Wireless Data

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Outline

- Markets and applications
- Paging networks
- Mobile data networks
- Data over cellular
- Data over 2.5G and 3G wireless
- Wireless LANs
- Future directions

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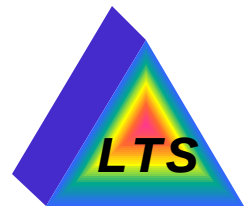
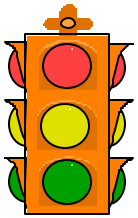
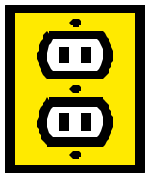


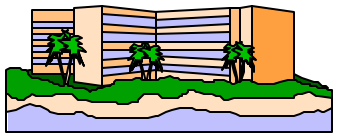
Mobile Data Applications



Traffic control/
messaging



Utility metering

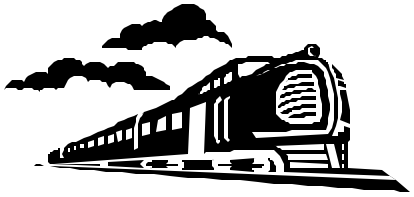


Mobile office

Remote Vending
Machine Control

Wireless Data Network

Alarm monitoring



Train Control

Mobile Fleet
Management
Location Tracking

Credit card
Verification

Wireless messaging
Financial Transactions

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Wireless Data Market

- Vertical services
  - Field service and sale
  - Package delivery services
  - Dispatch fleet management
  - Point-of-sale services
  - Public safety
- Horizontal services
  - Fax
  - E-mail
  - Data base access
  - Virtual office
  - Driven by the availability of laptop/palmtop computers/PDAs

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Wireless Data Networks

- Paging networks
  - One-way numeric and alphanumeric messages
- Mobile data networks
  - Two-way store and forward messaging and data
- Analog and 2G digital cellular networks
  - Low-speed data
- 2.5 G cellular networks
  - Low-to-medium speed data
- 3G cellular networks
  - Medium speed-data
- Wireless LANs
  - High-speed data
- Satellite Networks
  - Global or Wide area coverage

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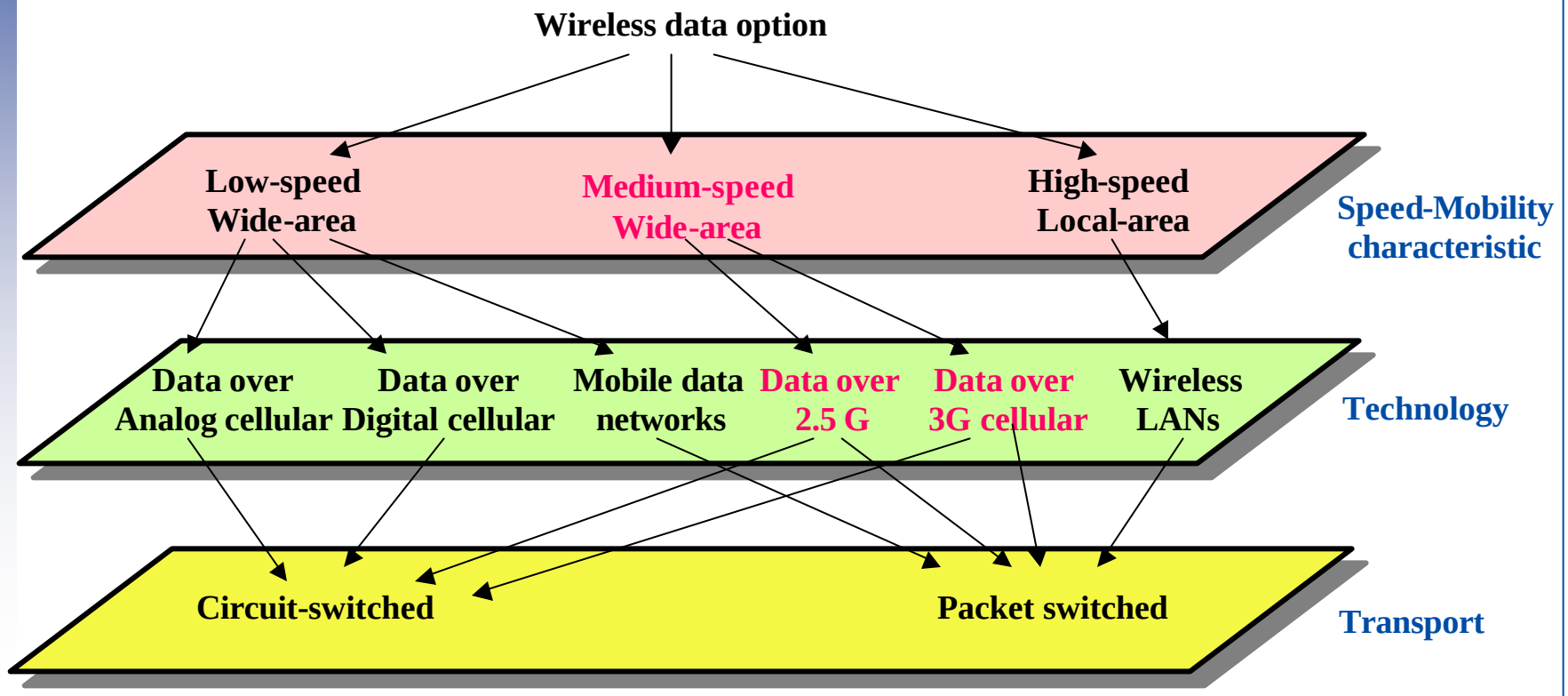
Wireless Data – Speed/Technology/Transport



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Paging

- Low cost service
- Small, lightweight terminals
- Excellent coverage
  - High transmit power, high antennas
  - One way (in most cases)
- Service
  - Local, Regional, Nationwide, Even international
- Limited messaging capabilities
  - Began as a “one-bit” messaging system
  - Numeric to ASCII alphanumeric messages (512 b/s - 2400 b/s)
  - Does not support computer data
- Delay - several seconds

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Paging - Evolution

- Higher data rates
- Longer messages
- Computer data
- Sleep mode for long battery life
- Voice paging
- Narrowband PCS
  - 3 MHz spectrum allocated by the FCC (901-902, 930-931 MHz)
  - Advanced messaging services
    - 2-way messaging
    - Email, Fax
    - Transfer of computer data
    - Voice paging

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Mobile Data Networks

- General characteristics
  - Two-way capabilities
    - Originate and receive messages
    - Interactive applications
    - Confirmation of messages (acknowledgment, retransmission)
  - Packet transport
  - Store and forward
  - Automatic delivery
    - Store if user cannot be reached
    - Alert the user when message is delivered
  - Lower transmit power
    - Less penetration compared to paging
    - More base stations required
- Examples
  - Mobitex (RAM), ARDIS, CDPD

Mobitex

- Developed by Swedish Telecom
  - Continued development by Ericsson Mobile Communications
- In operation in Sweden, Norway, Finland, Canada, UK, etc
- Introduced in the US by RAM Mobile Data
  - Covers over 90% of US's urban business population
  - Automatic seamless roaming
- Supports TCP/IP, X.25
- System description
  - Cellular layout
  - 12.5 KHz channel
  - 8 kbps data rate
  - 935-940 MHz downlink, 896-901 MHz uplink (in the US and Canada, 450 MHz most other countries)
- Capacity to support millions of users
- Other features
  - Switching occurs at the lowest level
  - Multicasting

