

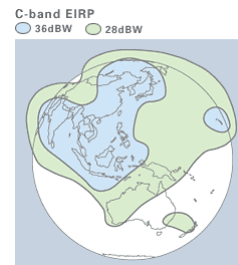
# Introduction to SOI-Asia Network

- AI<sup>3</sup> Project Overview
- SOI-Asia Network Overview
- UDLR Overview (Specification)
- UDLR in SOI-Asia Network (Implementation)
- Requirements for Developing SOI-Asia Network



## Before we go in detail on AI<sup>3</sup> and SOI-Asia Network...

- In general, satellite links have
  - Wide coverage without geographical limitation
  - Broadcast capability
  - Flexibility on link configuration
    - Frequency, information rate, etc...



JCSAT-3 Satellite Footprint  
<http://www.jsat.net/satellite/list.html>

## Earth Station Receive-Only v.s. Transmit-Capable (Original)



	Receive-Only	Transmit-Capable
Cost of building earth station	Cheap	Expensive
Size of earth station system	Small because of simple composition	Large because of many equipments
Transmission license	No need in most countries	Need and difficult to obtain
Radio specialist	No need	Need specialist always standing by

## Earth Station Receive-Only v.s. Transmit-Capable



	Receive-Only	Transmit-Capable
Cost	Reasonable	Expensive
Size	Small	Large
Transmission license	No need in most countries	Need and difficult to obtain
Radio specialist	No need	Need specialist always standing by

# AI<sup>3</sup> Project Overview



## What is AI<sup>3</sup> Project?



- Asian Internet Interconnection Initiatives
  - An international research consortium among research institutes in Asian region
  - Started in 1995
- Objective
  - To form a group of researchers to develop leading edge technologies for the Internet
- Supporting SOI-Asia project from the view point of network infrastructure

## Partners List (original)



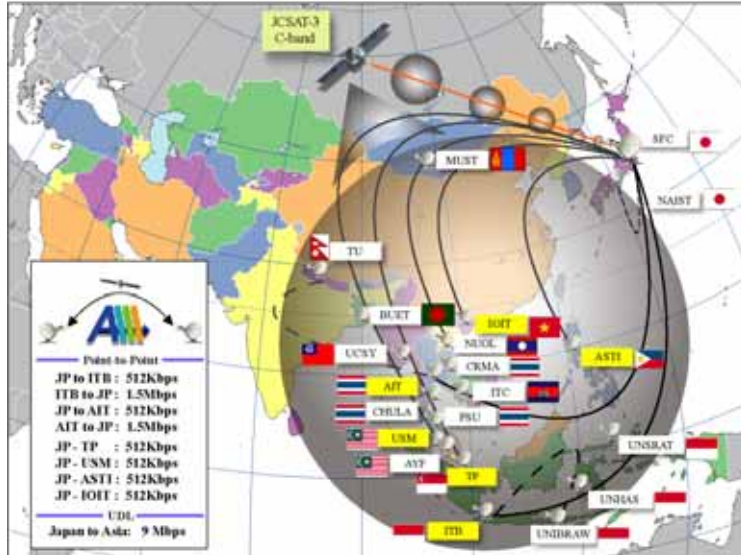
- AI<sup>3</sup> partners  
(Connected by BDL)
  - AIT (Thailand)
  - ITB (Indonesia)
  - TP (Singapore)
  - USM (Malaysia)
  - IOIT (Vietnam)
  - ASTI (Philippines)
  - KEIO (Japan)
  - NAIST (Japan)
- SOI-Asia partners  
(Connected by UDL)
  - 4 from Indonesia
  - 3 from Thailand
  - 1 from Philippines
  - 1 from following countries
    - Malaysia
    - Laos
    - Myanmar
    - Cambodia
    - Bangladesh
    - Mongolia
    - Nepal
- Some AI<sup>3</sup> Partners

## Partners List



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# AI<sup>3</sup> Network in the Map



**Point-to-Point**

JP to ITB : 512Kbps  
 ITB to JP : 1.5Mbps  
 JP to AIT : 512Kbps  
 AIT to JP : 1.5Mbps  
 JP - TP : 512Kbps  
 JP - USM : 512Kbps  
 JP - ASTI : 512Kbps  
 JP - IOIT : 512Kbps

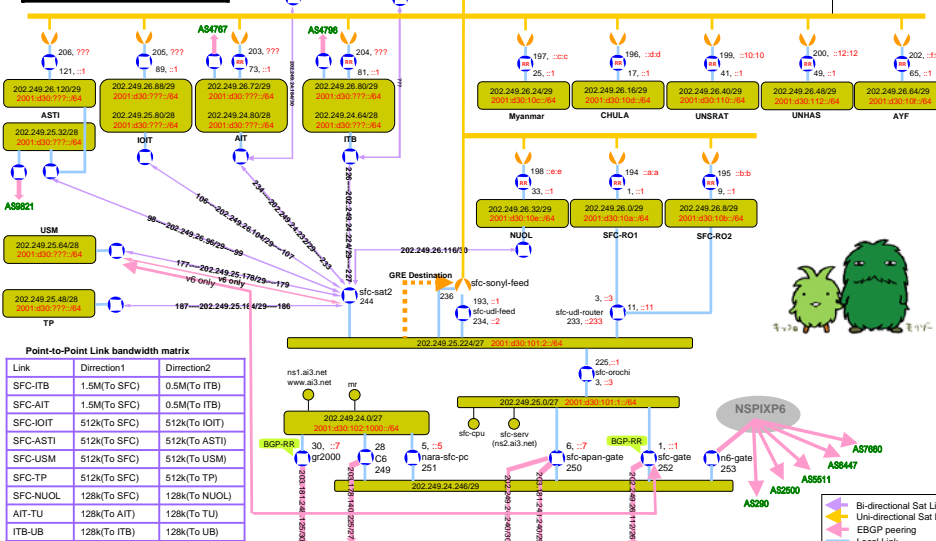
**UDL**  
 Japan to Asia : 9 Mbps

## AI<sup>3</sup> Network Topology

2005-04-17, by Shunsuke Fujieda (sfukuma@k.u-tokyo.ac.jp)

**AS Number and Prefix matrix**

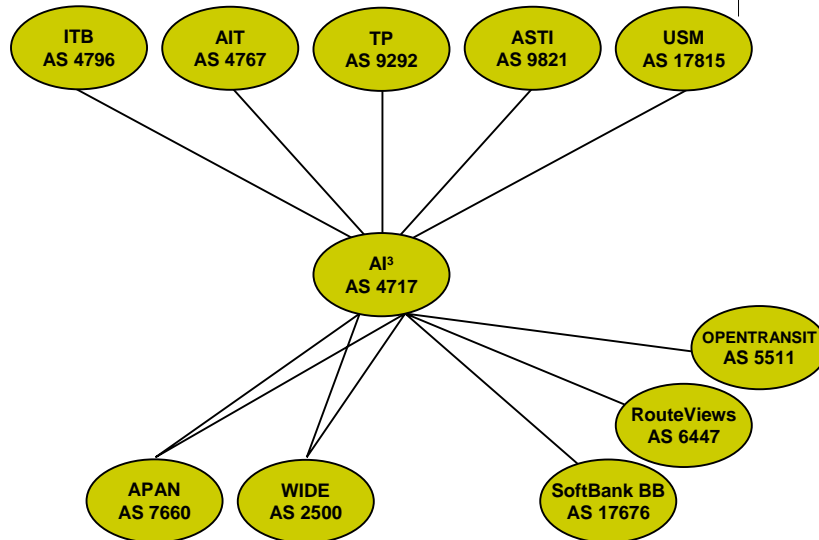
Organization	AS Number	Prefix
ITB	AS4796	167.205/16
AIT	AS4787	192.51.170/24 203.159/16
ASTI	AS9821	202.30.128/19
USM	AS17815	



**Point-to-Point Link bandwidth matrix**

Link	Direction1	Direction2
SFC-ITB	1.5M(To SFC)	0.5M(To ITB)
SFC-AIT	1.5M(To SFC)	0.5M(To ITB)
SFC-IOIT	512k(To SFC)	512k(To IOIT)
SFC-ASTI	512k(To SFC)	512k(To ASTI)
SFC-USM	512k(To SFC)	512k(To USM)
SFC-TP	512k(To SFC)	512k(To TP)
SFC-NUOL	128k(To SFC)	128k(To NUOL)
AIT-TU	128k(To AIT)	128k(To TU)
ITB-UB	128k(To ITB)	128k(To UB)

## AI<sup>3</sup> External Peering



## SOI Asia Network Overview



## What is SOI-Asia Network? (original)



- Network infrastructure for SOI-Asia activity
  - Deliver real-time lectures to SOI-Asia partners
  - Accommodate traffic for daily life
- Composed of several machines with specialized services and functions
- Operation body
  - AI<sup>3</sup>/SOI-Asia network operators

## What is SOI-Asia Network?

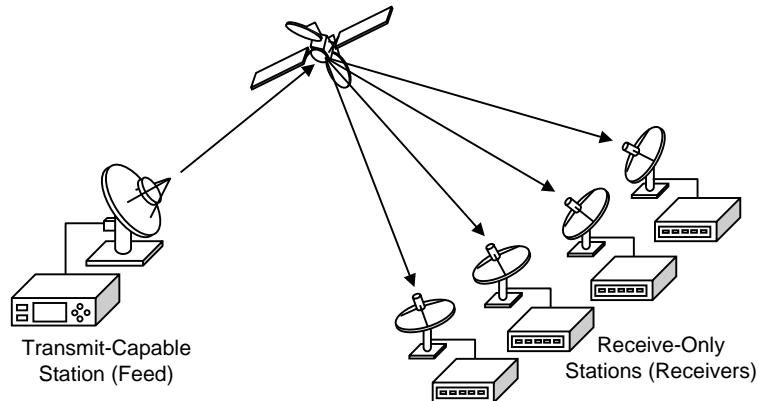


- Network infrastructure for SOI-Asia activity
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## Using Satellite link as Uni-Directional Link (UDL) (original)



