

ការគណនា network

↳ ① topology

② Transmission → ប្រភេទខ្សែ, កម្រិត → តម្លៃខ្សែ, ឥរិយាបថ, ប្រព័ន្ធប្រតិបត្តិ, maintenance

③ Speed ល្បឿន

④ distance ចម្ងាយ

cost តម្លៃ



# Transmission Media and High Speed Digital Services

# Transmission Media Selection Criteria



**Cost**

Purchasing (owning) / Rent (Monthly or Leasing) / Maintenance



**Speed**

Bandwidth



**Distance**

Attenuation (depending on frequency)  
Electromagnetic noise



**Delay**

Propagation speed



**Expandability**



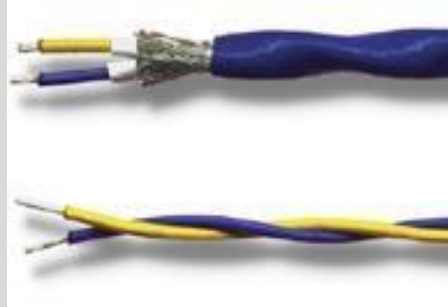
**Environment**



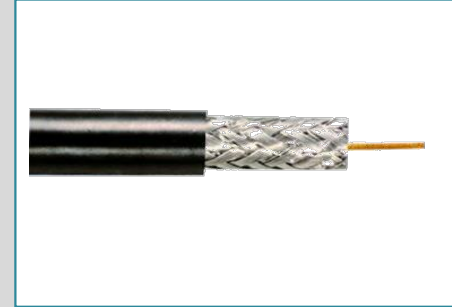
**Security**

# Transmission Media Choices

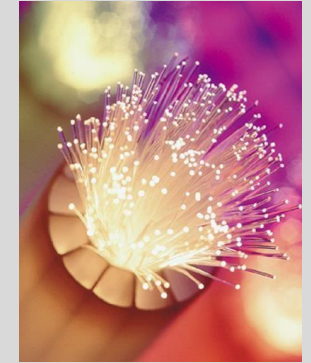
## ■ Wired Transmission



Twisted Pair

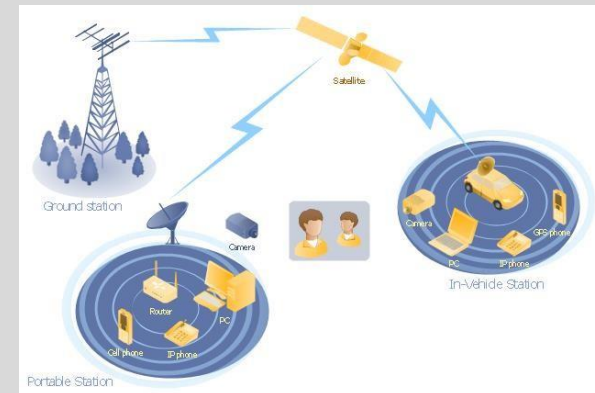


Coaxial cable



Optical Fiber

## ■ Wireless Transmission

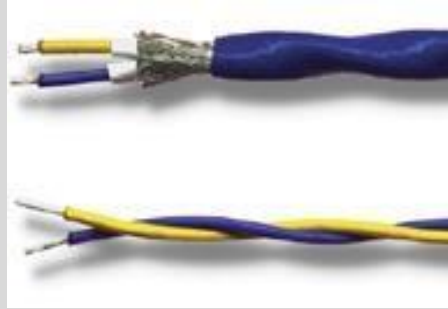




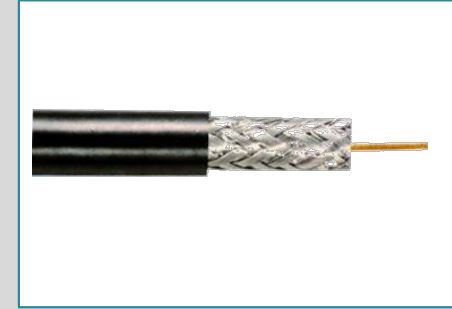
# Wired Transmission

# Transmission Media Choices

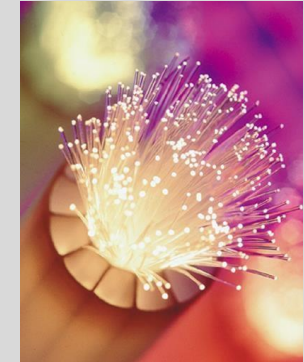
## ■ Wired Transmission



**Twisted Pair**



**Coaxial cable**

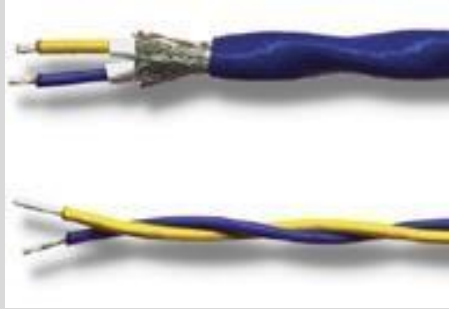


**Optical Fiber**

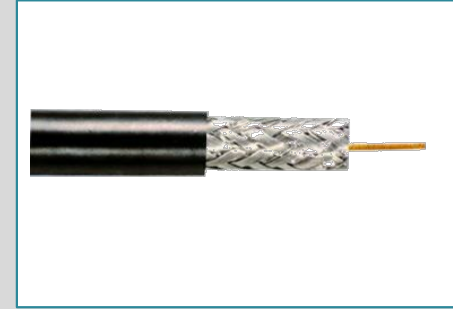
รายละเอียด	Twisted pair	Coaxial	Fiber
Bandwidth เท่าไหร่	~5MHz (100Hz – 5MHz)	~500MHz (100kHz – 500MHz)	150THz (180-330 THz)
Signal Conversion	ADSL: DMT (FDM (Channel Allocation) + QAM Modulation	Cable TV: FDM (Channel Allocation) + QPSK or QAM Modulation)	FTTx: WDM + QPSK or QAM or OFDM
ความเร็ว	10Mbps / 512Kbps 50Mbps/ 20Mbps	10Mbps/ 1Mbps 200Mbps/ 15Mbps	30Mbps/ 3Mbps 200Mbps/ 25Mbps

