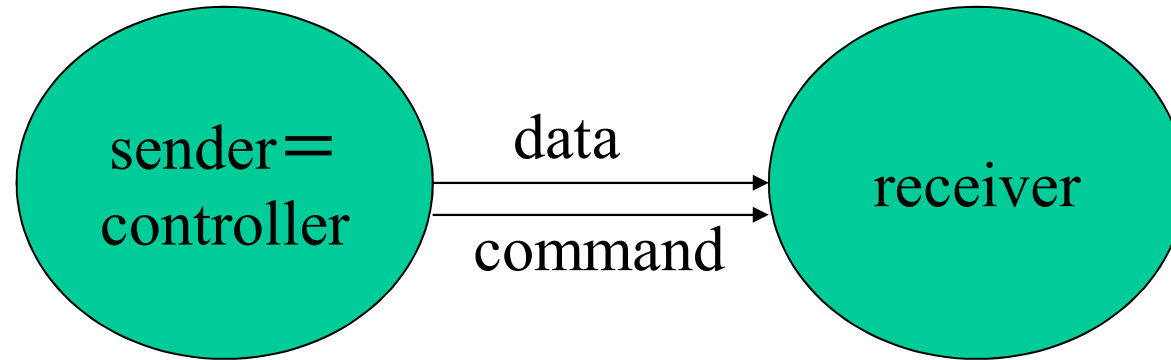# RTSP (Real Time Streaming Protocol, rfc2326)

- sender controls receiver, or
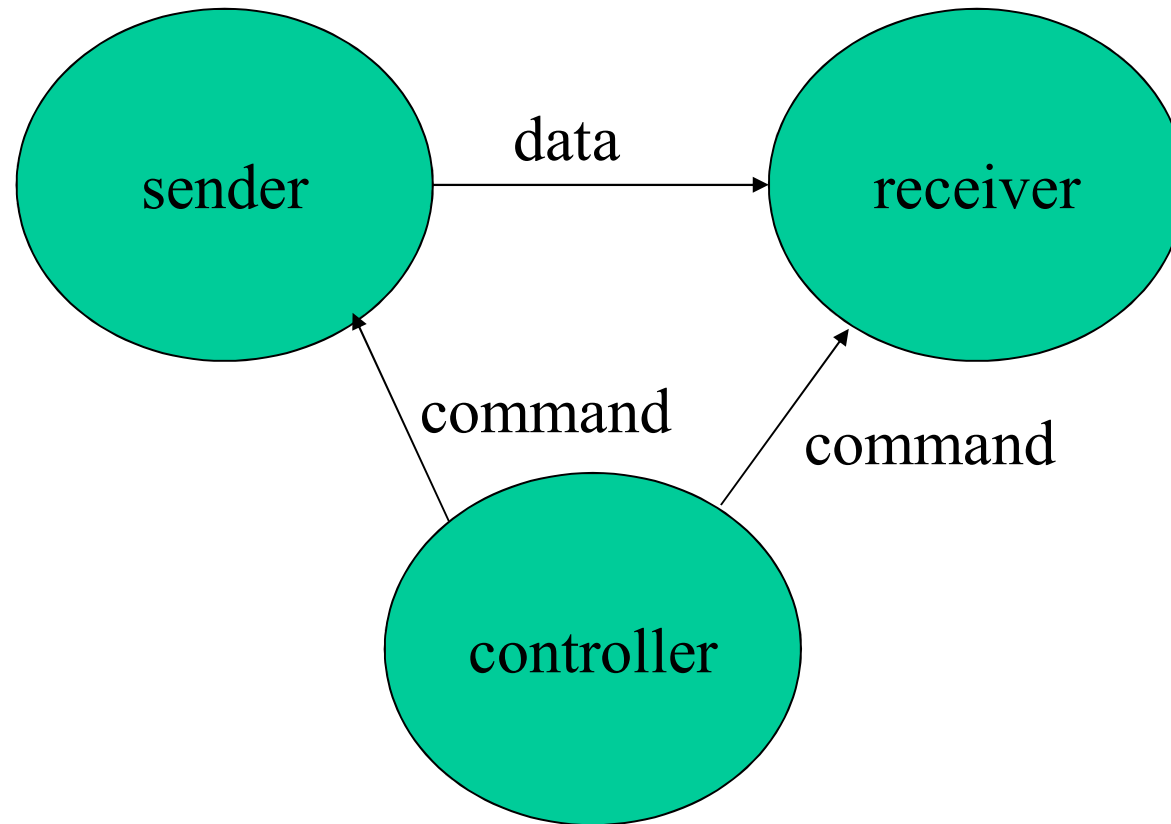- receiver controls sender