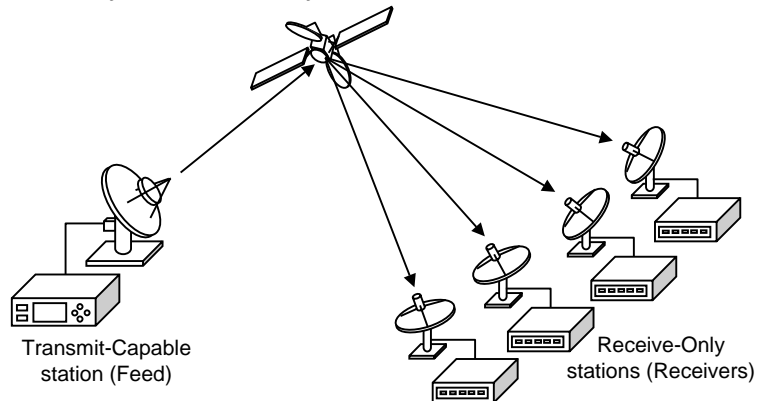
- A satellite network which is composed of:
  - One transmit-capable stations
  - Many receive-only stations

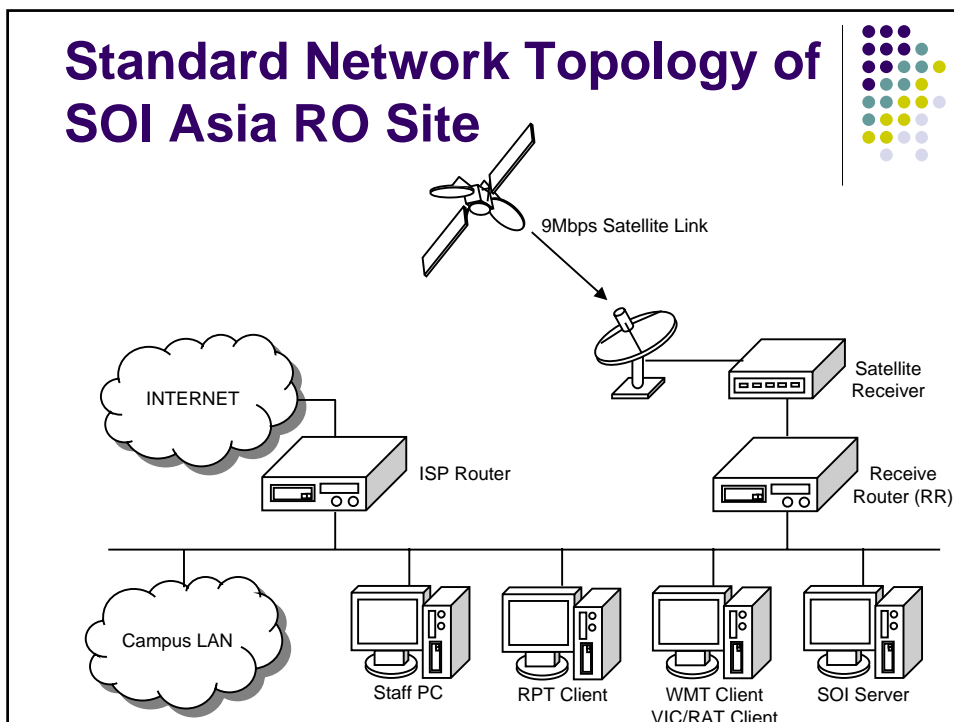
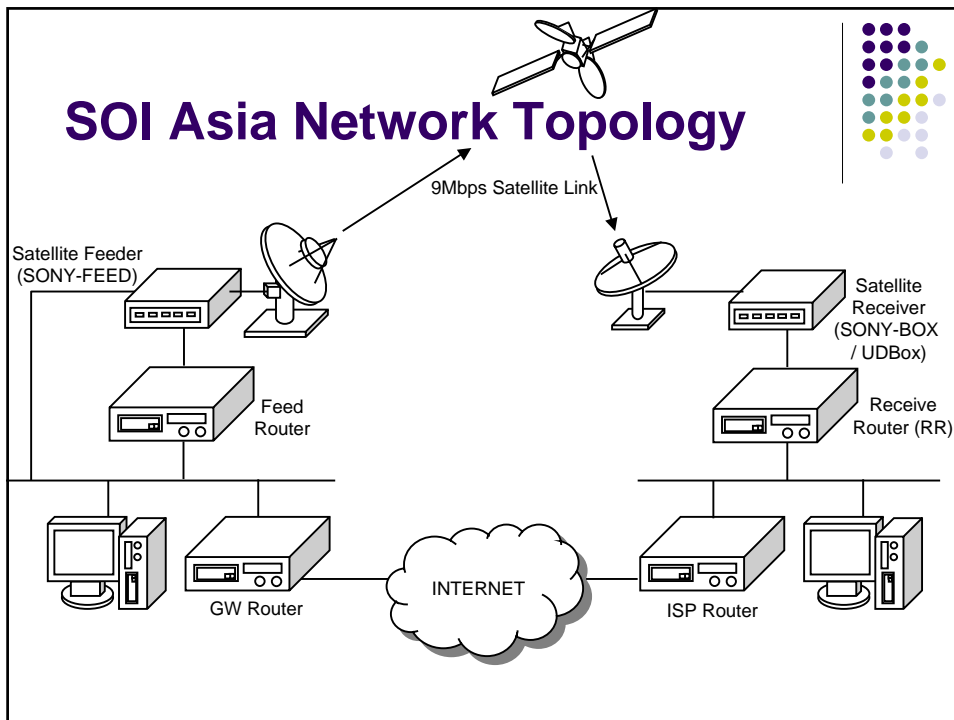


## Using Satellite Link as Uni-Directional Link (UDL)



- A satellite network which is composed of:
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## Is SOI-Asia Network Strange? Why?

Husni, please try  
“tracert www.ai3.net“  
from VIC/RAT PC



## Is SOI-Asia Network Strange? Why?

Husni, please try  
“tracert ayf-udl-recv.ai3.net“  
from VIC/RAT PC



## Before we go in detail of how SOI-Asia network works.... (original)



- 3 Generic Types of Data Link in the Internet
  - Point-to-Point
  - Broadcast Multiple Access
  - Non-Broadcast Multiple Access

## Before we go in detail of how SOI-Asia network works....



- 3 generic types of data link in the Internet
  - Point-to-Point
  - Broadcast (multiple access)
  - Non-Broadcast Multiple Access



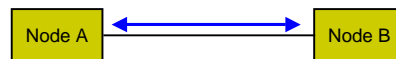
## Point-to-Point (original)

- Only 2 nodes on the link
  - Nobody else to send a packet
  - MAC address is not necessary on Point-to-Point link
  - Bi-directional
- Examples
  - Serial Connection
  - Digital dedicated line



## Point-to-Point

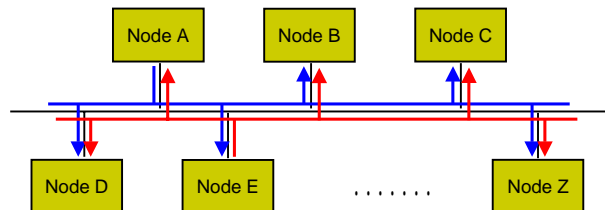
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- Examples
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  - Digital dedicated line
  - Dial-up connection



## Broadcast Multiple Access (original)



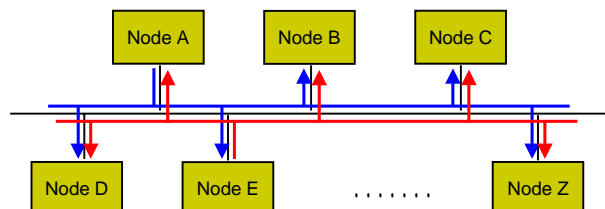
- Multiple nodes connects on the link
  - A packet is broadcasted to all nodes on the link
  - Requires MAC address resolution
  - Bidirectional
- Example
  - Ethernet



## Broadcast (Multiple Access)



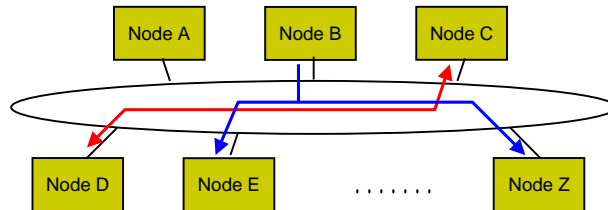
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## Non-Broadcast Multiple Access (original)



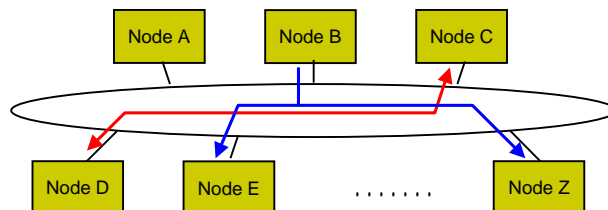
- Multiple nodes connects on the link
  - Data is delivered to a single or multiple nodes
  - No broadcast capability
  - Bi-directional
- Example
  - ATM (Asynchronous Transfer Mode)



## Non-Broadcast Multiple Access



- Multiple nodes connects on the link
  - Data is delivered to a single or multiple nodes
  - No broadcast capability
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- Example
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## Problem on SOI-Asia Network (original)