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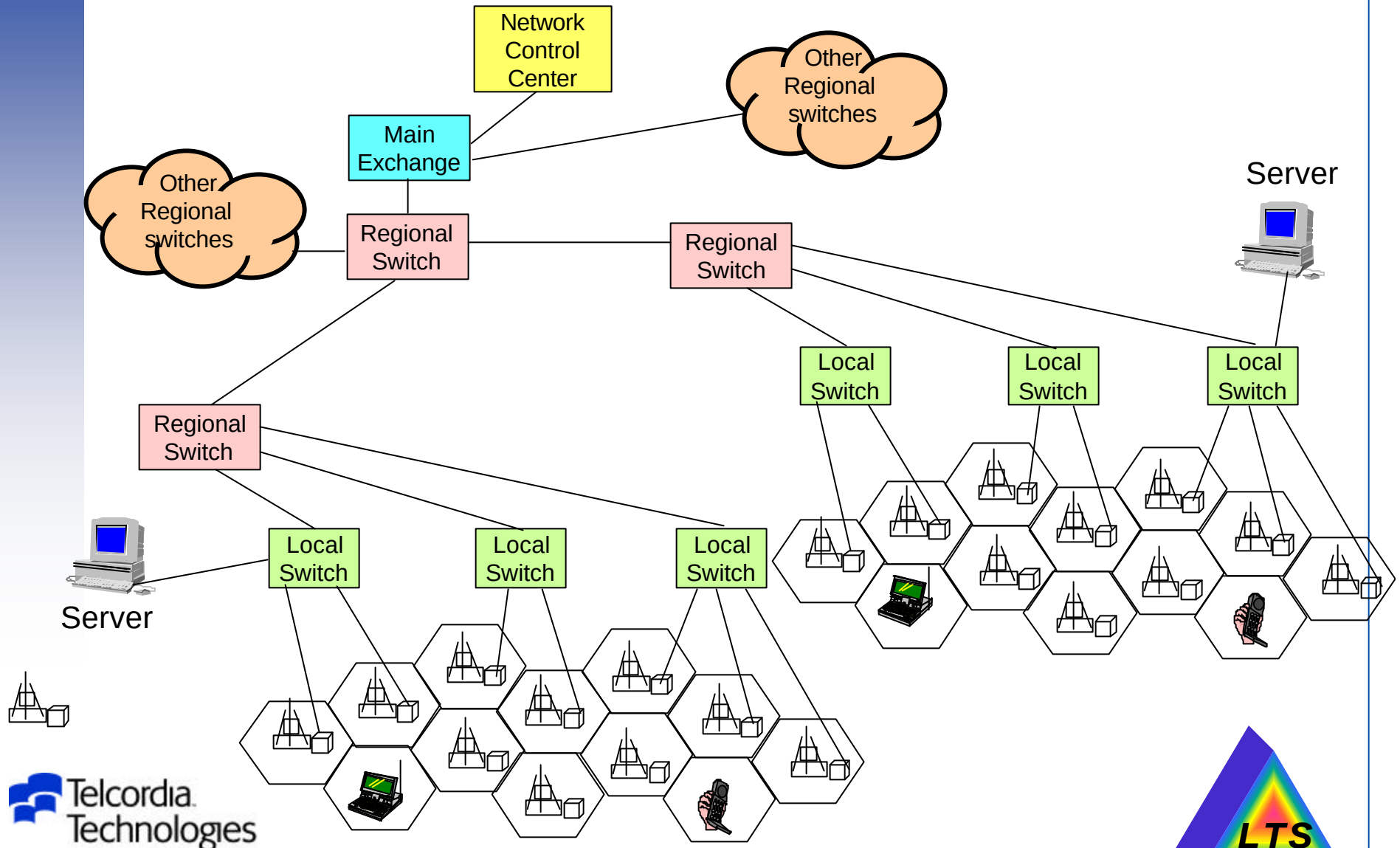
Mobitex Architecture



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Advanced Radio Data Information Service (ARDIS)

- Joint venture between IBM and Motorola
  - Acquired by American Mobile Satellite Corporation in 1998
- Introduced to serve IBM field engineers
- Operating frequency - 800 MHz
- Raw rates 4.8 kb/s, 19.2 kb/s in some markets
- High overhead and contention reduce the throughput
- Not suitable for interactive applications (latency)
- Targeted for vertical markets
- Coverage
  - Over 10,000 cities in 50 states in the US, Puerto Rico, US Virgin Islands
  - Serves 90% of the business centers

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Cellular Digital Packet Data (CDPD)

- Introduced by IBM as a packet switching overlay to AMPS
- Creates a standard by a consortium of cellular carriers
- Designed to take advantage of idle voice channels in AMPS
- Short packets sent in idle voice channels
  - Voice always higher priority
  - Hops among available cellular frequencies
- Raw data rates of 19.2 kb/s
- Mobility management follows Mobile-IP model
- Shares the cellular infrastructure
  - Only towers and frequencies
  - Different radio technologies and protocols
  - Different network switching equipment

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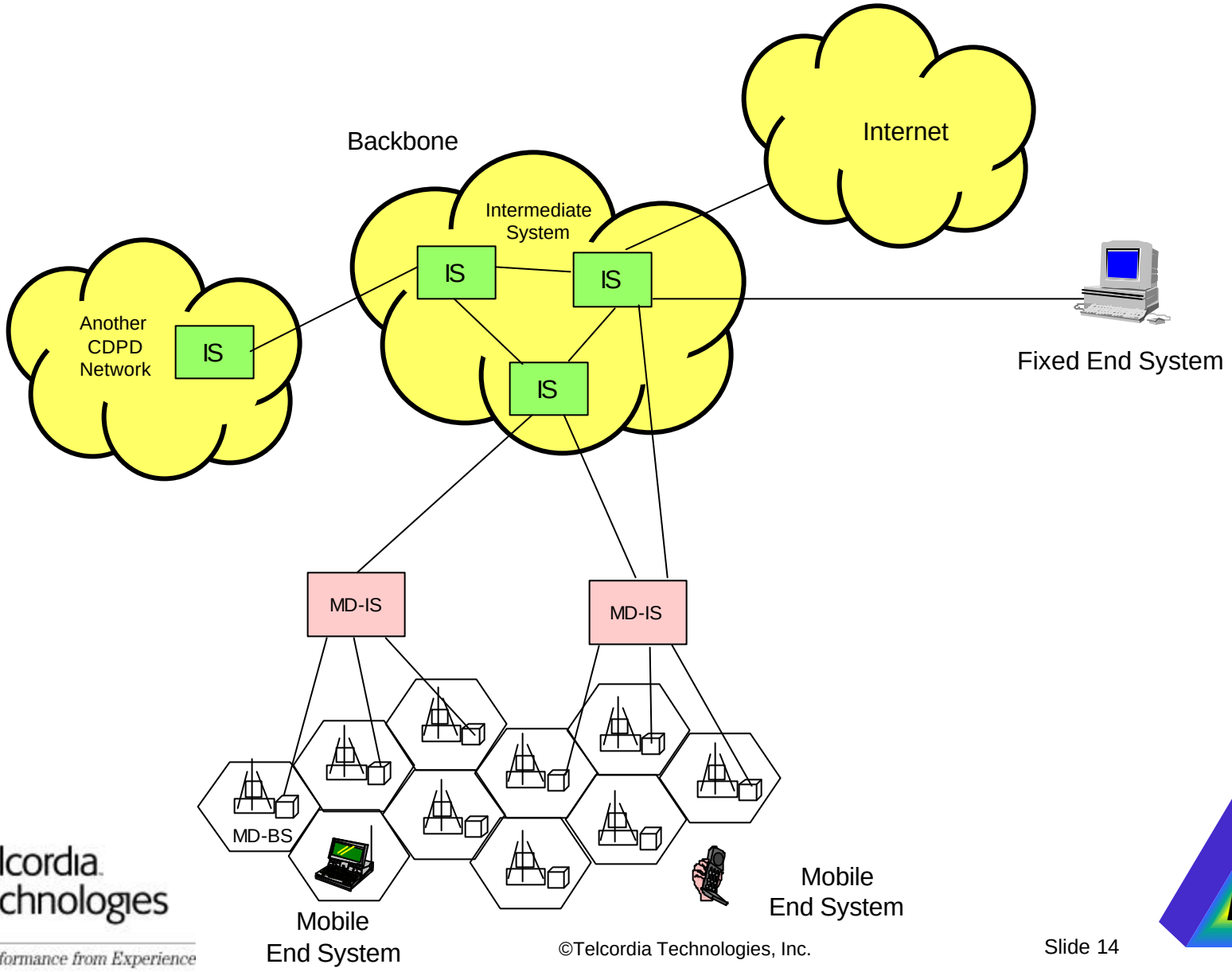
CDPD Network Architecture