# Transmission Media Choices

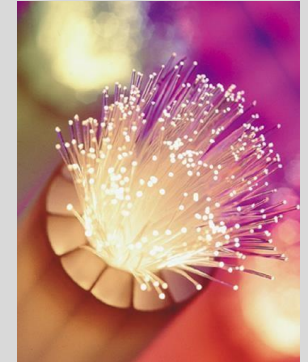
## ■ Wired Transmission



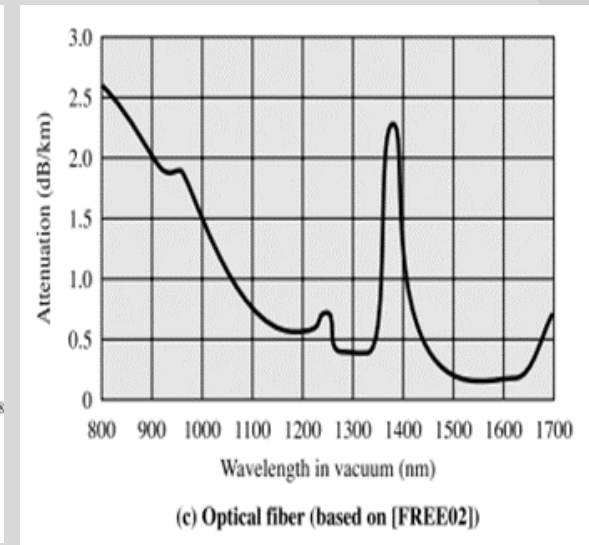
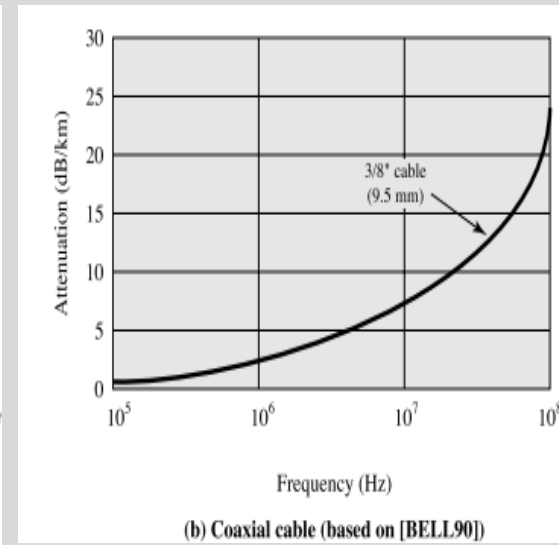
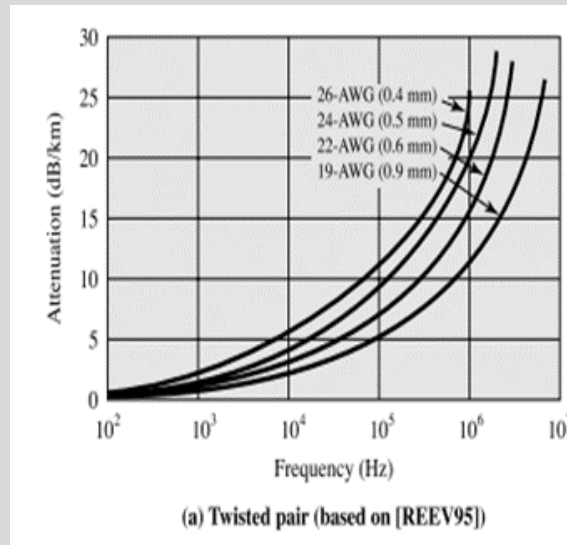
Twisted Pair



Coaxial cable



Optical Fiber



ส่งได้ไกลแค่ไหน

100 m

RG11: 1000m

RG6: 400-700m

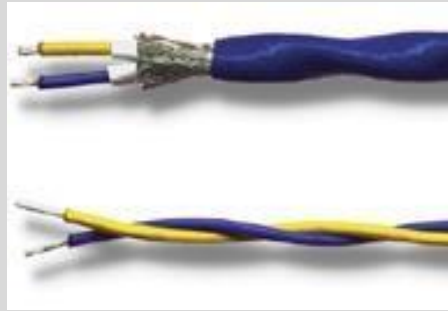
RG59: 200-500m

Single Mode: 20-100 km

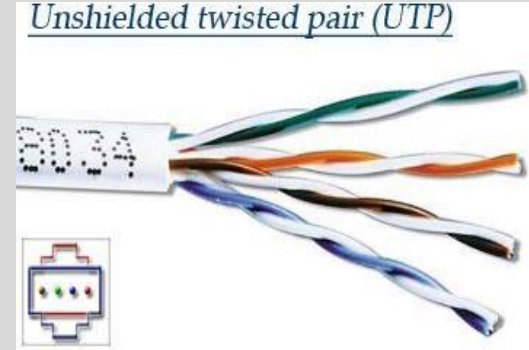
Multimode: 200-500m

# Transmission Media Choices

## ■ Wired Transmission



Twisted Pair



Unshielded twisted pair (UTP)



Shielded twisted pair (STP)

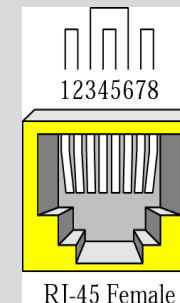
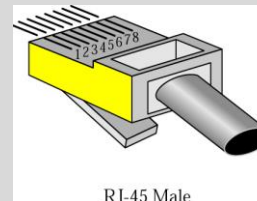
***Cable Type: Categories of twisted-pair cables (EIA)***

***UTP (Unshield): CAT 1-6***

***LAN: CAT 5e, CAT 6***

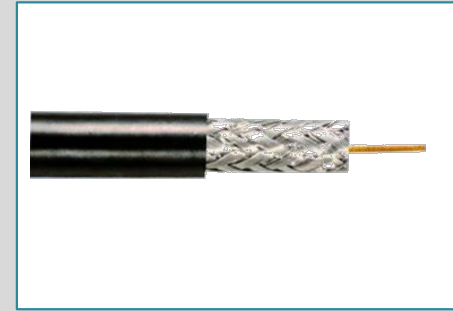
***STP (Shield): CAT 7***

***Connector Type: RJ-45***



# Transmission Media Choices

## ■ Wired Transmission



Coaxial cable

*Cable Type: Radio Government (RG) rating*



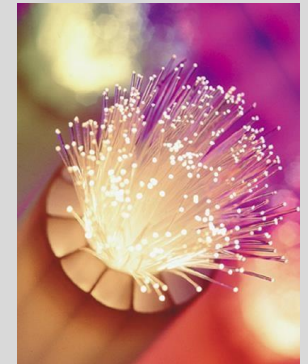
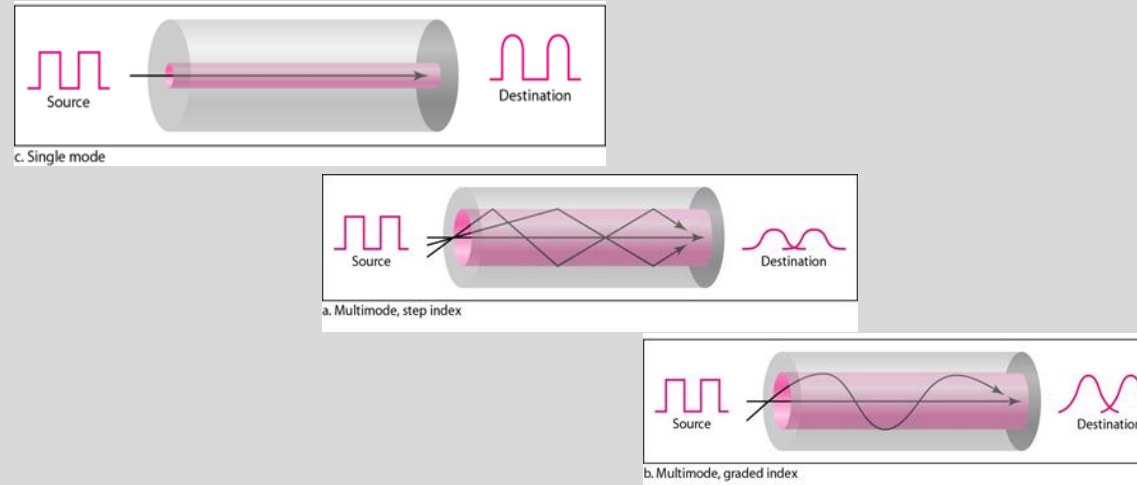
*Connector Type: **BNC***