- We're using satellite link as UDL
  - **Not** categorized in none of previous 3 link types
- What does it mean, actually?
  - Send-only node can't find other nodes on the link
  - Receive-only node can find other nodes on the link but can't transmit any packets
- One-way link is unexpected in the Internet
  - Routing protocols
  - Address resolution (ARP, NDP)
  - Transport protocols and applications

## Problem on SOI-Asia Network



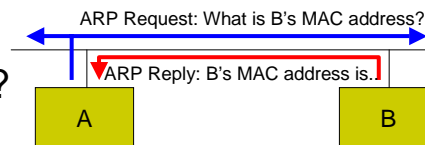
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  - Receive-only node can find only send-capable node but no other receive-only nodes
- One-way link is unexpected in the Internet
  - Routing protocols
  - Address resolution (ARP, NDP)
  - Transport protocols and applications



## Example: ARP (original)

- Assumption of the Internet
  - Data link is bi-directional
- Process to communication between A and B
  - A requests the MAC address of B (ARP Request)
  - B answers its MAC Address to A (ARP Reply)
  - A know the destination interface

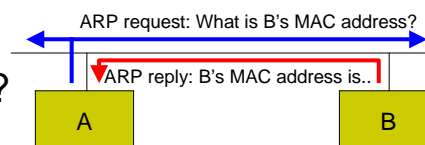
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## Example: ARP

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  - A knows the destination interface MAC address

- No ARP Reply from B?



# UDLR Overview

Specification

Why packets could come and go  
on the one-way link?



## What is UDLR?

- Uni-Directional Link Routing
  - Specified as “A Link-Layer Tunneling Mechanism for Unidirectional Links” in RFC3077
- Objectives
  - To allow nodes to communicate on a uni-directional link
- Approach
  - Deliver a packet from receive-only node to send-capable node via the Internet
  - To emulate Broadcast Multiple Access link on a uni-directional link



## Definition of Links and Nodes

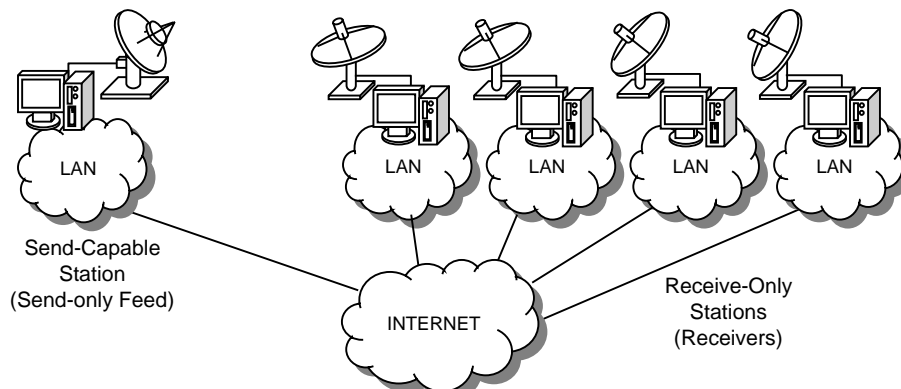


- Links
  - UDL: Uni-directional Link
  - BDL: Bi-directional Link (LAN Connectivity to the Internet)
- Nodes
  - Send-only Feed: A router that has send-only connectivity to a UDL
  - Receiver: A router or a host that has receive-only connectivity to a UDL
- Assumption
  - Both Send-only Feed and Receiver has BDL connection

## Physical Connection (original)



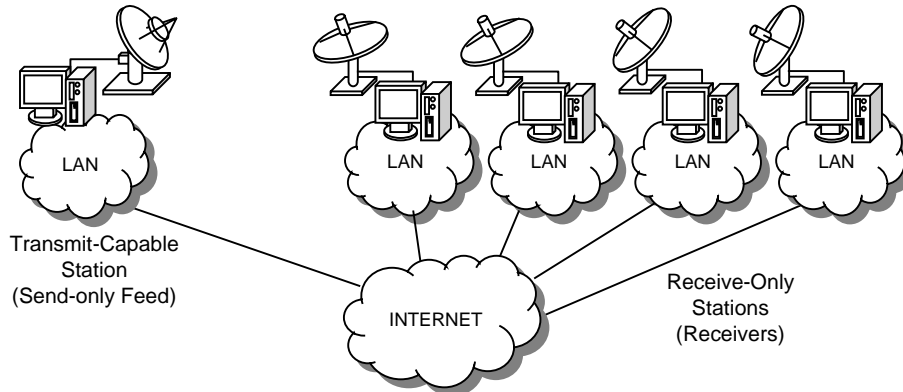
- Each Node is belonging to the different LAN
  - Can't directly communicate with others on UDL





## Physical Connection

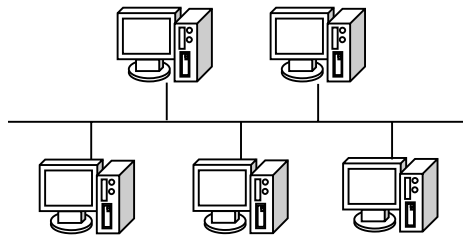
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## Logical Connection with UDLR



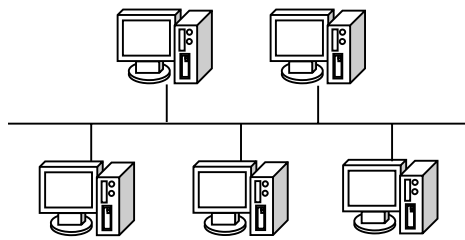
- Every node connects to the single subnet
- The subnet works like Ethernet
  - Bidirectional
  - Broadcast Multiple Access



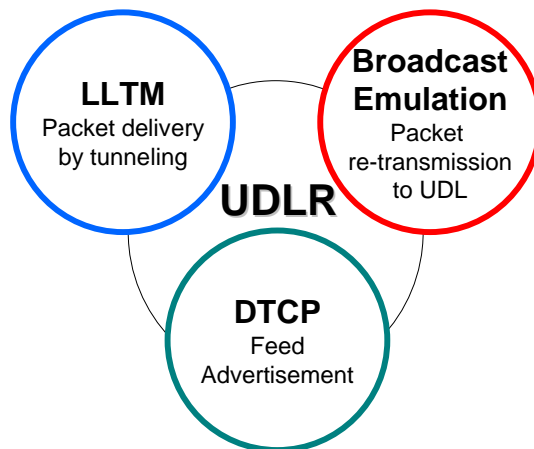
## Logical Connection with UDLR



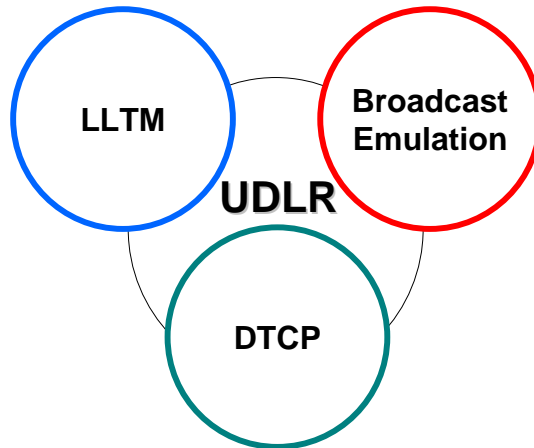
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## UDLR as Collection of 3 Technologies



## UDLR as Collection of 3 Technologies



## Link Layer Tunneling Mechanism (LLTM)

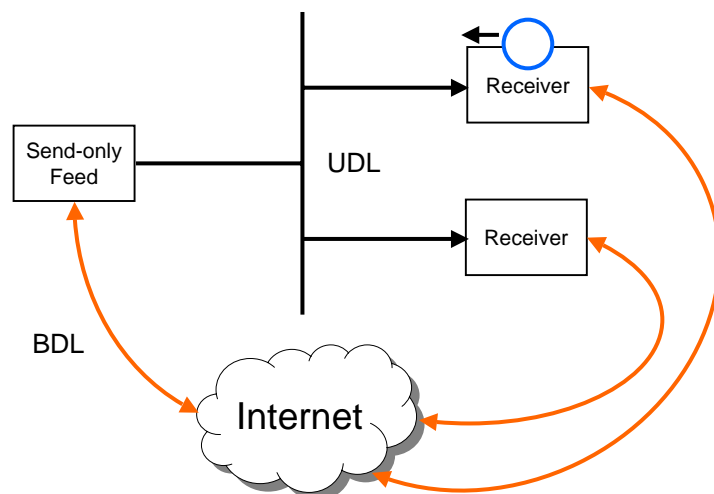




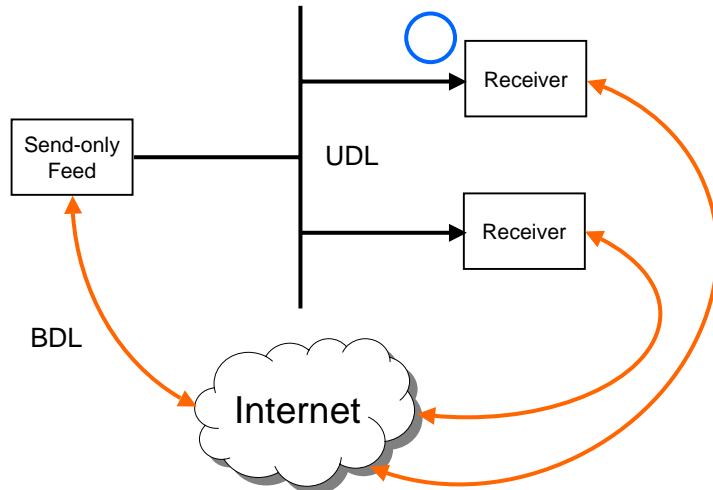
## What is LLTM?