FTP (rfc959)

- File Transfer Protocol
- protocol to exchange files over the Internet
- port# 21 is used for command and response
- various file formats are supported

What are Ends of File Transfer?

- sender
- receiver
- controller!!

usual file transfer

more general form of file transfer

CRCP (Camera Recorder Control Protocol)

- based on ftp
- controller, sender and receivers, in general, are independent
- support various data format
- ftp://ftp.hpcl.titech.ac.jp/draft-ohta-ccc-video-01.txt

Commands of FTP

- various

    - USER PASS ACCT CWD CDUP SMNT QUIT
      REIN PORT PASV TYPE STRU MODE
      RETR STOR STOU APPE ALLO REST RNFR
      RNTO ABOR DELE RMD MKD PWD LIST
      NLST SITE SYST STAT HELP NOOP

Some Commands of FTP (1)

- USER
  - user name

- PASS
  - password

Some Commands of FTP (2)

- PORT
  - specify IP address and port number to connect
- PASV
  - ask IP address and port number of server waiting for connection
- TYPE STRU MODE
  - file format

Some Commands of FTP (2)

- RETR
  - read from a file
- STOR
  - write to a file

Command Format of CRCP

<Command> = ("STAT" / "HELP") [<sp> <subunit>] CR LF /

        [<subunit> <sp>] <subunit-command>

        [<sp> <arguments>] CR LF

<subunit> = <subunit-type> [<subunit-no>]

<subunit-type> = "POWER" / "CONNECTION" / "FILE" / "STREAM" /

        "TAPE" / "CAMERA" / ...

Some Commands of CRCP (1)

- based on ftp
- stat command identify subunits
- commands for connection subunit
  - USER
    - user name
  - PASS
    - password

Some Commands of CRCP (2)

- commands for connection subunit
  - PORT
    - specify IP address and port number to connect
  - PASV
    - ask IP address and port number of server waiting for connection
  - TYPE STRU MODE
    - file format
  - RETR, STOR
    - read from and write to a file,

Persistent Connectivity and Security

- is persistent connectivity insecure?
  - persistently under attack
- windows
  - was assuming safe home network
  - was (still is?) not very secure
- UNIX
  - multiuser environment, from the beginning
  - secure by design
    - security holes may be caused by bugs

Firewall?

- was good for windows PC
  - e.g. to close some vulnerable ports
- firewalls may also be buggy
  - as realiable as UNIX?
- not very useful against high level virus
  - secure OS is not enough
  - all the applications must be secured
    - all the users must be security conscious

Security of Home Appliances

- unlike PC, designed for single purpose
  - simple OS with few security holes should be used
    - no windows CE
- unlike PC, may have dangerous feature
  - igniting gas cooker, heating electric oven
- should depends on physical security
  - dangerous feature should not be turned on by software
    - not remotely controllable even with bugs
- like PC, privacy breach is a problem

Remote Control of Air Conditioners?

- is remote control by smart phones safe?
  - legally, only turning off was allowed
    - can turn on/off by (local) IR remote controller
      - what if, IR remote controller connected to internet?
- an extreme example
  - in summer, children and dogs are dying in cars
    - in some case, because someone turns off air conditioner
- remote control of air conditioners can be dangerous

Wrap Up

- TV set is no longer the king of home appliances
  - home appliance control needs dedicated protocol
- refrigerators and electric ovens least need internet connectivity
- power line communication could have been useful for its low cost
- security!