# Transmission Media Choices

## ■ Wired Transmission



Optical Fiber

***Cable Type (Core size):***

***Single Mode: < 10 micron***

***Multimode (Step Index): > 10 micron (Ex. 50, 62.5, 100)***

***Multimode (Graded Index): > 10 micron (Ex. 50, 62.5, 100)***

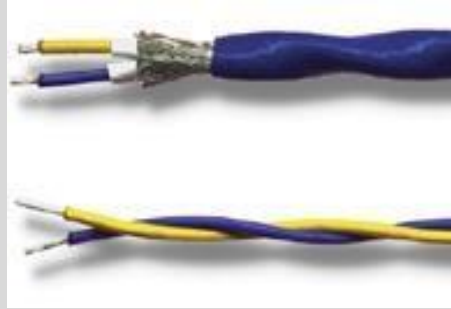
***Connector Type: FC, ST, SC, MT-RJ***



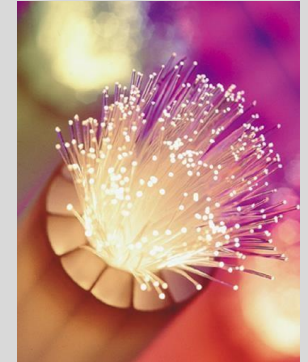
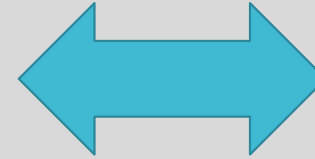
# Transmission Media

## Transceiver (Optical to Electrical)

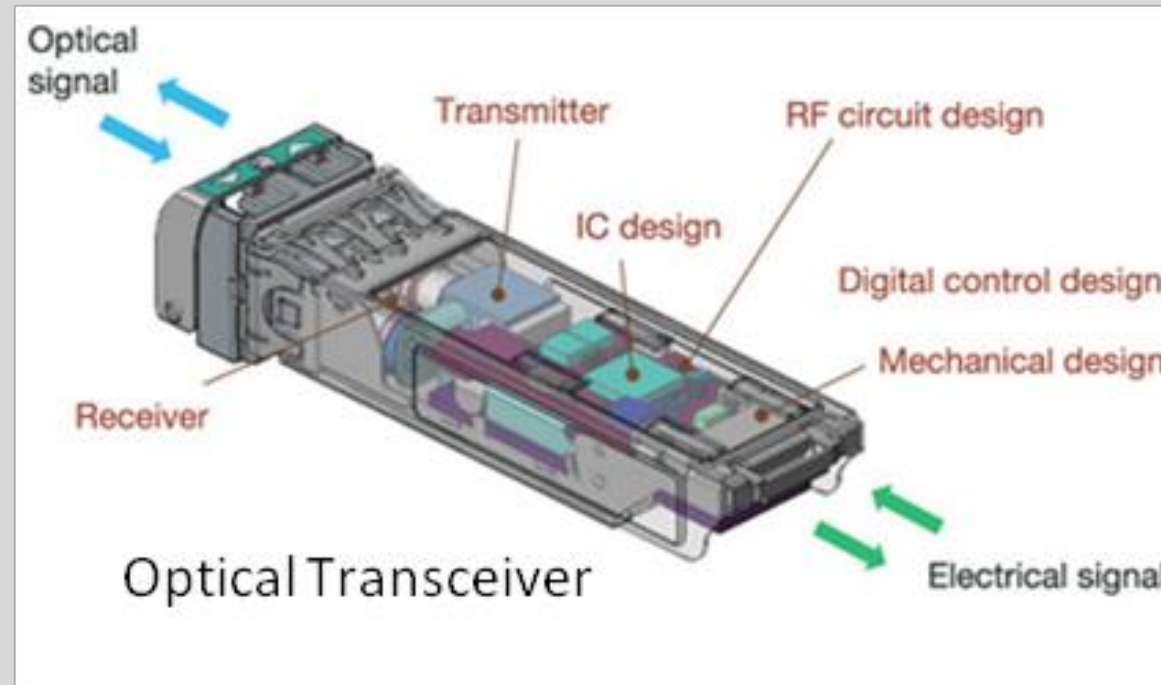
### ■ Wired Transmission



Twisted Pair

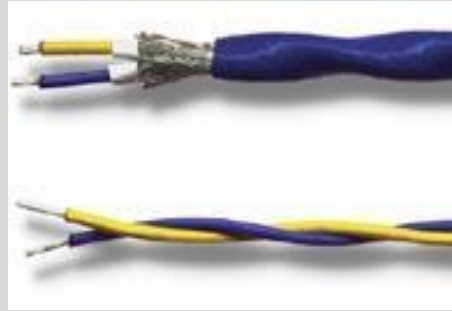


Optical Fiber

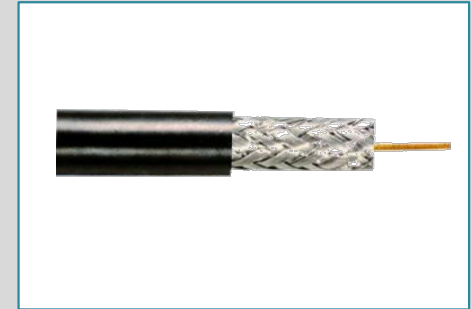
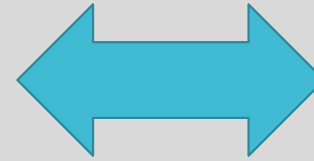