- Give virtual “Send Capability” to Receiver on the UDL
  - Emulate direct bi-directional communication between Send-only Feed and Receiver on UDL
- Each Receiver establishes Link Layer Tunnel with Send-only Feed
  - Data link frame from Receiver is delivered to UDL I/F of Send-only Feed via the Internet
- Send-only Feed processes the data link frame as if it were directly received from Receiver over UDL

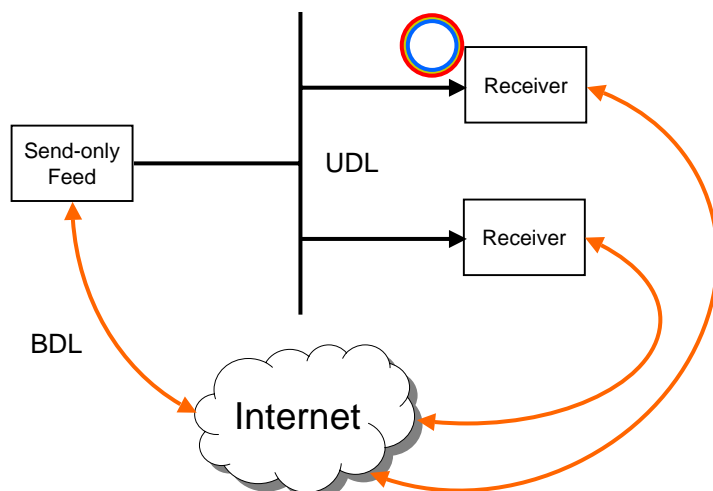
## Packet from Receiver to Send-only Feed



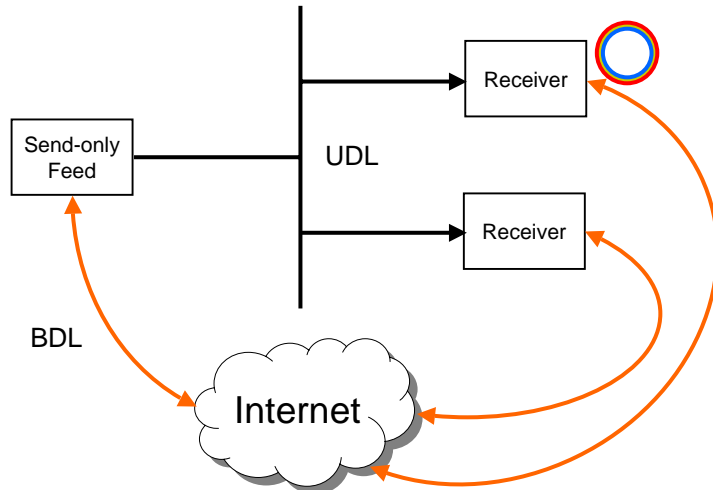
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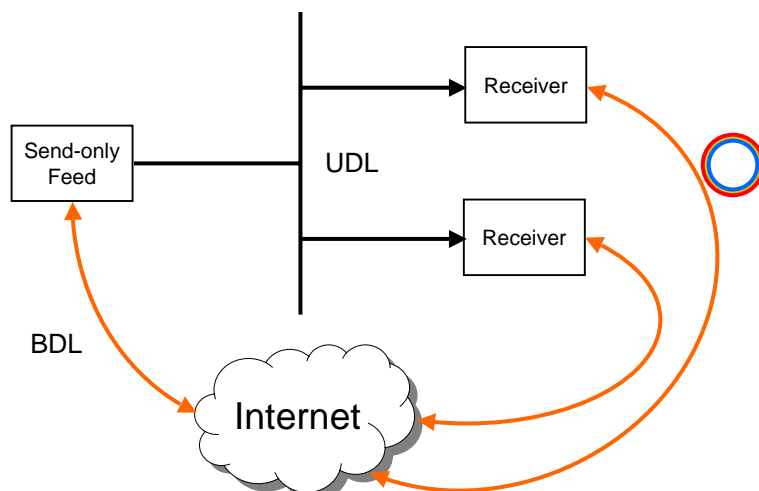
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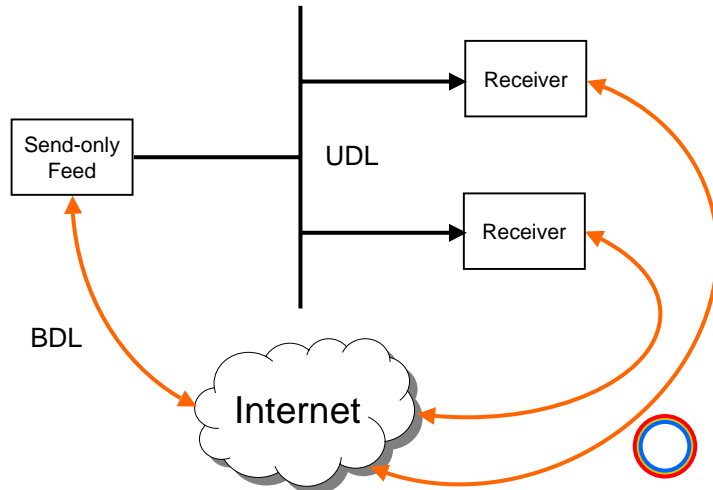
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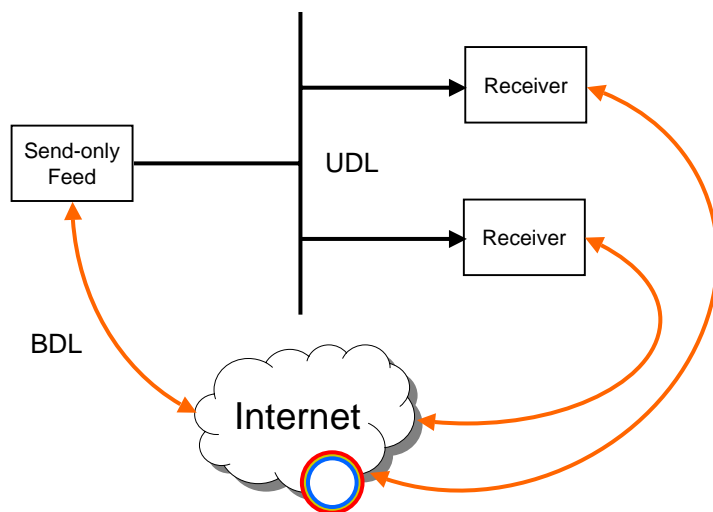
## Packet from Receiver to Send-only Feed