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CDPD

- Pros
  - Widespread coverage
  - Suitable for bursty data
  - Broad industry support - standard
  - May be able to use same handset
  - Support of Internet and OSI protocols
- Cons
  - Delay
    - Not suitable for interactive applications
  - Effective throughput is lower
  - Slower than expected growth
  - May lose out as 2.5 G and 3G cellular with packet data capability expands

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Data Over Analog and 2G Cellular Systems

- Analog cellular
  - Low-speed data using special voiceband modems
- 2 G digital cellular
  - Direct digital data
    - No voiceband data support
  - Requires interworking functions at the network
    - Converts the radio-specific protocols to wireline protocols
  - All of them provide short message service
  - EIA/TIA-136
    - Up to 9.6 kb/s on one timeslot
  - EIA/TIA-95
    - Data rate up to 14.4 kb/s
  - GSM
    - Data rates up to 9.6 kb/s

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2.5 G Wireless

- What is missing in 2G?
  - Packet data support
  - Higher speed circuit-switched data
- 2.5 G approaches
  - GPRS overlay for GSM
  - EIA/TIA-136+ with GPRS overlay
  - EIA/TIA-95B

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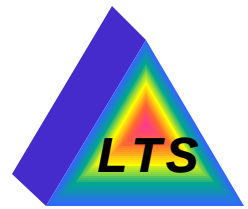
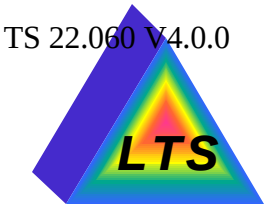


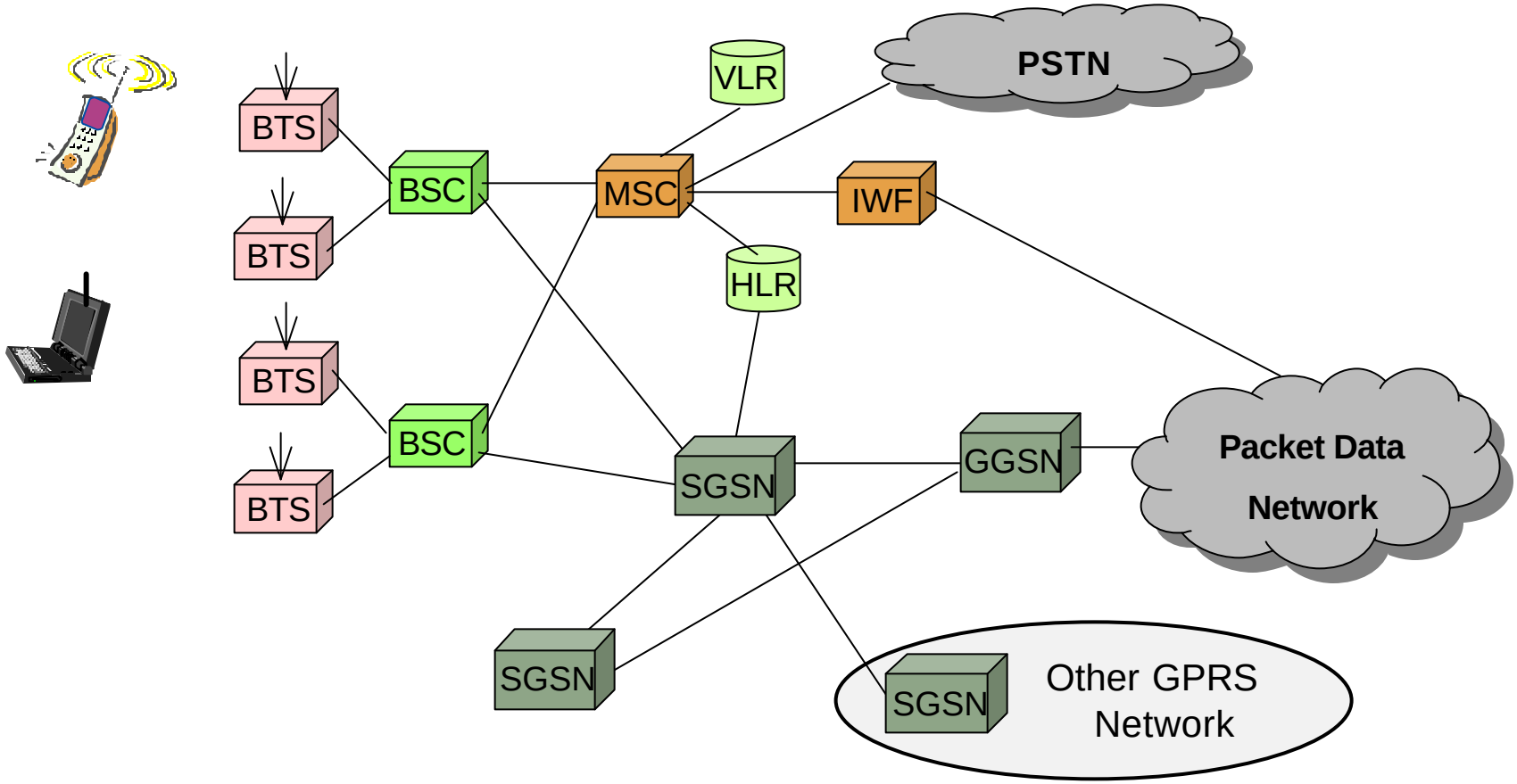
What is GPRS?

- General packet radio service
  - A new packet data service in GSM consisting of packet wireless access network and IP-based backbone
  - Provides an access to packet data networks (PDN)
  - Radio resources shared dynamically between speech and data services
- Allows subscriber to send and receive data in an end-to-end packet transfer mode without using network resources in the circuit-switched mode
- Data rates
  - 43.2 – 115 kbps
- Benefits
  - Users – charging based on traffic volume, not hold time
  - Operators – efficient use of spectrum
- Applications
  - Web surfing, messaging, telnet,
  - News, weather, traffic reports, dispatch services