Transmission  
Media  
**Transceiver**  
**(Coaxial to UTP)**

■ Wired Transmission



Twisted Pair



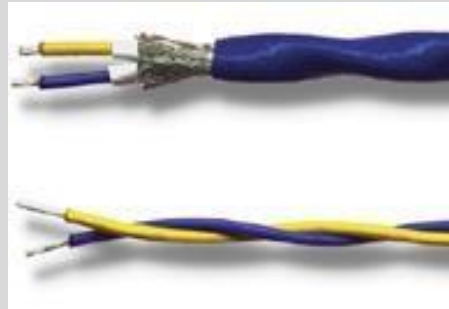
Coaxial cable



# Transmission Media

## Device Power (PoE: Power over Ethernet)

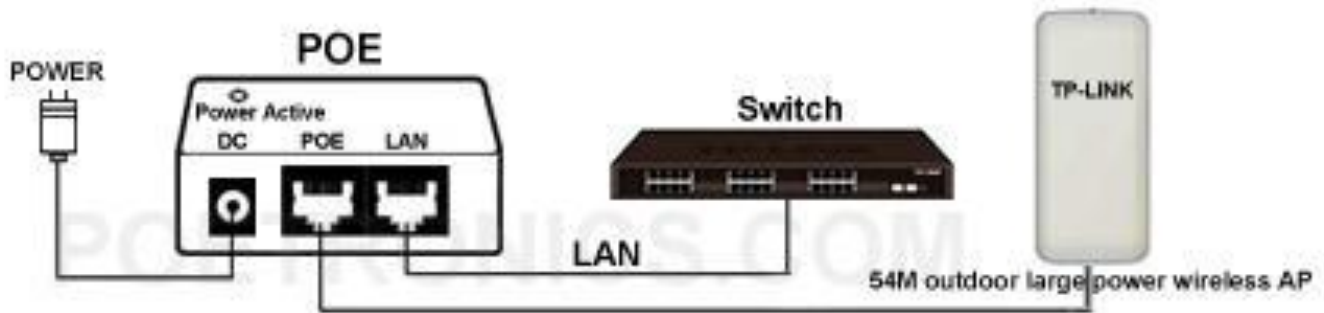
### ■ Wired Transmission



Twisted Pair



Passive POE Injector Connection Diagram

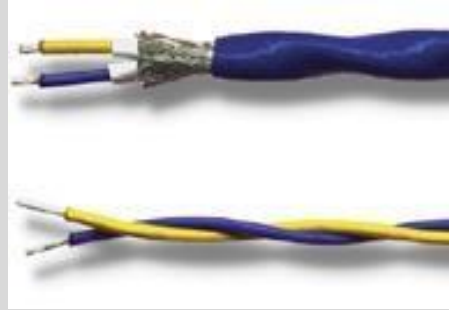


PoE: ลดการเดินสายไฟฟ้า โดยพ่วงไฟไปกับสาย LAN

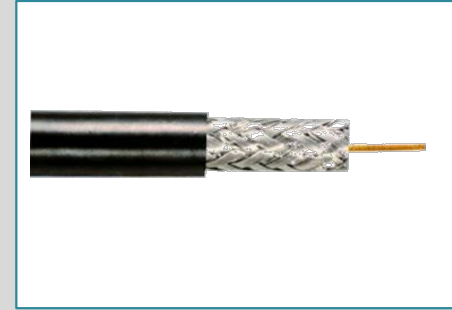
# Transmission Media

## High Speed Digital service

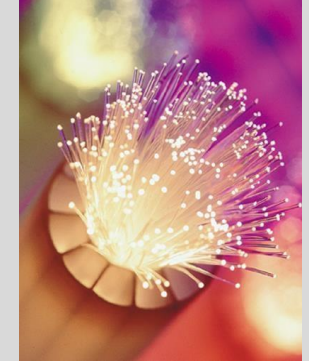
### ■ Wired Transmission



Twisted Pair



Coaxial cable



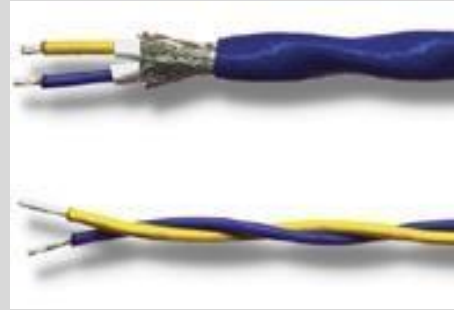
Optical Fiber

บริการรับส่งข้อมูลรายเดือนมีแบบไหนบ้าง	xDSL (ADSL, VDSL, SDSL)	Cable TV, DOCSIS	FTTx
มีใครให้บริการบ้าง	3BB, True, ToT	True	3BB, True, AIS, ToT

# Transmission Media

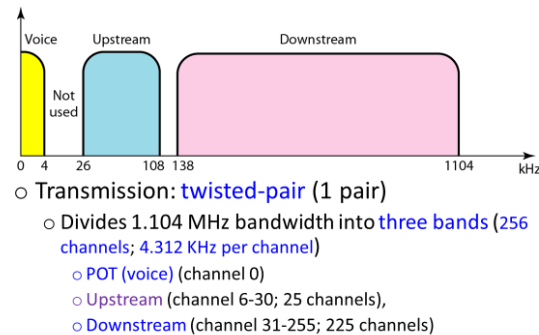
## High Speed Digital service (ADSL)

### ■ Wired Transmission



Twisted Pair

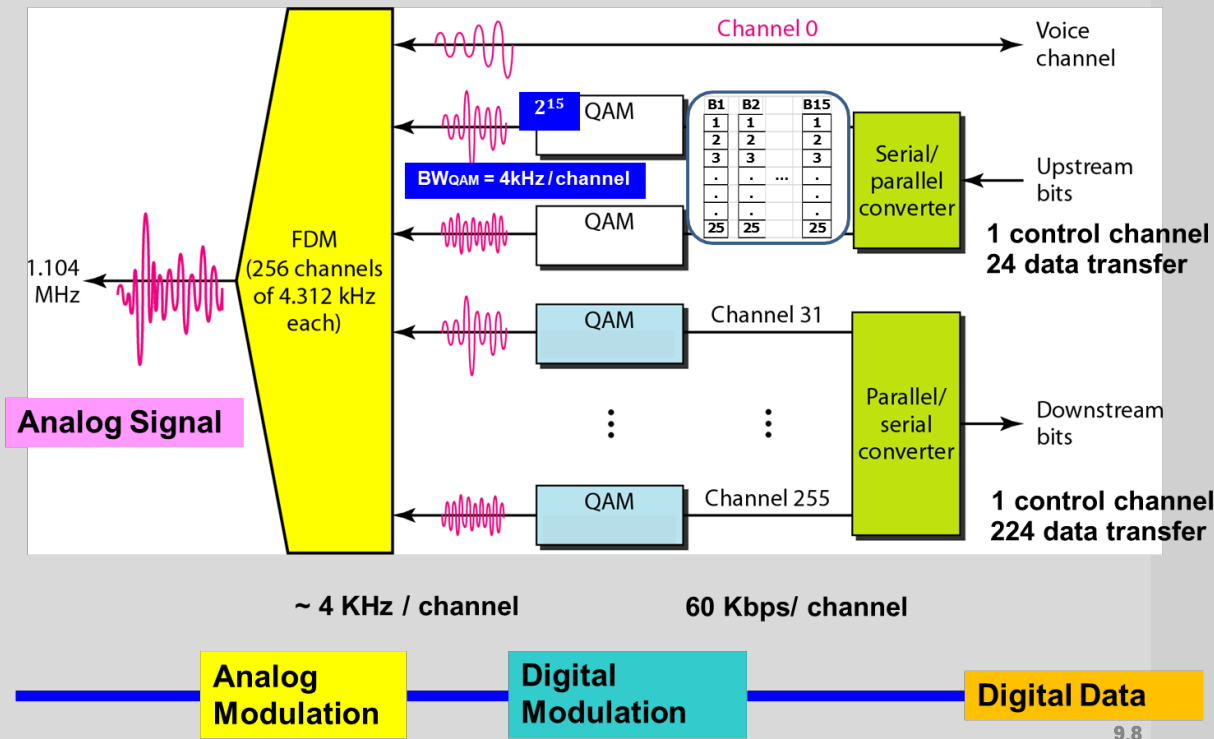
Figure 9.11 Bandwidth division in ADSL



#### ANSI standard for ADSL

- Upstream (25-200 KHz -> 25 channels)
  - Each FDM sub channel: 4 KHz
  - Discrete Multitone Technique (DMT): 15 bits per baud
  - Data rate: 60 Kbps / channel
  - Upstream data rate (no noise) :  $25 \times 60\text{Kbps} = 1.5\text{ Mbps}$
  - data rate (with noise) : 64 Kbps – 1 Mbps

Figure 9.10 Discrete Multitone Technique (**DMT**) : modulation technique standard for ADSL