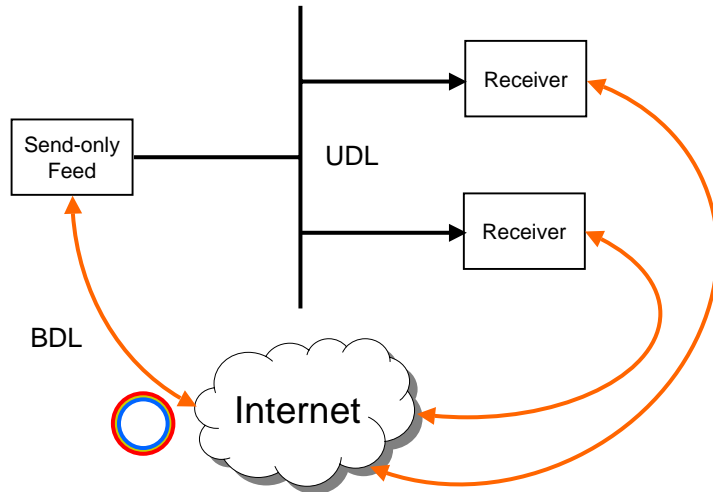
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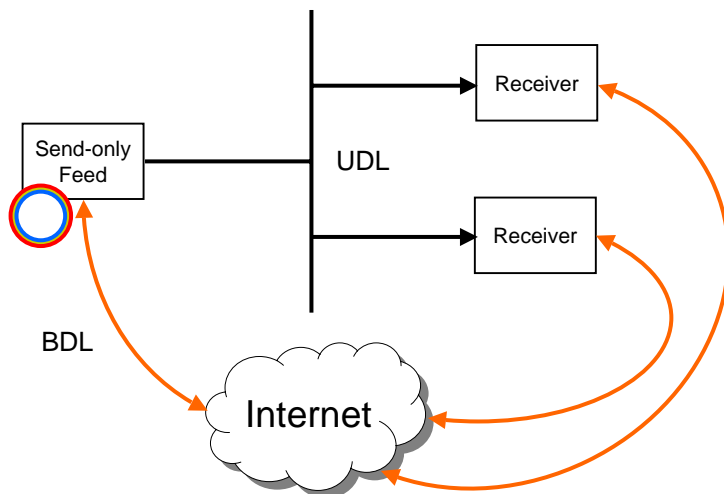
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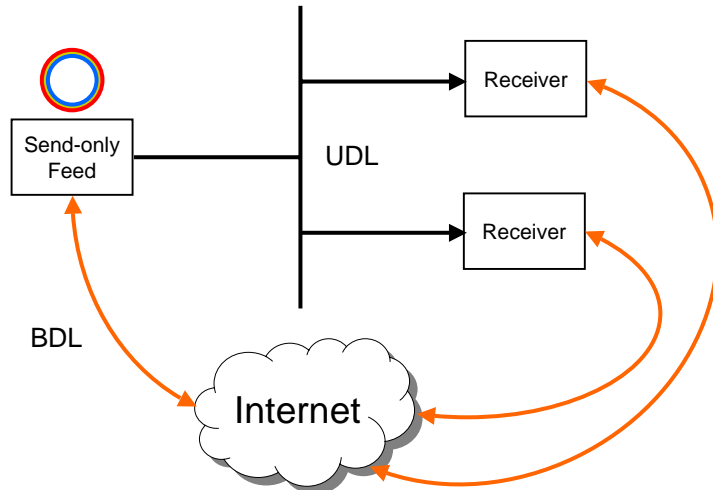
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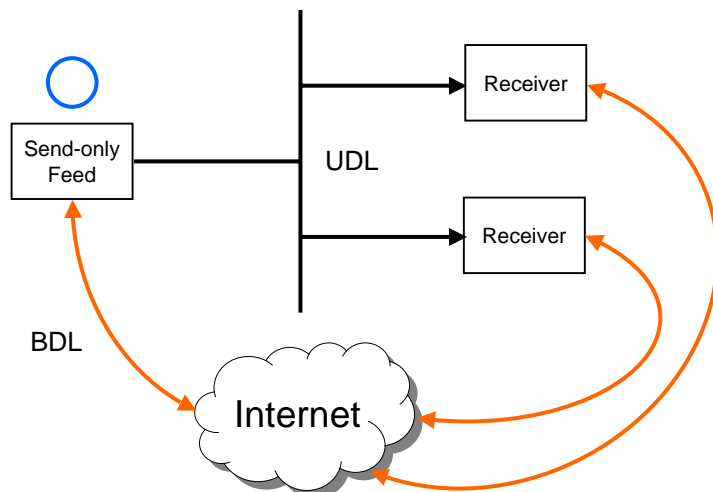
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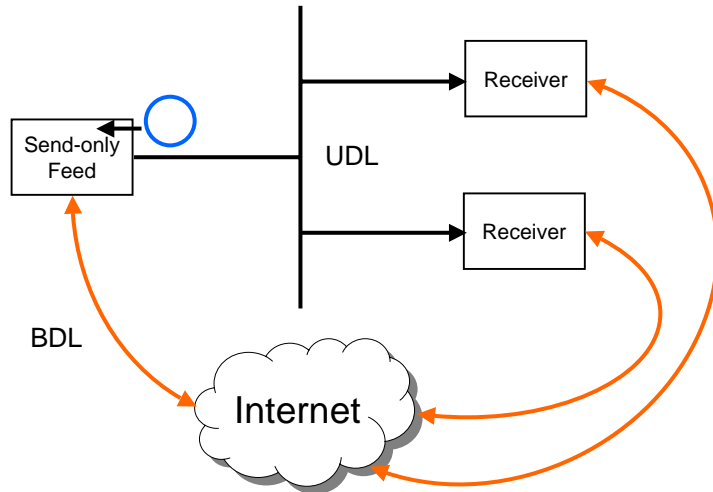
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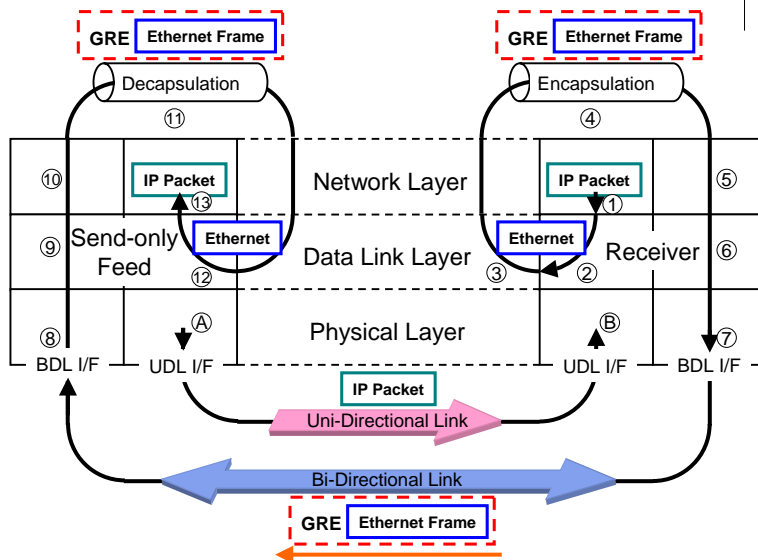
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# Packet from Receiver to Send-only Feed



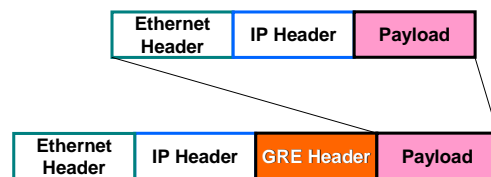
# What does it happen in Send-only Feed and Receiver?



## GRE Encapsulation



- Generic Routing Encapsulation
  - Receiver encapsulates a data link frame as IP payload data with GRE header
  - Send-only Feed decapsulates the original data link frame and receives it from UDL I/F