Ref. 3GPP TS 22.060 V4.0.0



GPRS Logical Architecture



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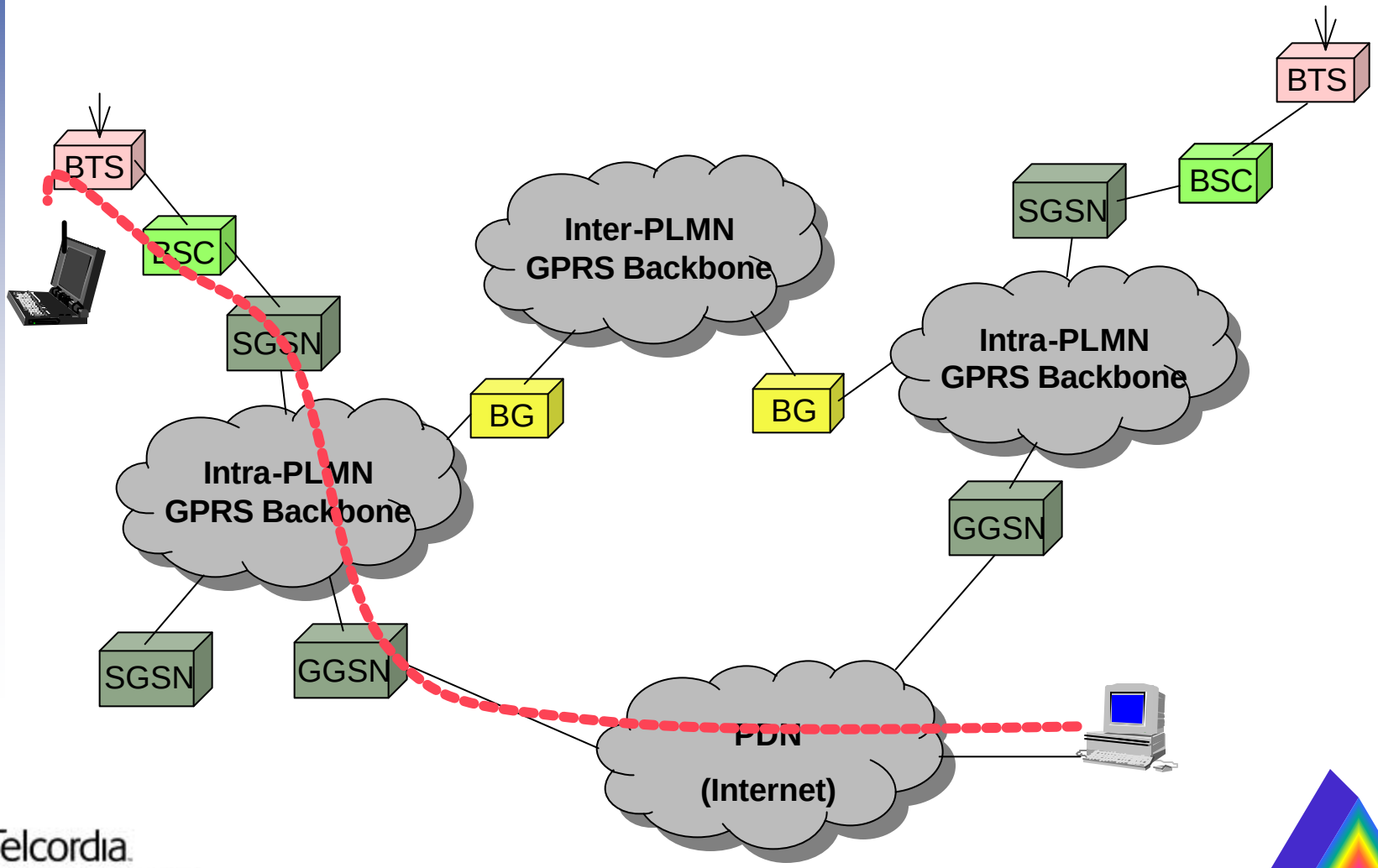
Example of Packet Routing in GPRS



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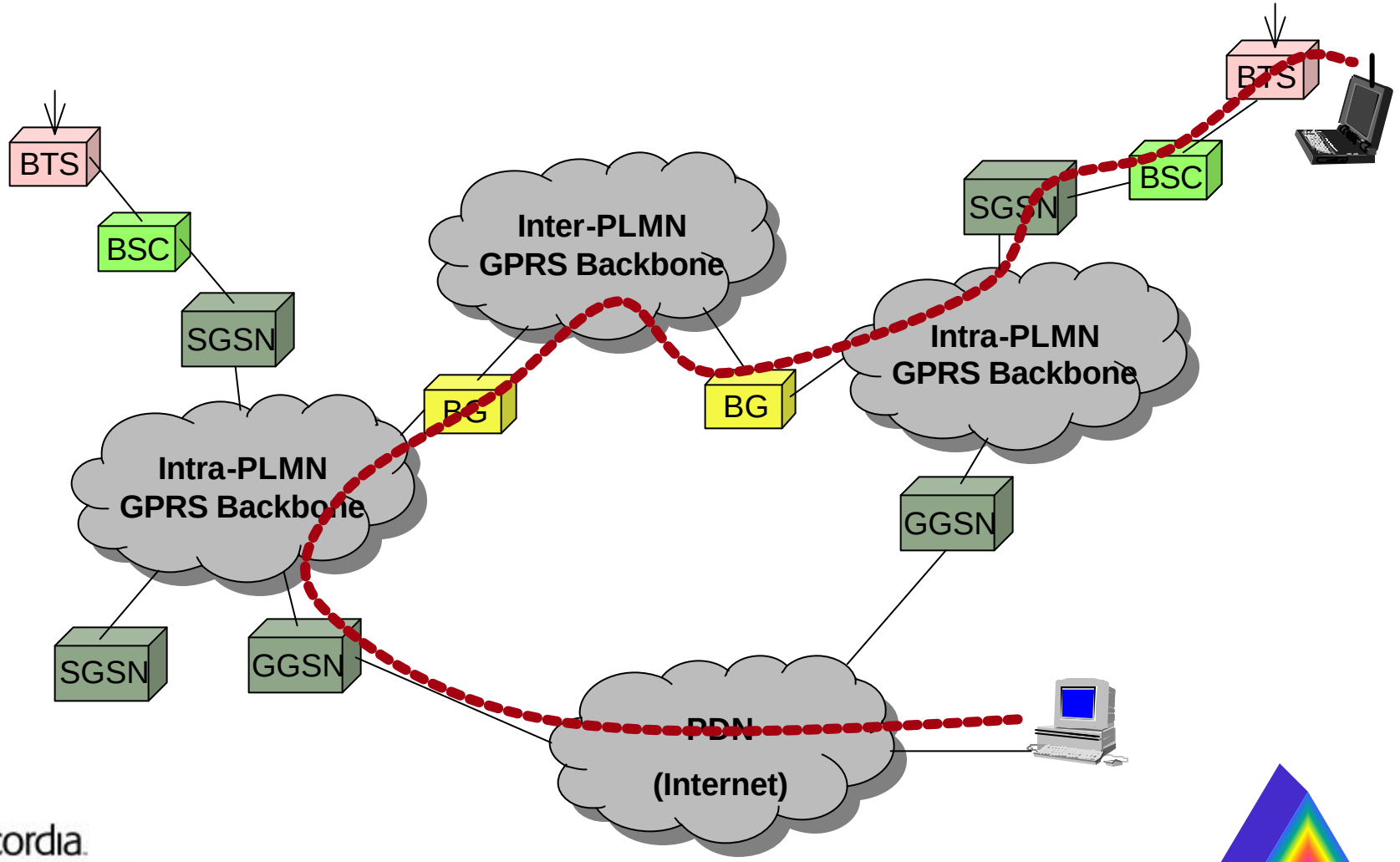
Example of Packet Routing in GPRS