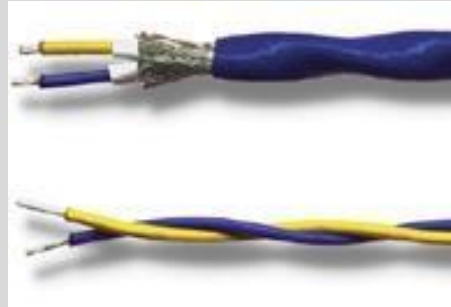
- Downstream (250-100 KHz -> 200 channels)
  - Downstream data rate:  $200 \times 60\text{ Kbps} = 12\text{ Mbps}$
  - data rate (with noise): 500 Kbps – 8 Mbps



# Transmission Media

## High Speed Digital service (LAN)

### ■ Wired Transmission



Twisted Pair

## LAN

### IEEE 802.3 Ethernet Protocol

Variants [\[edit\]](#)

Line Coding

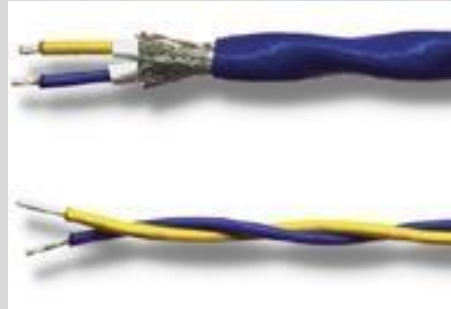
Speed [Mbit/s]	Distance [m]	Name	Standard / Year	Description
1	100 (nominally)	StarLAN	802.3e 1986 <sup>[13]</sup>	Runs over four wires (two <i>twisted pairs</i> ) on telephone <i>twisted pair</i> or Category 3 cable. An active hub sits in the middle and has a port for each node. <b>Manchester</b> coded signaling.
10	100 (nominally)	LattisNet	(pre) 802.3i 1987	Runs over AT&T Premises Distribution System (PDS) wiring or four wires (two <i>twisted pairs</i> ) on telephone twisted pair or Category 3 cable. <sup>[7][14]</sup>
10	100 (nominally) <sup>[15]</sup>	10BASE-T	802.3i 1990	Runs over four wires (two <i>twisted pairs</i> ) on a Category 3 or Category 5 cable. Star topology with an active <i>hub</i> or <i>switch</i> sits in the middle and <i>has a port</i> for each node. This is also the configuration used for 100BASE-T and gigabit Ethernet. <b>Manchester</b> coded signaling.
100	100	100BASE-TX	802.3u 1995	<b>4B5B MLT-3</b> coded signaling, Category 5 cable copper cabling with two twisted pairs.
1000	100	1000BASE-T	802.3ab 1999	<b>PAM-5</b> coded signaling. At least Category 5 cable with four twisted pairs copper cabling. Category 5 cable has since been deprecated and new installations use Category 5e. Each pair is used in both directions simultaneously.
10 000	100	10GBASE-T	802.3an 2006	<b>THP PAM-16</b> coding. Uses <i>category 6a</i> cable.
40 000	≥30	40GBASE-T	802.3bq <sup>[5]</sup>	under development, uses encoding from 10GBASE-T on proposed <i>Cat 8.1/8.2</i> shielded cable

- [http://en.wikipedia.org/wiki/Ethernet\\_over\\_twisted\\_pair](http://en.wikipedia.org/wiki/Ethernet_over_twisted_pair)

# Transmission Media

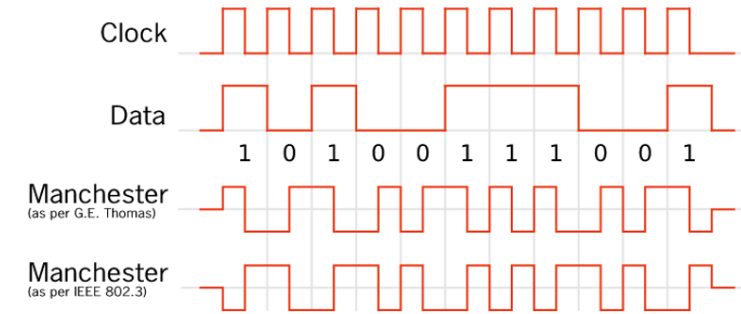
## High Speed Digital service (LAN)

### ■ Wired Transmission

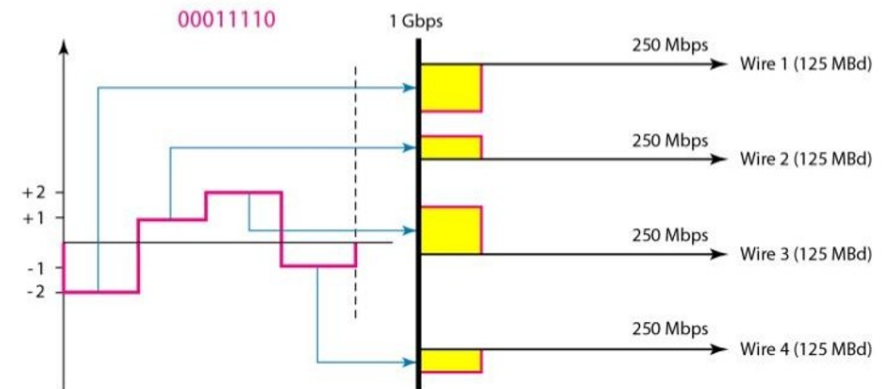


Twisted Pair

### IEEE 802.3 (10BaseT-10Mbps)



### IEEE 802.3 (1000BaseT-1Gbps)

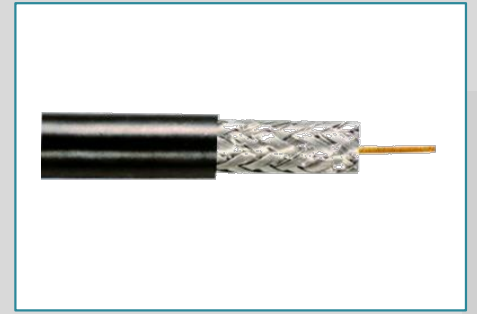
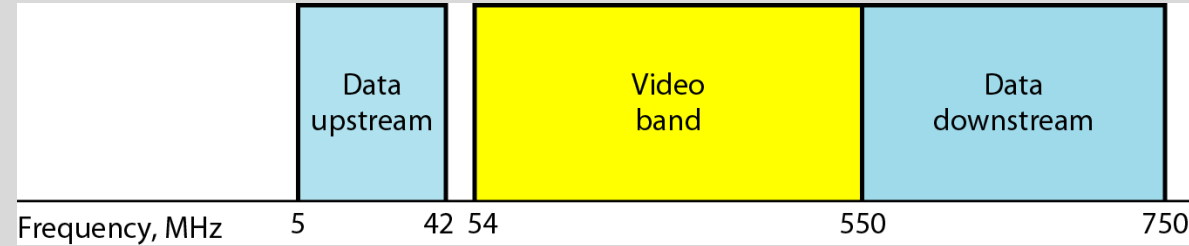