## Broadcast Emulation

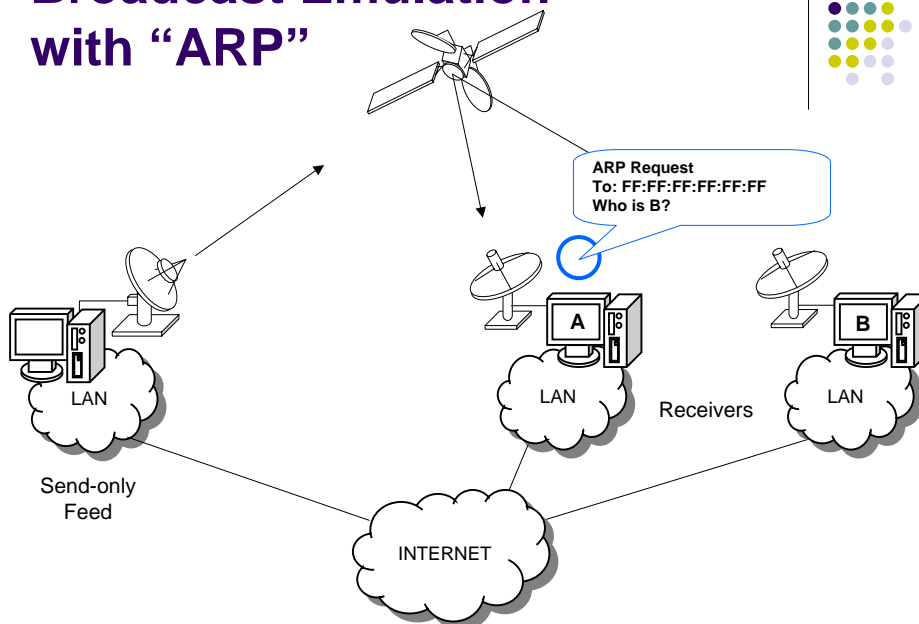


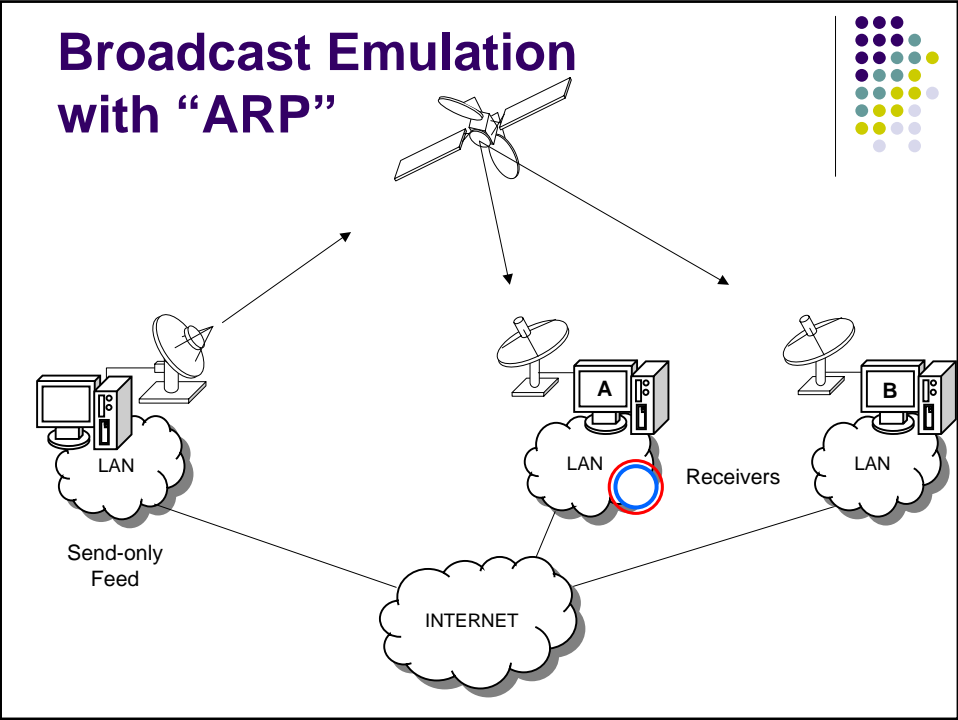
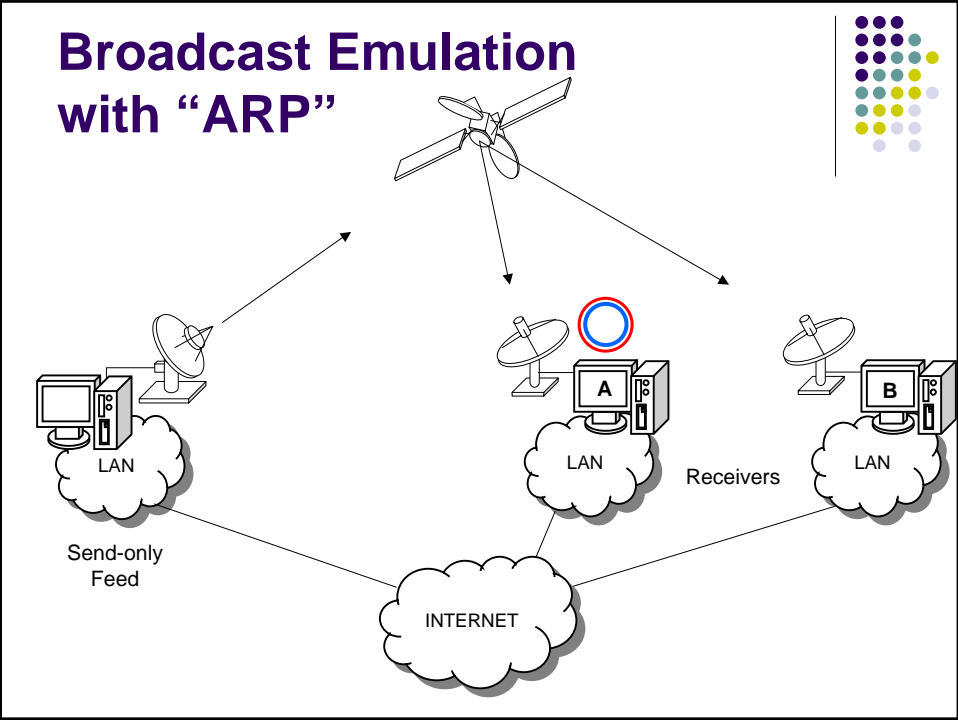
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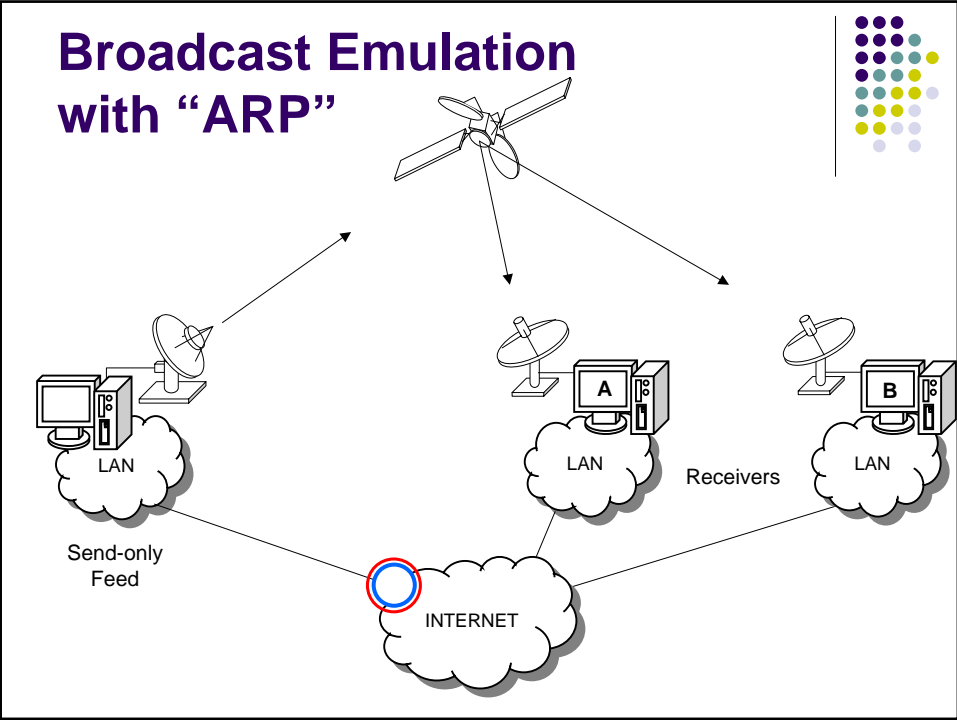
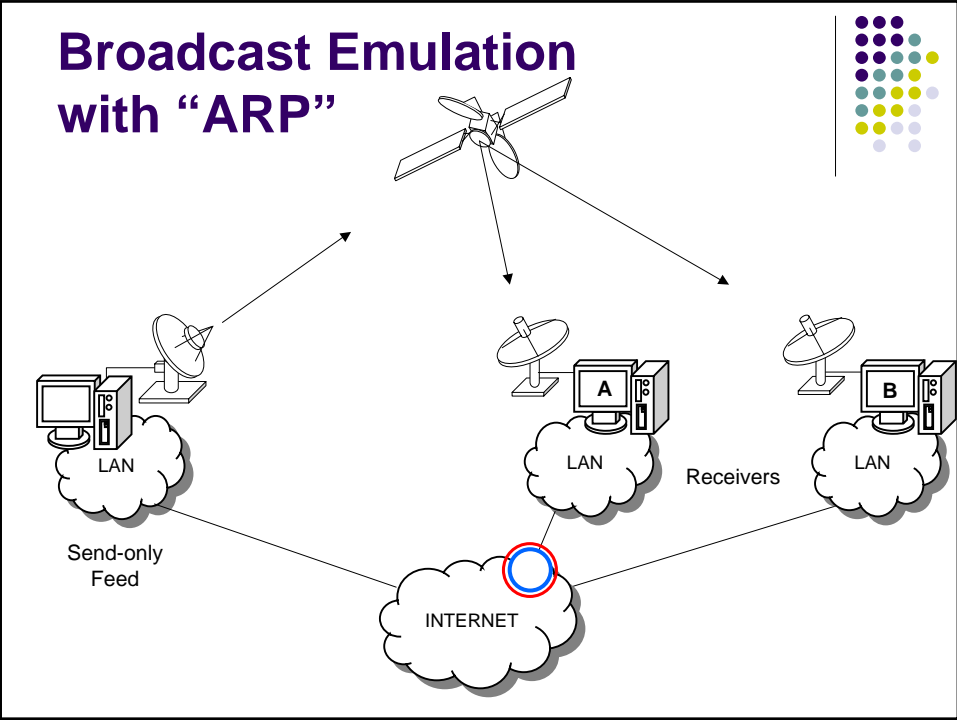


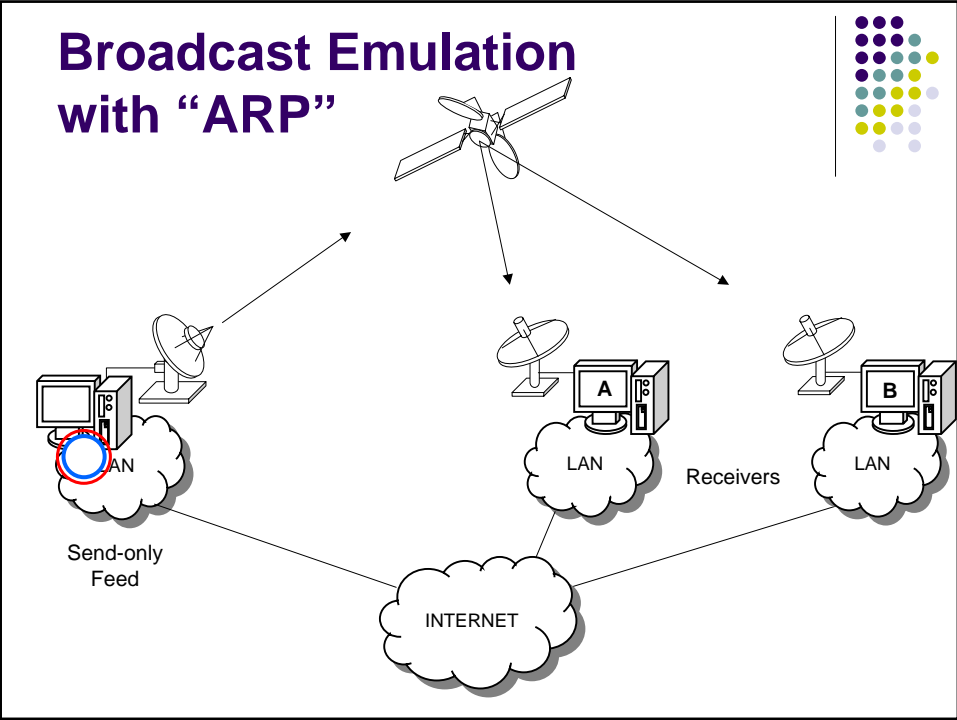
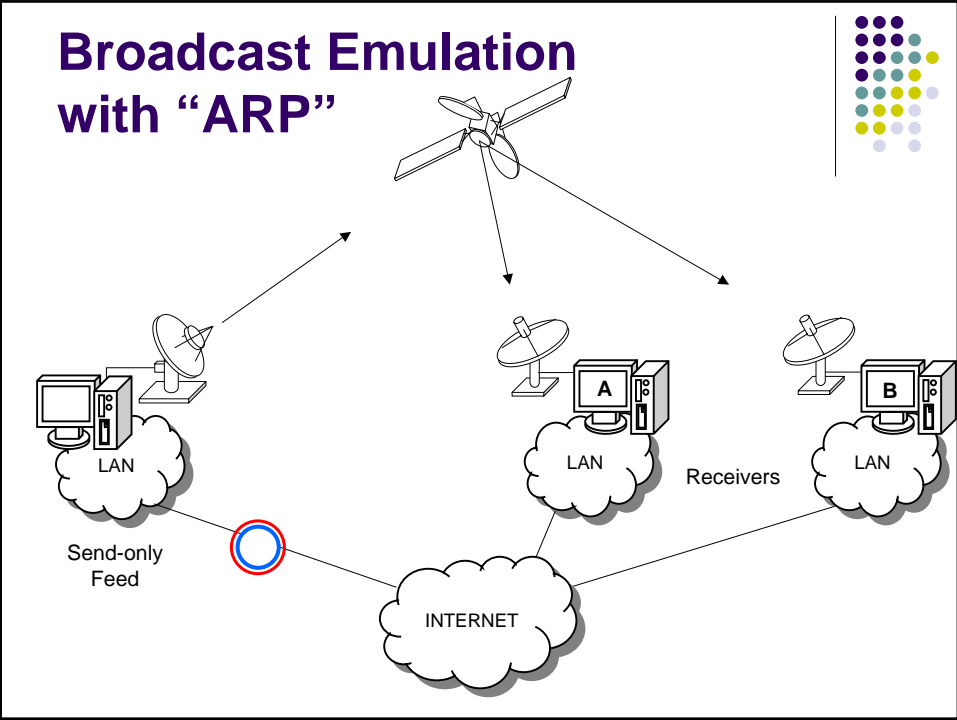
- Emulate Bi-Directional Multi-access Link on UDL (i.e. Ethernet)
  - Feed forwards the decapsulated data link frame from Receiver if its destination MAC address is:
    - Multicast
    - Broadcast
    - Receiver's
- Essential for normal behavior for ARP or other infrastructure technology of the Internet