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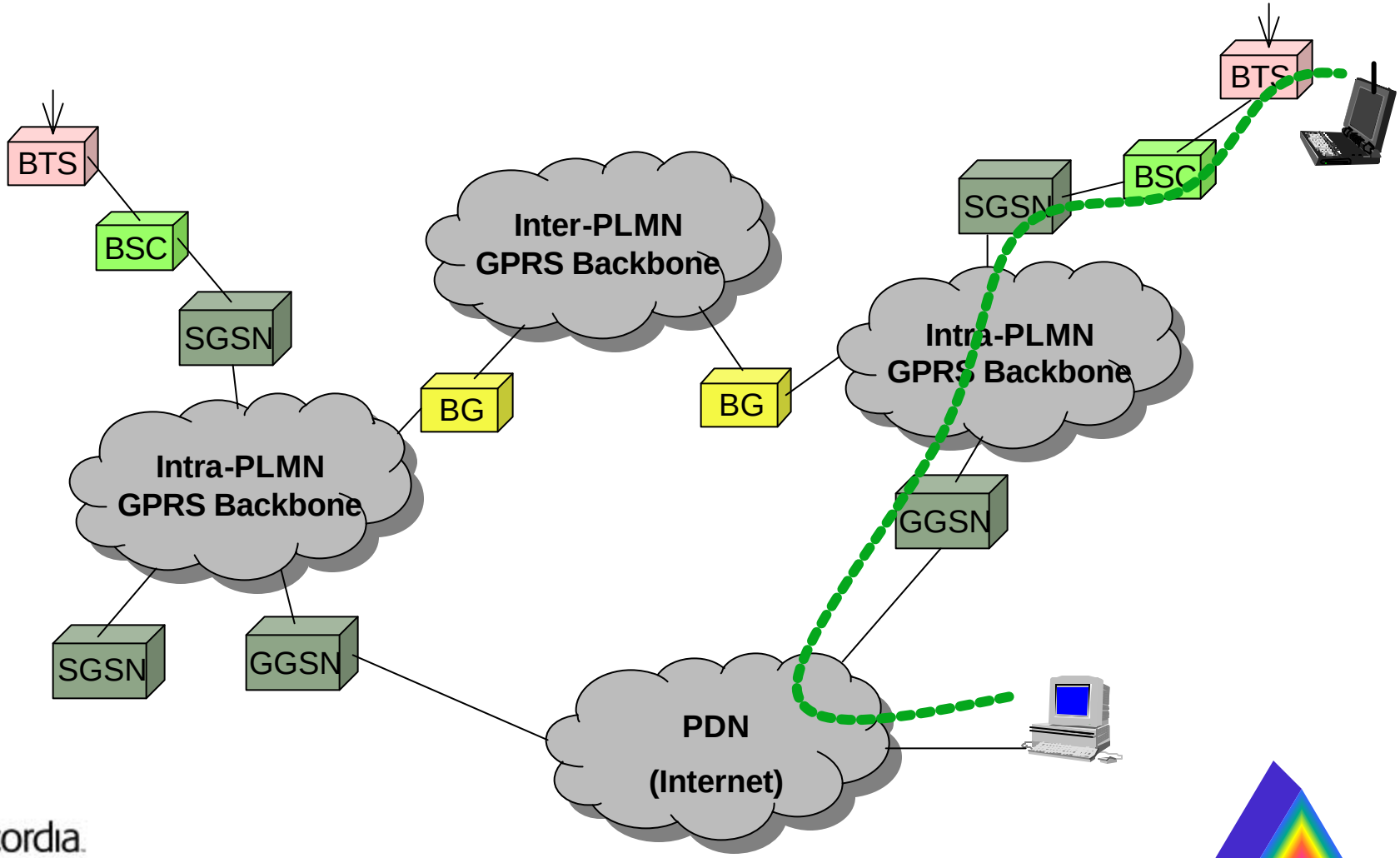
Example of Packet Routing in GPRS



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North American TDMA and CDMA

- EIA/TIA-136+
  - Introduces GPRS overlay
  - Up to 43.2 kb/s
- EIA/TIA-95B
  - Support of multicodes
  - Data rates up to 64 kbps (115.2 kbps also quoted)
- HDR
  - 1.25 MHz channel
  - Peak rate up to 2.4 Mbps forward link and 307 kbps on the reverse link
  - Separate rf channels from low-data rate (voice) services
  - Decentralized architecture based on IP protocols

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3G Wireless

- Collectively known as IMT 2000
- Promise
  - All kinds of information available to anytime, anywhere, to a large population, at a low cost
- Transport requirements
  - Circuit-switched transport
  - Packet-switched transport
- Data rate requirements
  - 144 kb/s at vehicular speed
  - 384 kb/s outdoor to indoor and pedestrian
  - 2 Mb/s indoor
- Systems
  - Universal Mobile Telecommunications Systems (UMTS) or WCDMA
  - CDMA2000

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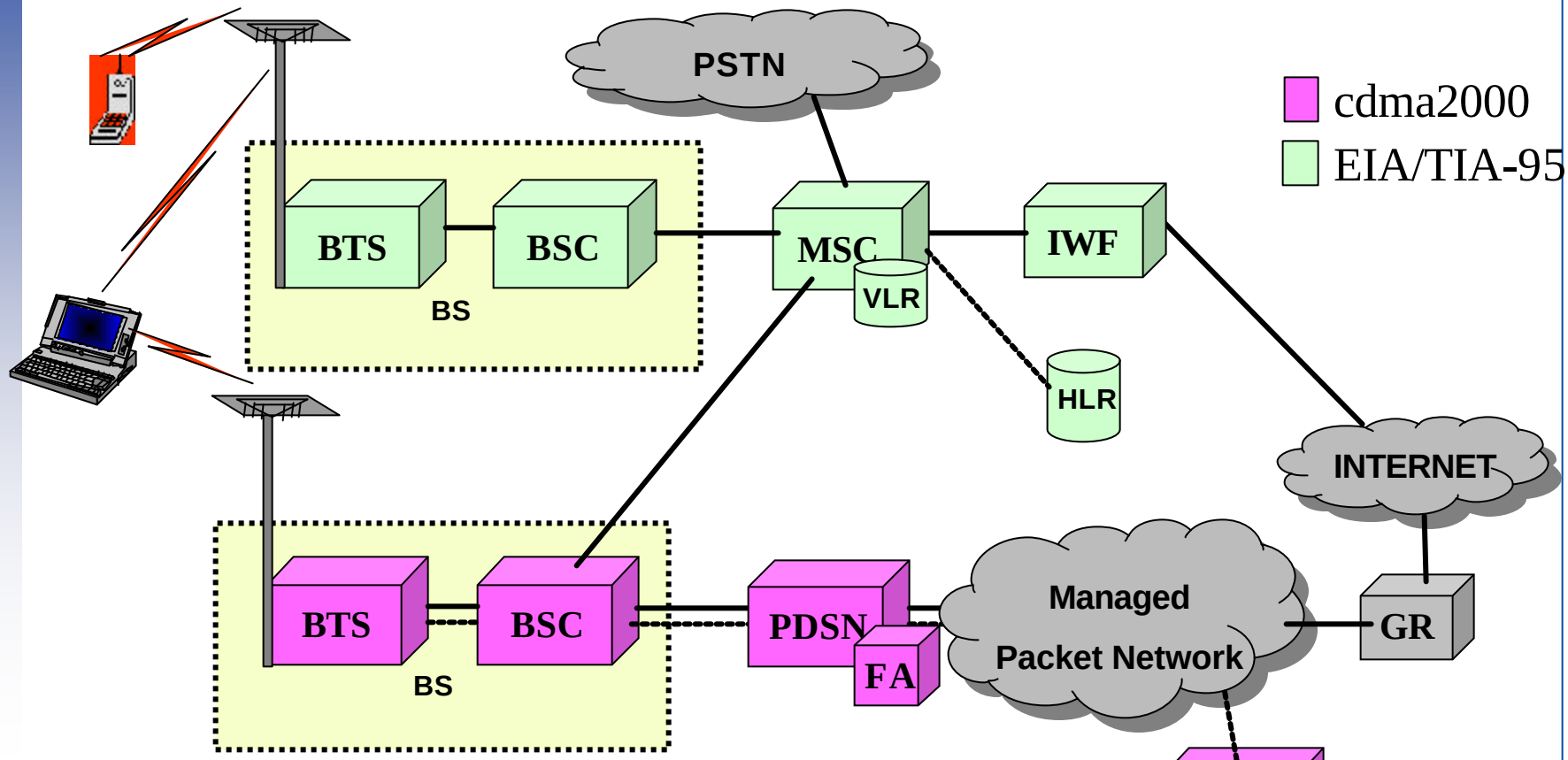
3G Wireless

- UMTS
  - Uses GPRS infrastructure
  - Uses WCDMA air interface
- CDMA2000
  - Uses the packet data model
  - Uses Mobile IP

Cdma2000 Packet Data Architecture



AAA: Authentication, Authorization and Accounting
FA: Foreign Agent
GR: Gateway Router
HA: Home Agent
PDSN: Packet Data Serving Node