# Transmission Media

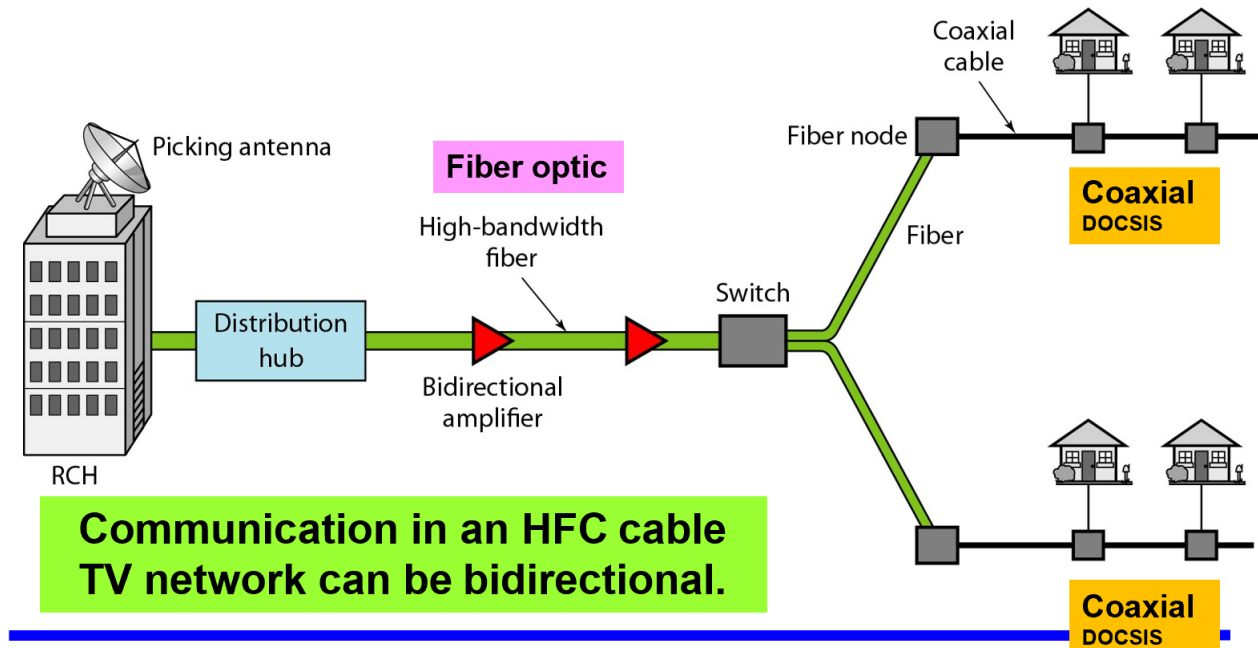
## High Speed Digital service (Cable TV / DOCSIS)

### ■ Wired Transmission



Coaxial cable

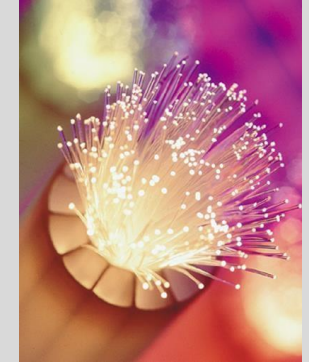
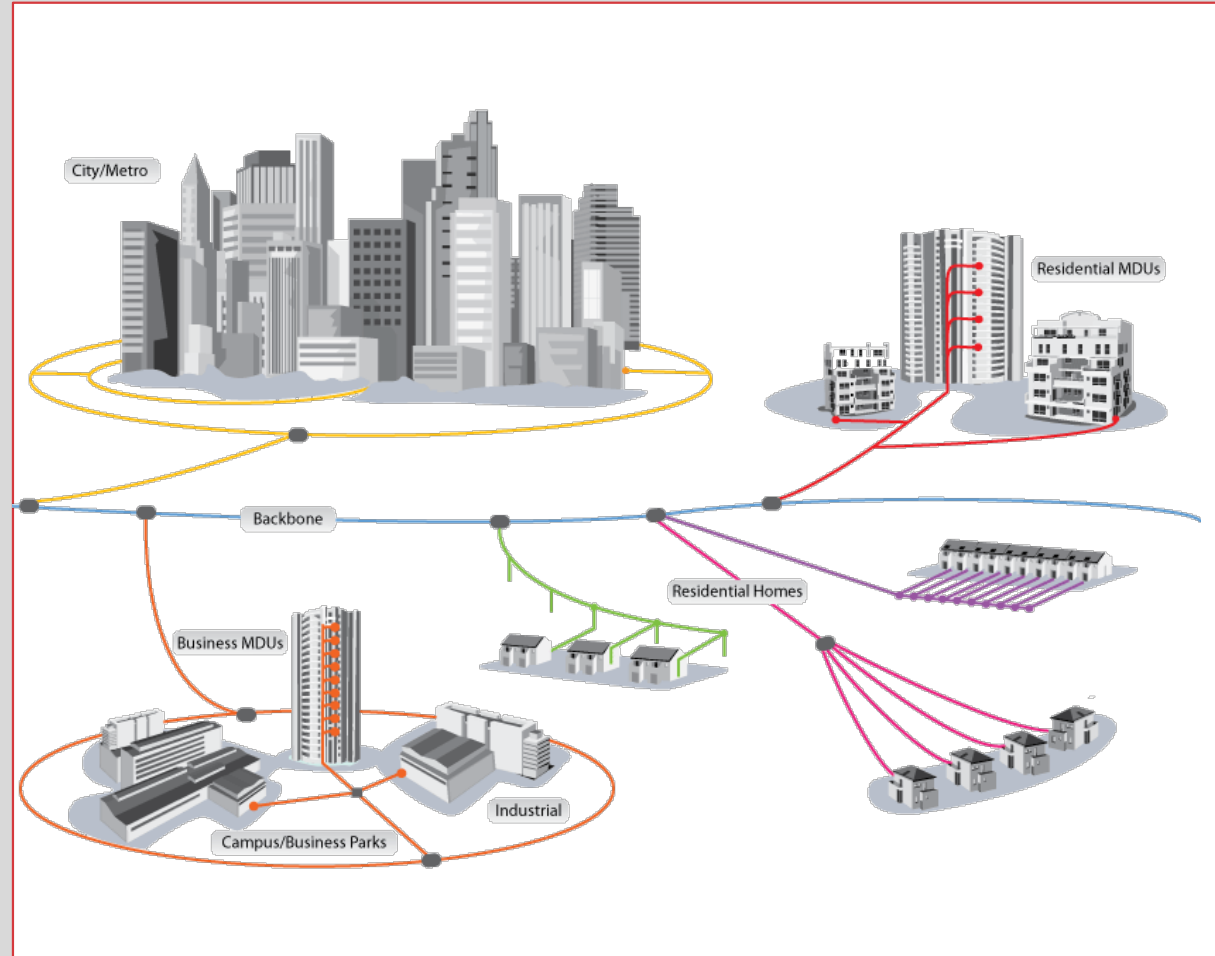
**Figure 9.15** Hybrid fiber-coaxial (HFC) network



# Transmission Media

## High Speed Digital service (FTTx)

### ■ Wired Transmission



Optical Fiber



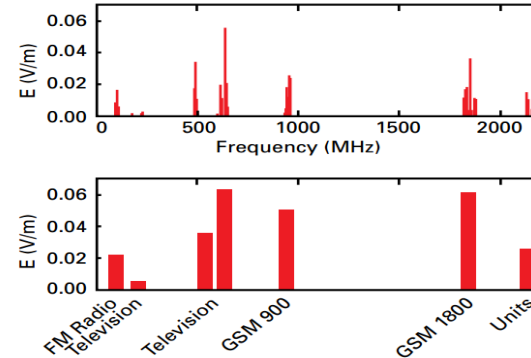
# Wireless Transmission

# Transmission Media Choices

(Frequency Utilization Allocation)