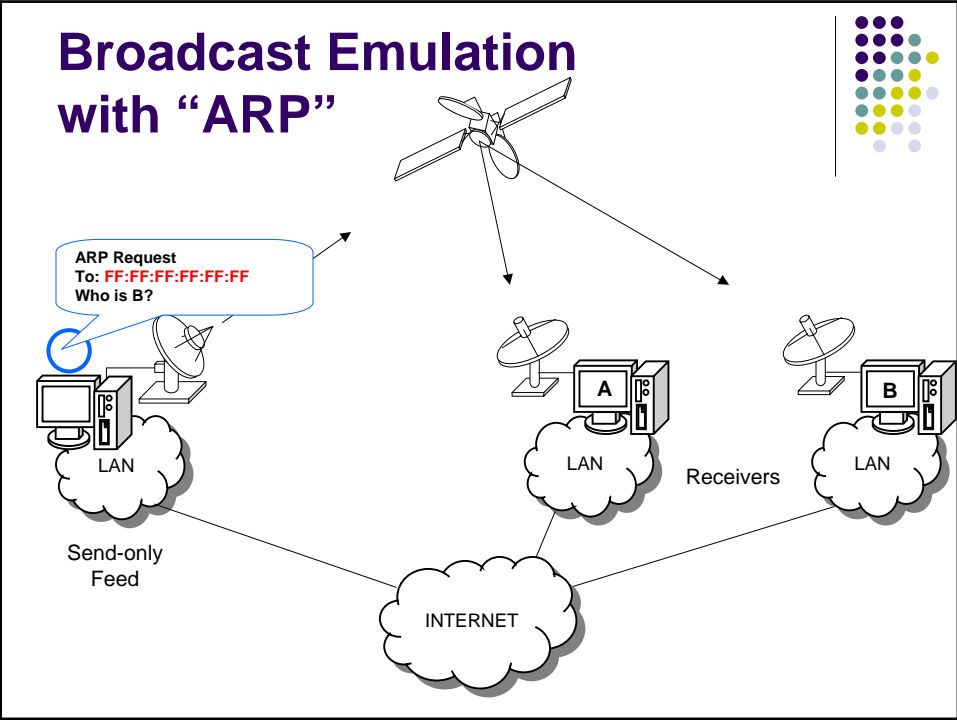
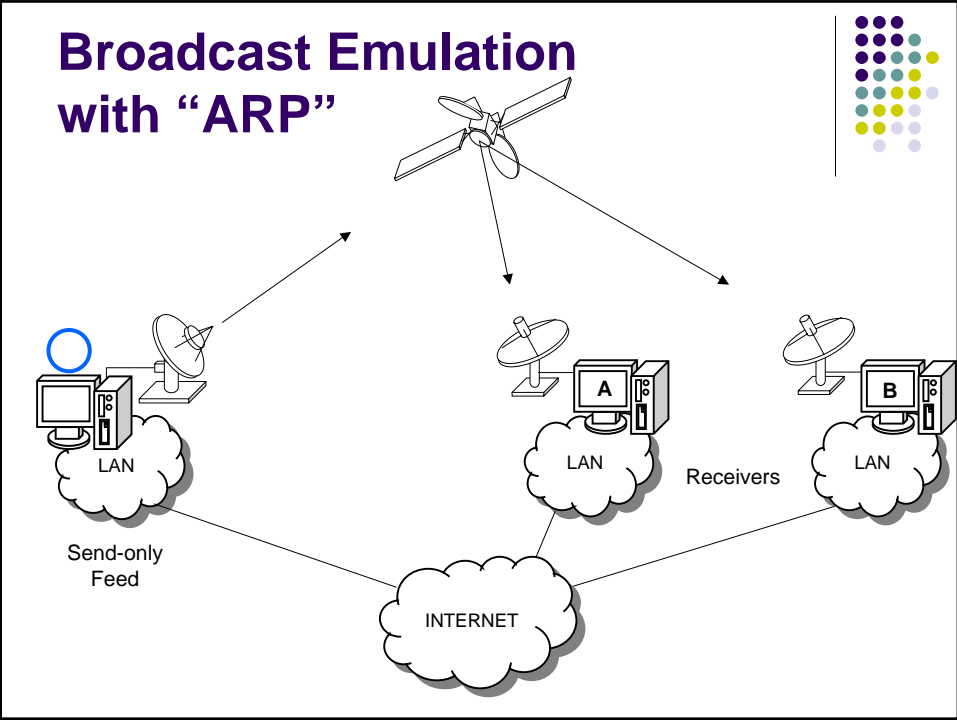
## Broadcast Emulation with "ARP"

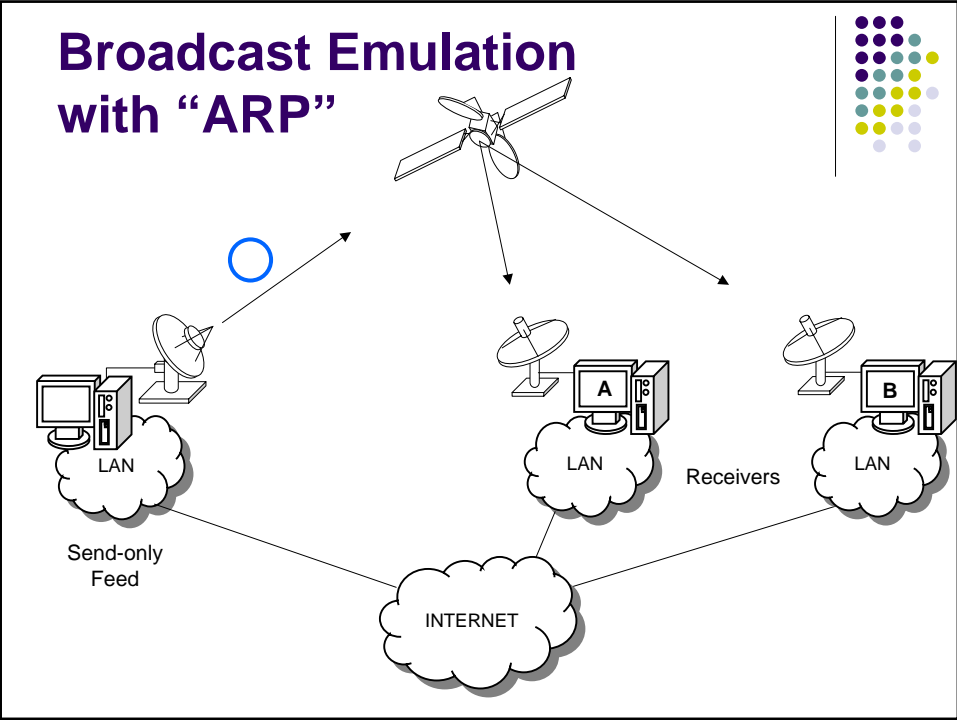
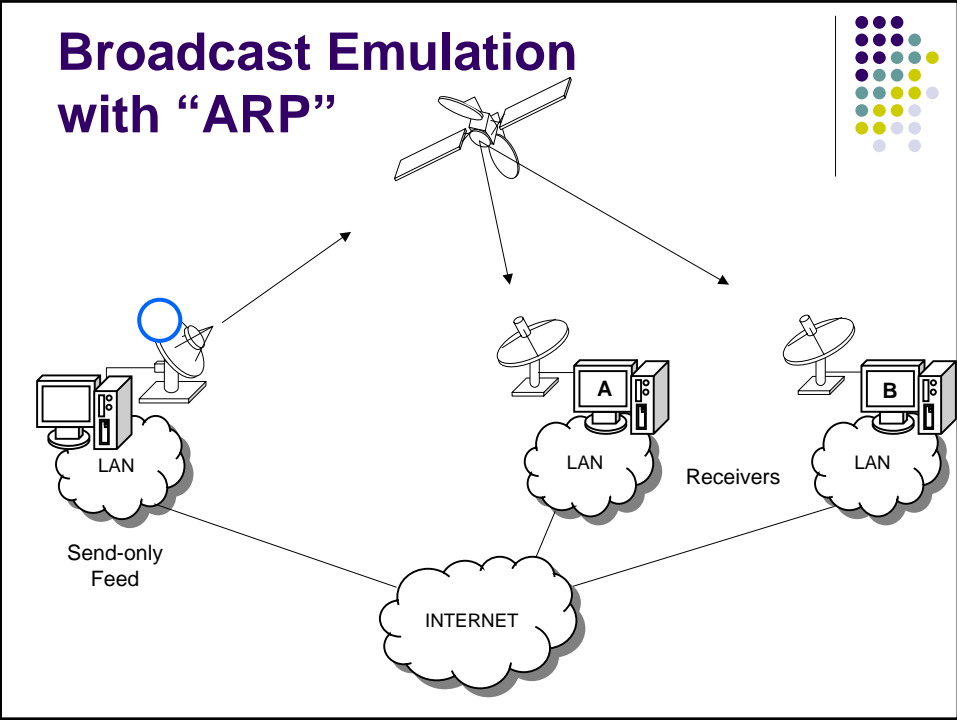