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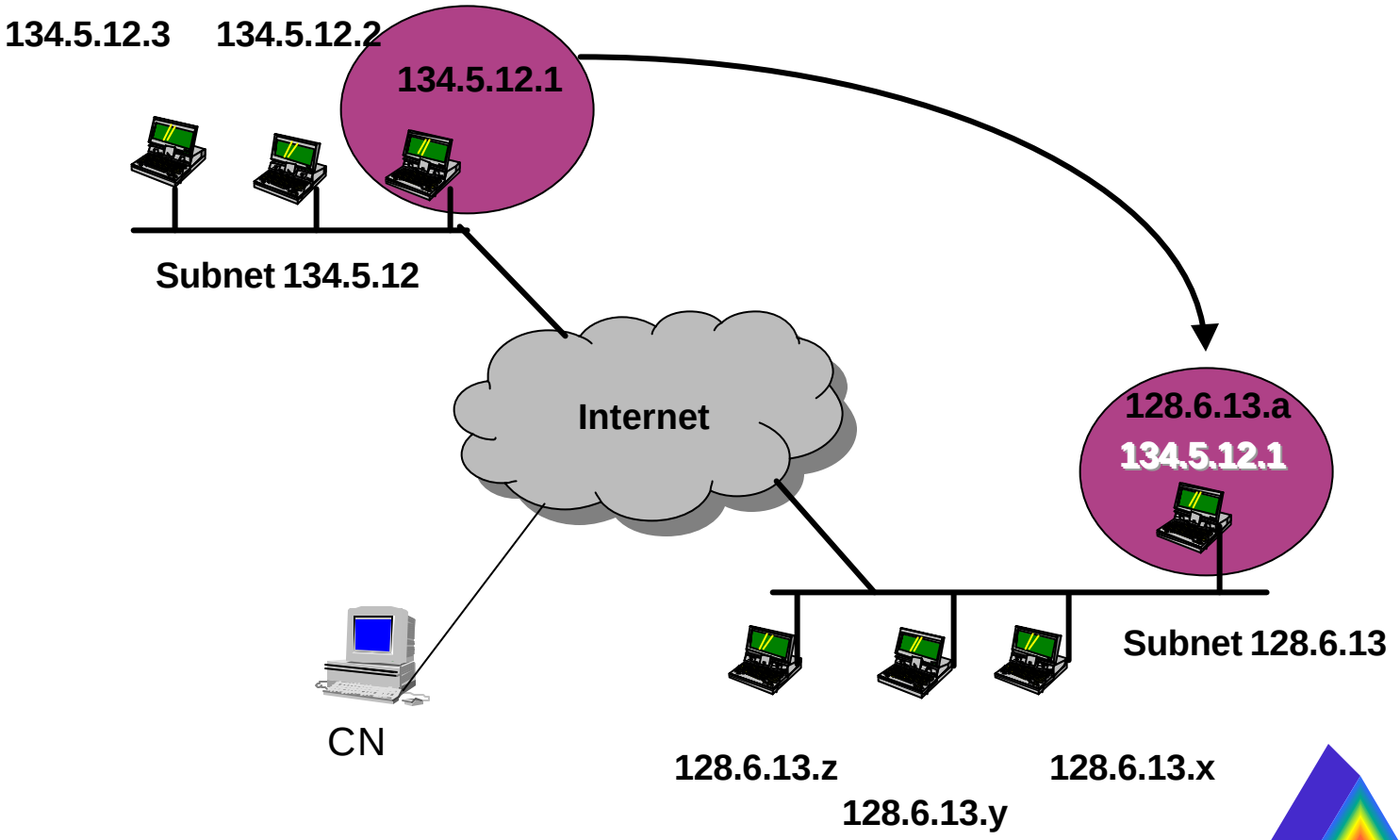
Mobile IP



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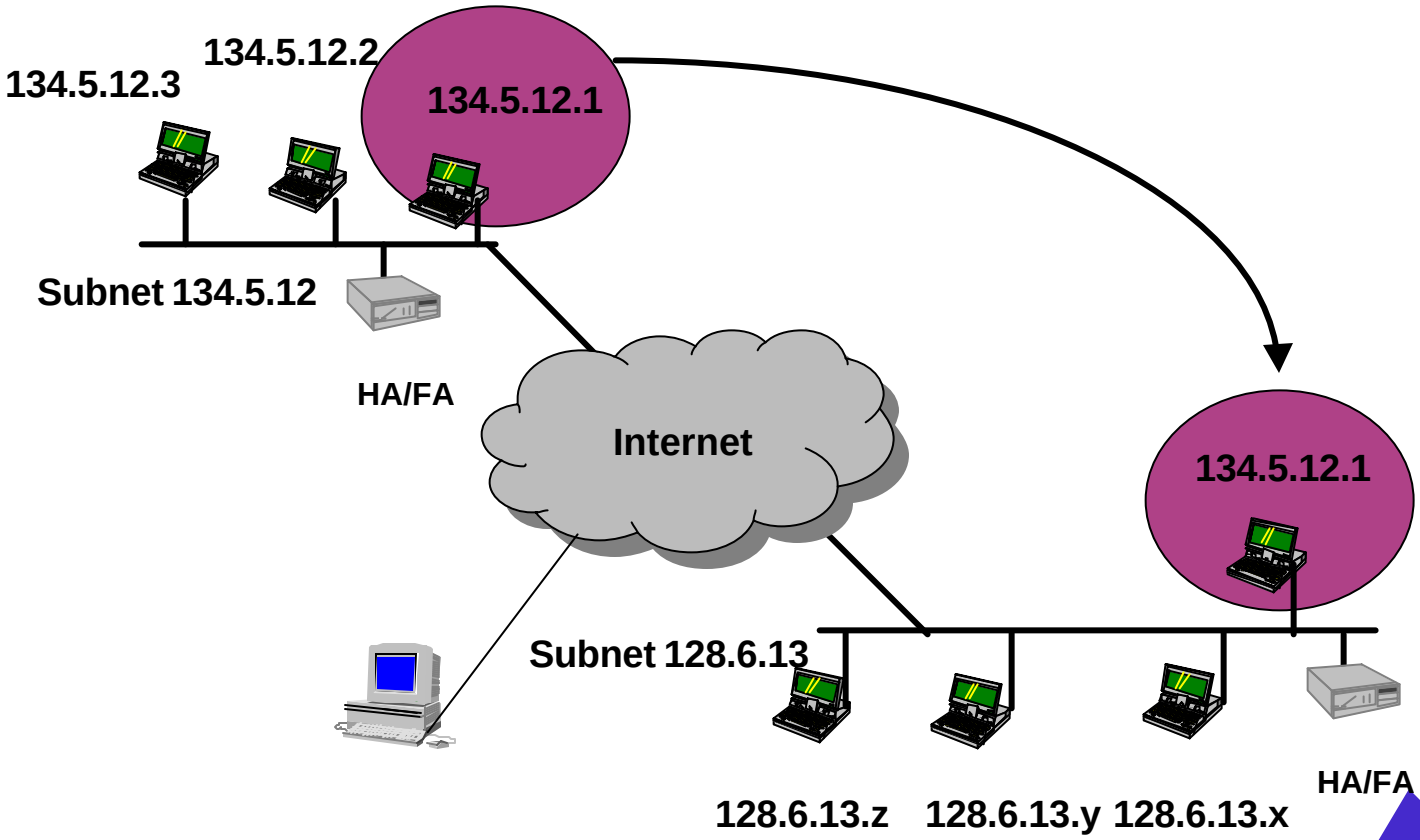
Mobile IP



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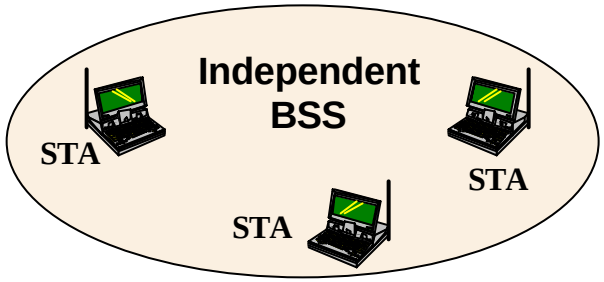
Wireless Local Area Network (WLAN)

- This category includes high-speed short range wireless technologies for home, public access, and enterprise solutions
- Support for roaming subscribers is limited to pedestrian speeds
- Operate in unlicensed (or licensed-exempt) frequency bands over distances of 10's to a few 100's of meters
- Four types of systems in this category
  - IEEE 802.11 systems (802.11, 802.11a, 802.11b, 802.11xx(20 MHz version))
  - ETSI Broadband Radio Access Network (BRAN) High Performance Radio LAN 2 (HIPERLAN/2)
  - Bluetooth
  - IEEE 802.15 Wireless Personal Area Network (WPAN)