## Wireless Transmission

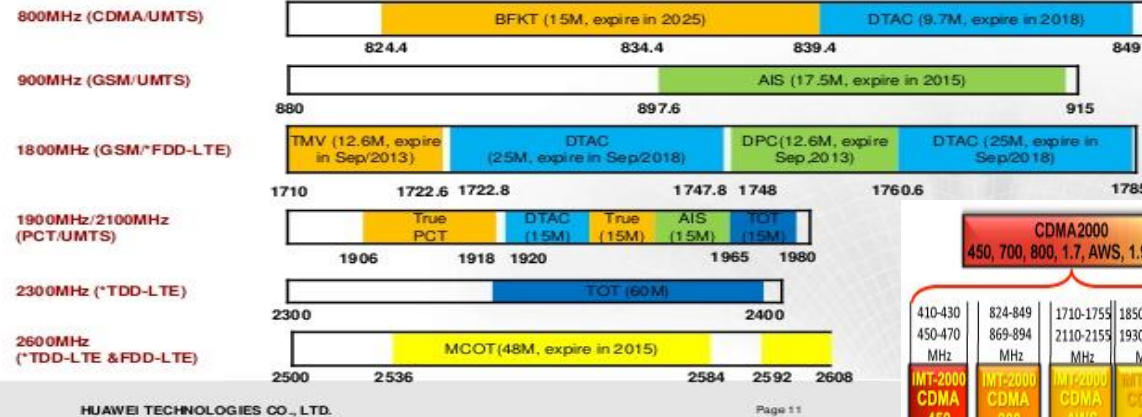
**Figure 2.** Spectrum plot of typical radio communications signal levels in a community.



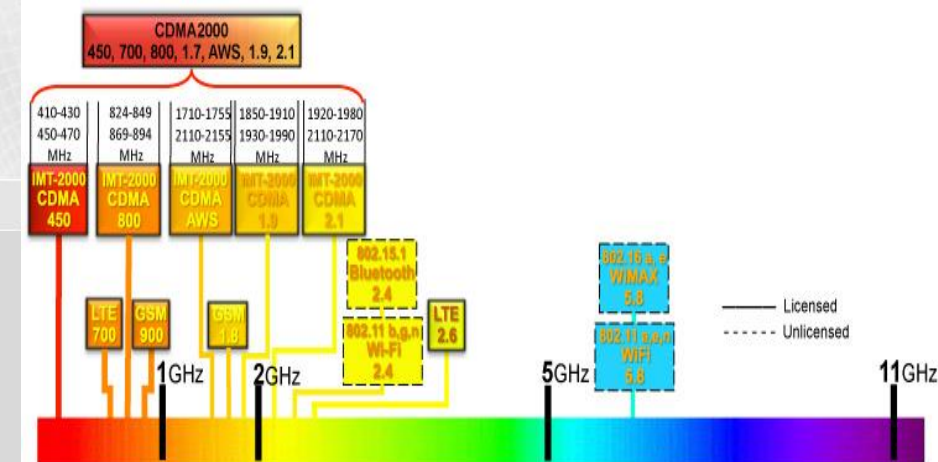
L-band (1.4 – 1.6 GHz)	Mobile Satellite Service (MSS) - Narrowband Voice and Data
S-band (2.2 – 2.6 GHz)	Digital Audio Radio Service (DARS)
C-band (4 - 7 GHz)	Fixed Satellite Service (FSS) – Shared with Terrestrial
X-band (8 - 10 GHz)	FSS – Government Exclusive Use
Ku-band (11.7 – 14.5 GHz)	FSS – Broadband Services, Not Shared with Terrestrial
Ku-band (12.2 – 18.8 GHz)	Broadcasting Satellite Service (BSS) DTH Television
Ka-band (20 - 30 GHz)	FSS – Broadband Services. Not Shared with

Frequency, GHz

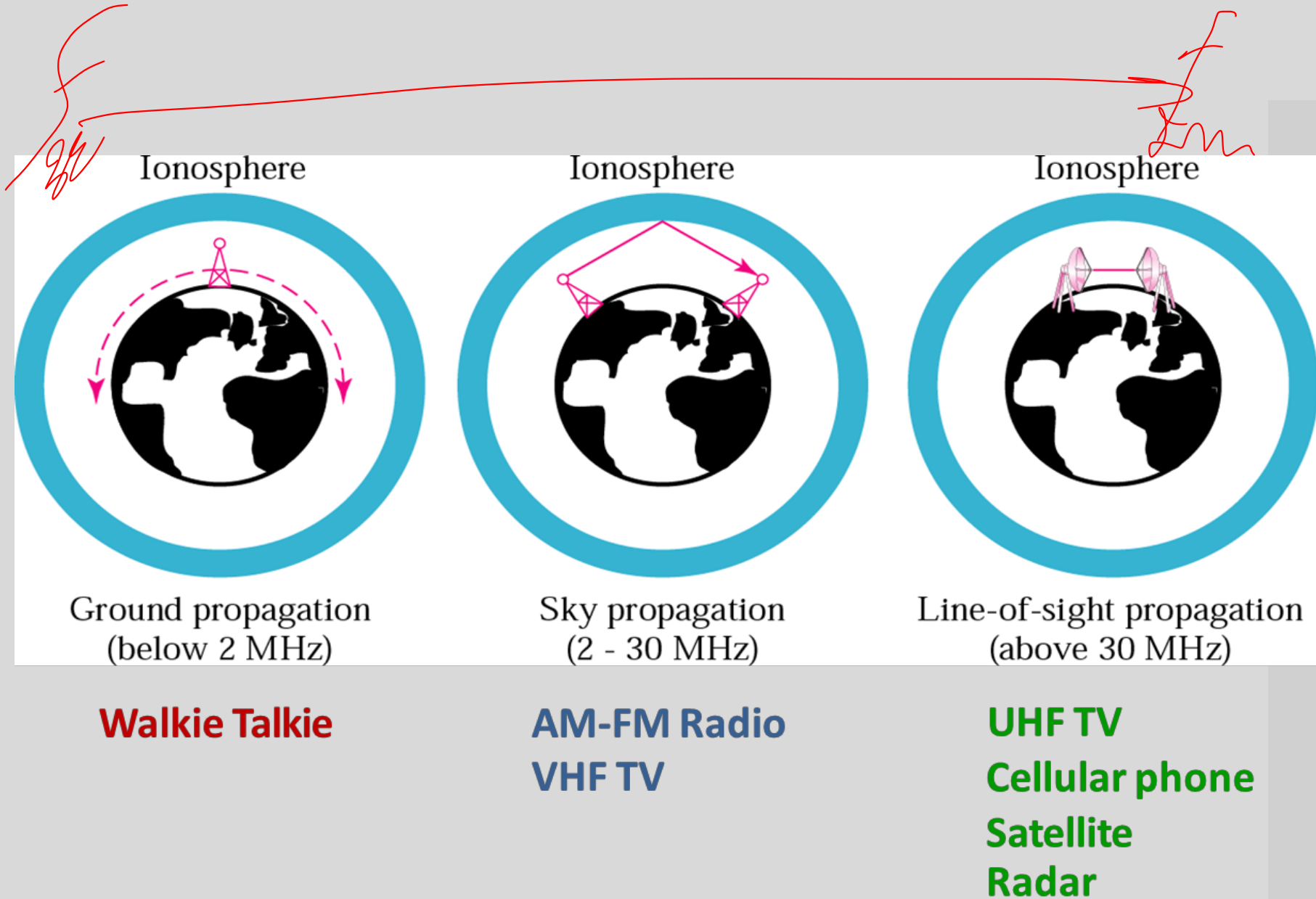
### Thailand Spectrum Allocation



- Digital TV (UHF)
  - Freq. 470-698MHz
- Infrared
  - 100GHz – 1,000 THz

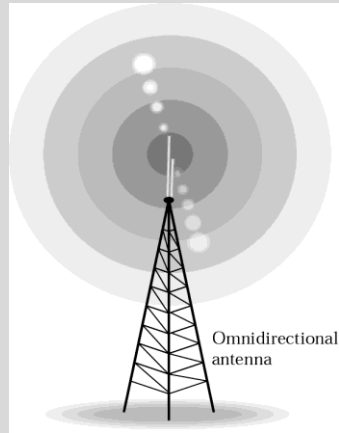


# Transmission Media (Wireless Propagation)

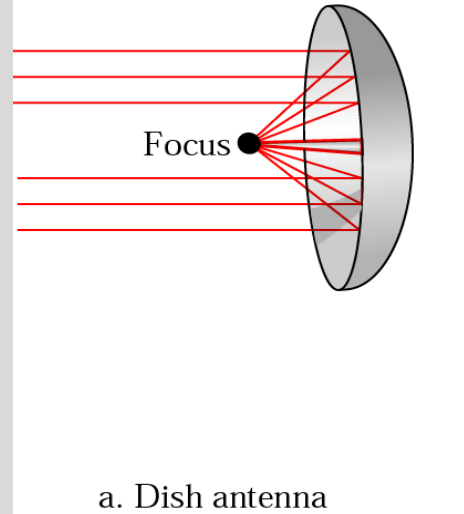


# Transmission Media **Antenna**

- Wired Transmission
  - Antenna
    - Distance & Area limit depending on
      - Antenna Gain (dBi) and Beaming degree



***Omnidirectional antennas***



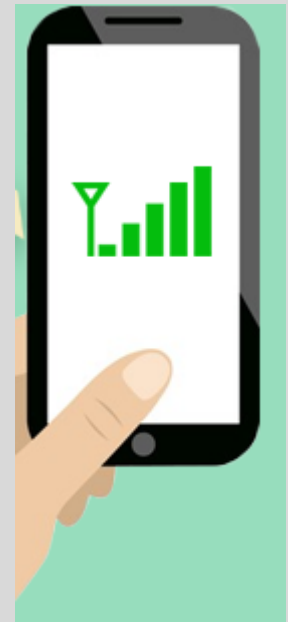
***Unidirectional antennas***



***Sector Beaming antennas***

# Mobile: 3G/4G

Transmission  
Media  
**Choices**



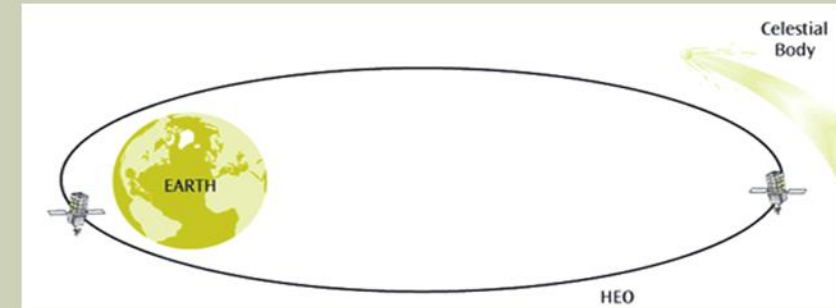


# Transmission Media Choices

## Terrestrial Microwave



## Satellite Microwave





# Transmission Media Choice

# Bluetooth



# Transmission Media Choices



## Infrared Transmission

Infrared signals can be used for **short-range** communication in a closed area using **line-of-sight** propagation.



# ACTIVITY #13

- ให้ออกแบบและคำนวณค่าใช้จ่ายในการจัดสร้างเครือข่าย
- เงื่อนไขคือ
  - เชื่อมต่อคอมพิวเตอร์ 3 แผนก แผนกละ 10 เครื่อง
  - ระยะทางระหว่างแผนกที่ 1&2 80 m
  - ระยะทางระหว่างแผนกที่ 1&3 300 m
  - ระยะทางระหว่างแผนกที่ 2&3 280 m
- เงื่อนไขสายส่งสัญญาณที่ใช้
  - 1. ใช้สาย utp
  - 2. ใช้สาย coaxial
  - 3. ใช้สาย fiber
- สิ่งที่ต้องส่ง
  - 1. ภาพวาดผังและการเชื่อมต่ออุปกรณ์
  - 2. คำอธิบาย topology ที่เลือกต่ออุปกรณ์ พร้อมเหตุผลที่เลือก
  - 3. แสดงตารางรายการอุปกรณ์และค่าบริการใดๆที่ต้องใช้ ราคาต่อชิ้น จำนวนที่ต้องใช้ ราคารวมแต่ละอุปกรณ์ ราคารวมทั้งระบบ แบบเดินสาย
  - 4. คำนวณราคาระบบแบบเช่าบริการ เป็นระยะเวลา 5 ปี

กำหนดให้เดินสายไฟฟ้าสำหรับอุปกรณ์เป็นแบบ  
PoE (Power on the Ethernet)

**ทดลองออกแบบระบบเครือข่ายแบบเดินสาย และ แบบเช่าบริการ**

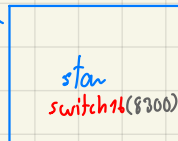
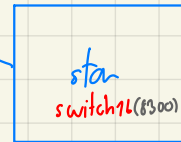
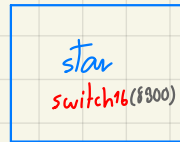
No	รายการอุปกรณ์	ราคาต่อหน่วย	No	รายการอุปกรณ์	ราคาต่อหน่วย
1	Cisco Router 10/100Mbps 4 ports	7,800	9	RJ-45 male connector	10
2	Cisco Router 10/100Mbps 8 ports	9,600	10	RJ-45 female connector	15
3	Cisco Router 10/100Mbps 16 ports	18,000	11	ST male connector	90
4	Linksys Switch 4 ports	2,500	12	ST female connector	120
5	Linksys Switch 8 ports	4,000	13	wireless 2.4 GHz router modem	1,800
6	Linksys Switch 16 ports	8,300	14	wireless 2.4 / 5 GHz router modem	2,500
7	CAT6 UTP (ราคาต่อเมตร)	8	15	Optical Router 4 ports	8,000
8	Single mode cable (ราคาต่อเมตร)	35	16	RJ-45-to-ST transceiver	2,000

# ค่าเช่าบริการ Internet

ความเร็ว (Download / Upload)	ค่าบริการรายเดือน FTTx (บาท)
20M / 7M	590
50M / 10M	790
100M / 10M	1100
200M / 50M	1400

02210 → rj male 10 x 10 = 100  
rj female 10 x 15 = 150

02210 → rj male 10 x 10 = 100  
rj female 10 x 15 = 150



02210 → rj male 10 x 10 = 100  
rj female 10 x 15 = 150

mesh