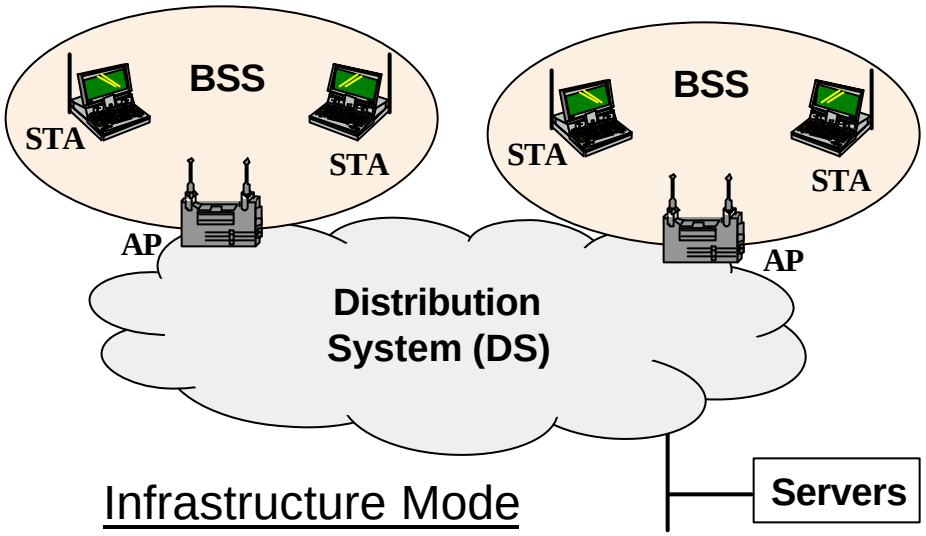
IEEE 802.11 Systems

- 802.11 Network Configurations



Ad Hoc Mode

- One Basic Service Set (BSS)
- No APs
- Direct communications among Stations (STAs)
- Limited coverage



Infrastructure Mode

- Multiple BSS (and APs) connected to form Extended Service Set (ESS)
- STAs can access fixed resources
- Extends wireless coverage
- IAPP to allow interoperability

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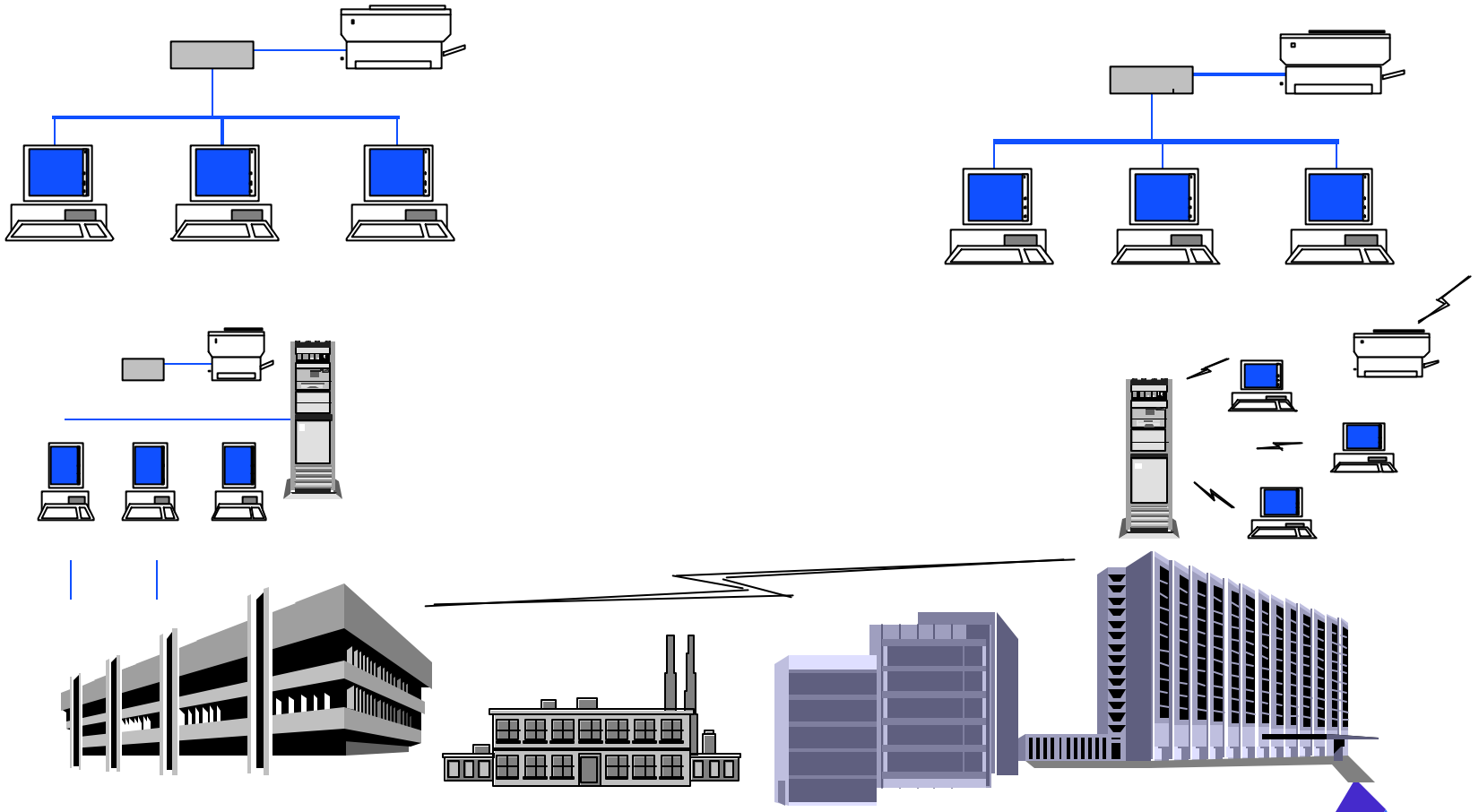
An Example of WLAN Application



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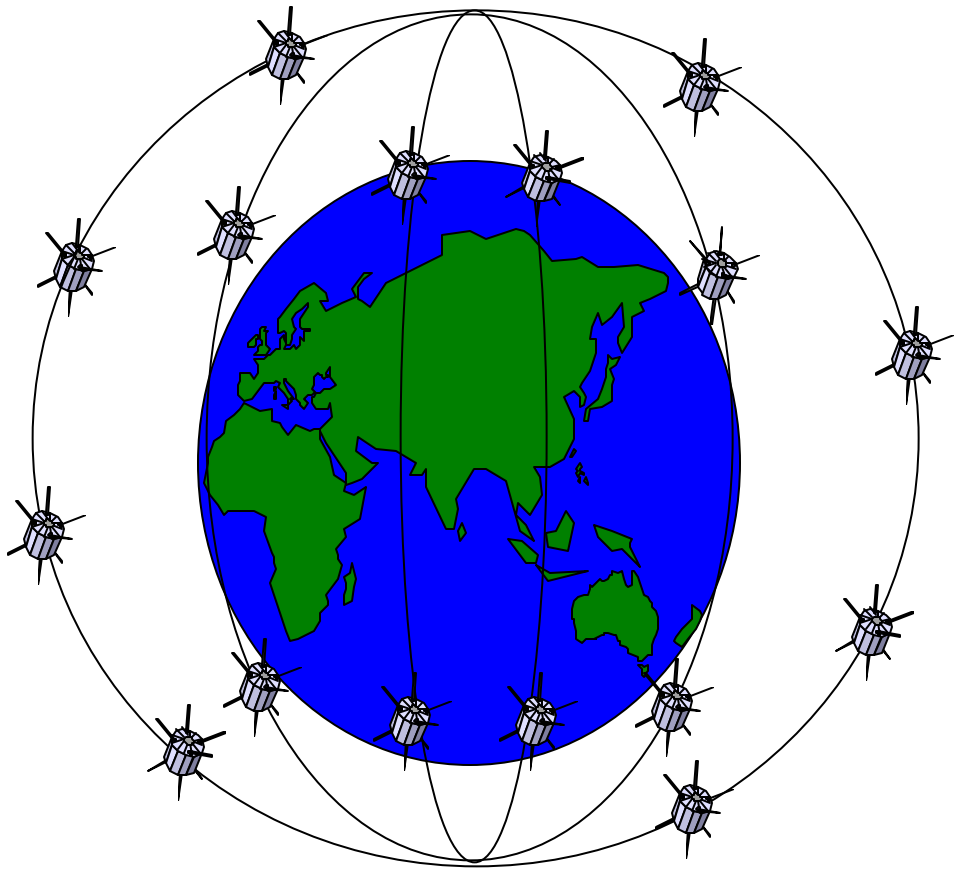
Satellite Networks

GEOs

MEOs



LEOs

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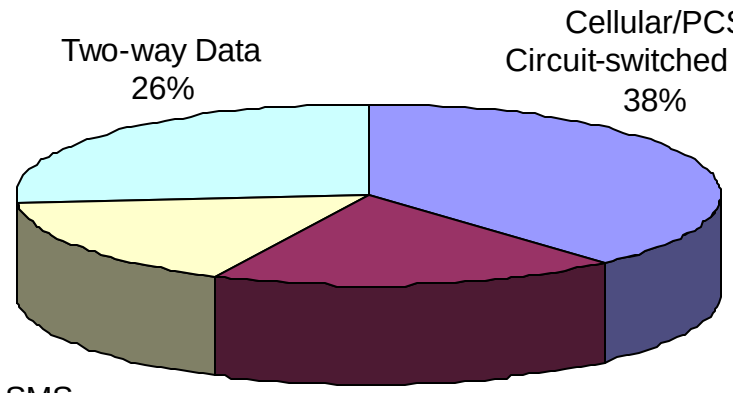
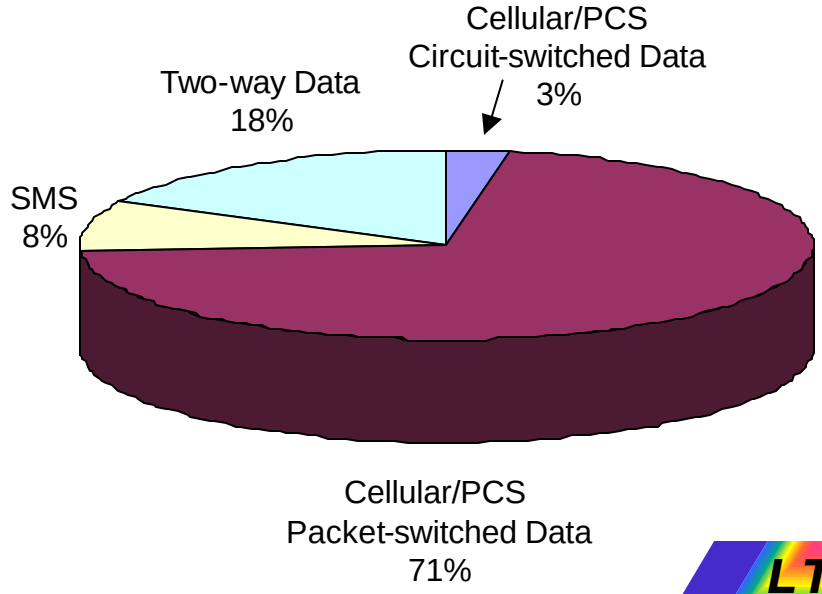
North American Mobile Data Subscriber Market Share in 2000 and Forecast for 2005



2000



2005

Source – Gartner Dataquest (May 2001)

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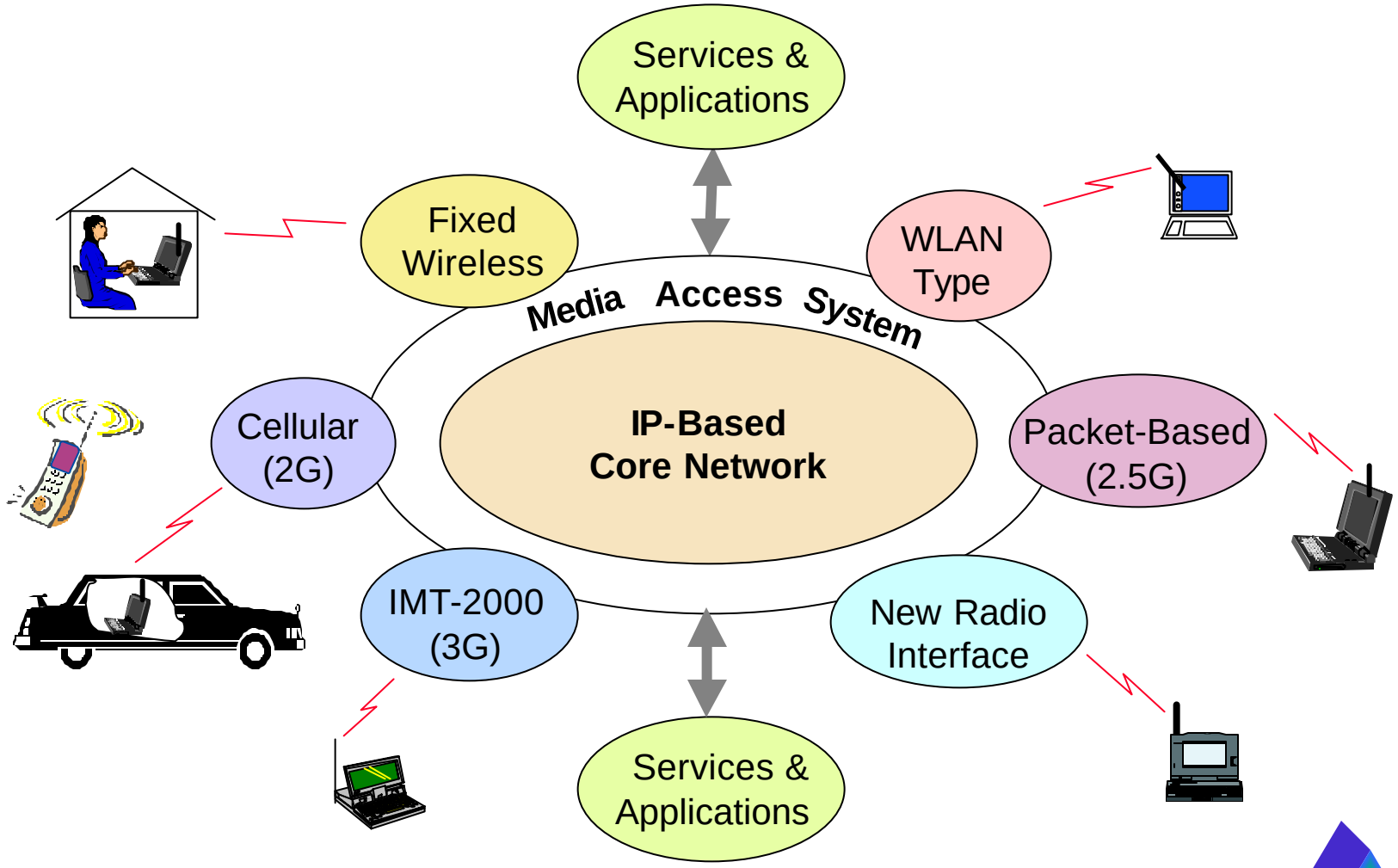
Future Directions



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Summary

- Wireless data networks started to support vertical markets
- Low cost computer terminals and wireless technologies are driving the market for wireless data in horizontal markets
- 2.5 G and 3G cellular networks are capable of providing low to medium-speed data over wide area and high mobility
- WLANs and its derivatives will offer high-speed data in low mobility indoor areas and outdoor areas
- Seamless interworking among various access technologies will provide the best of all worlds
- Future direction seems to be core IP networks supporting different access technologies in a seamless fashion
- Significant growth expected in wireless data subscribers and revenues