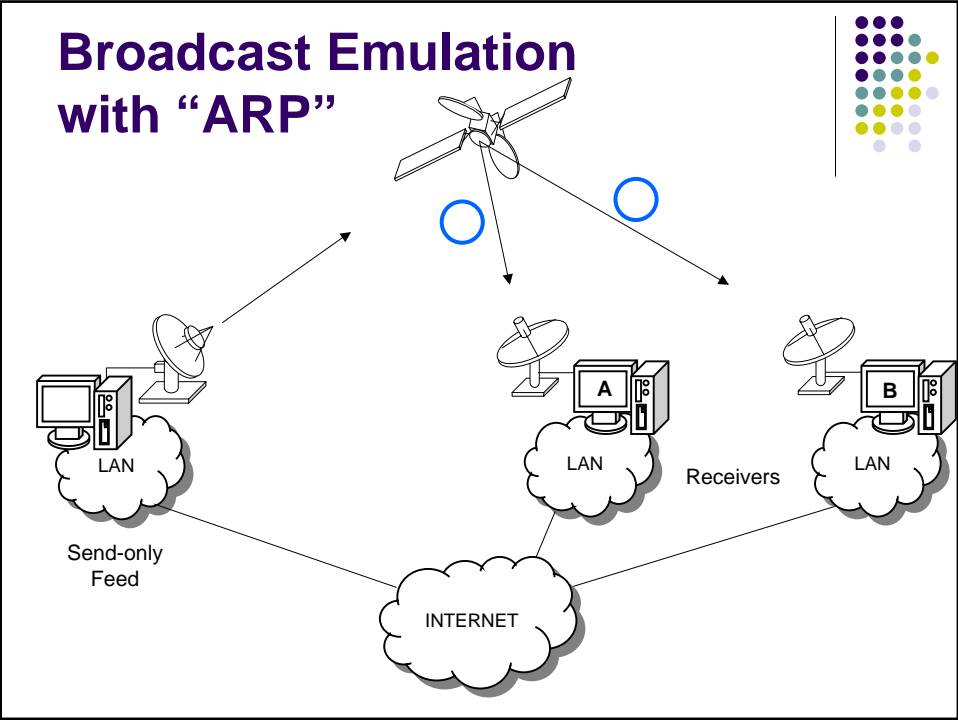
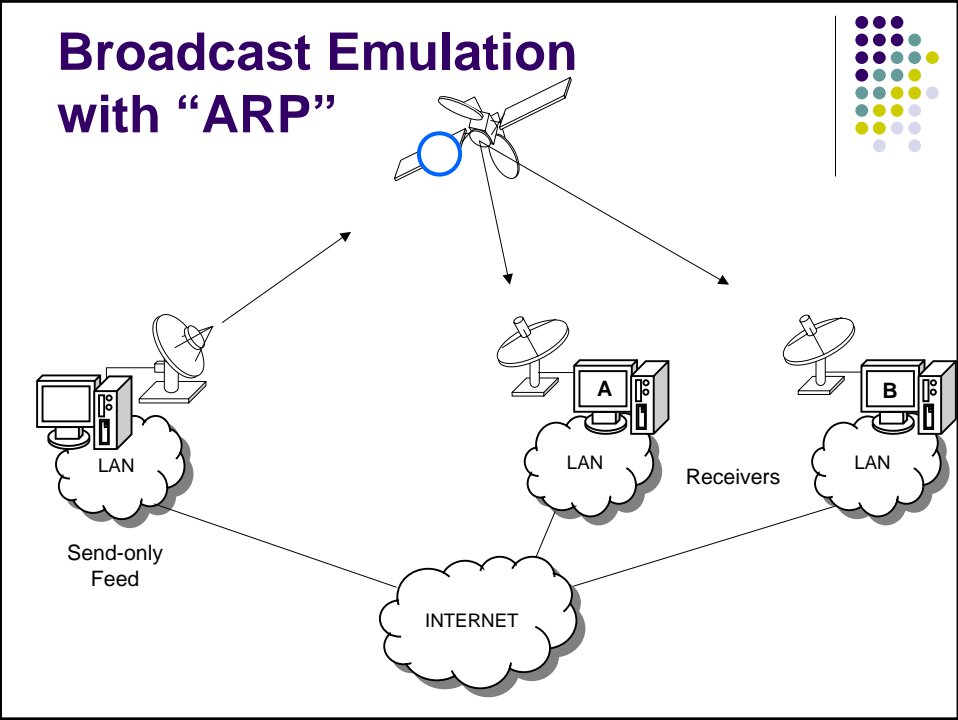


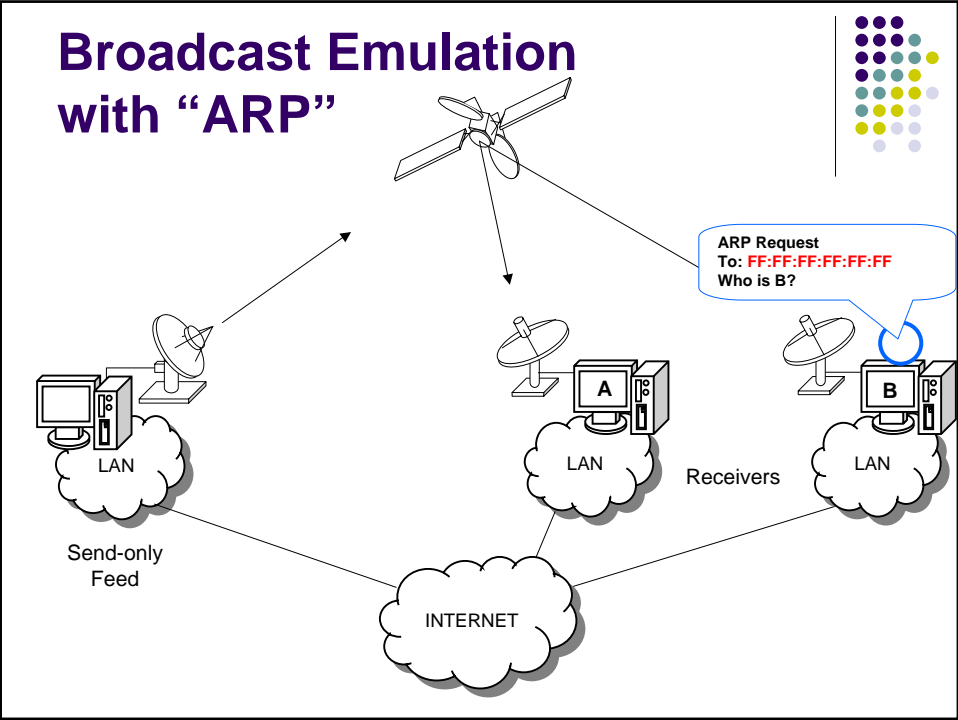
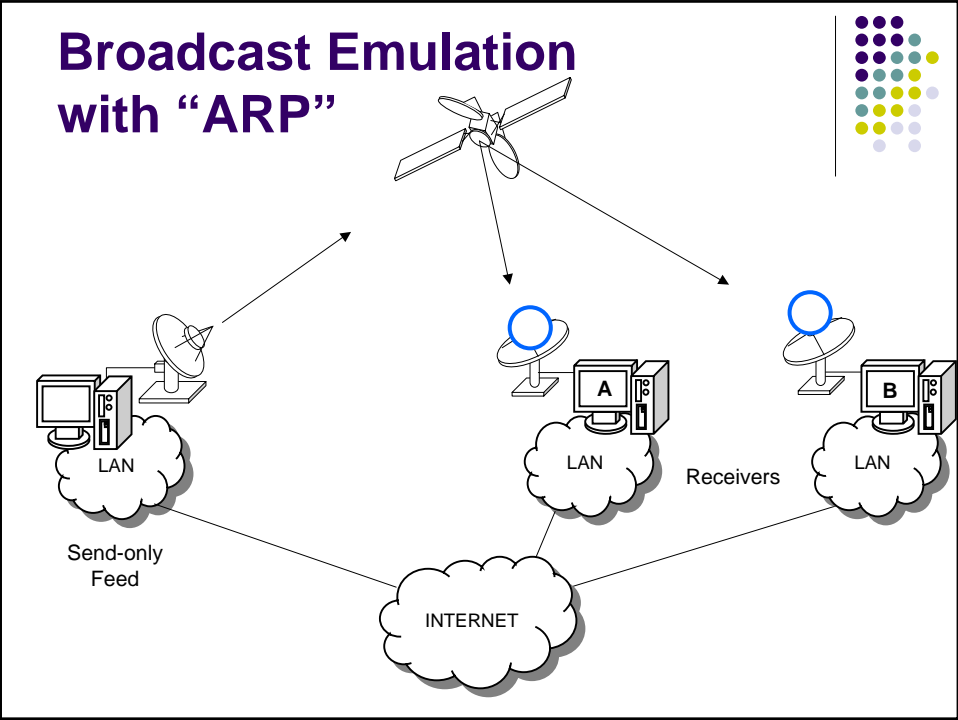


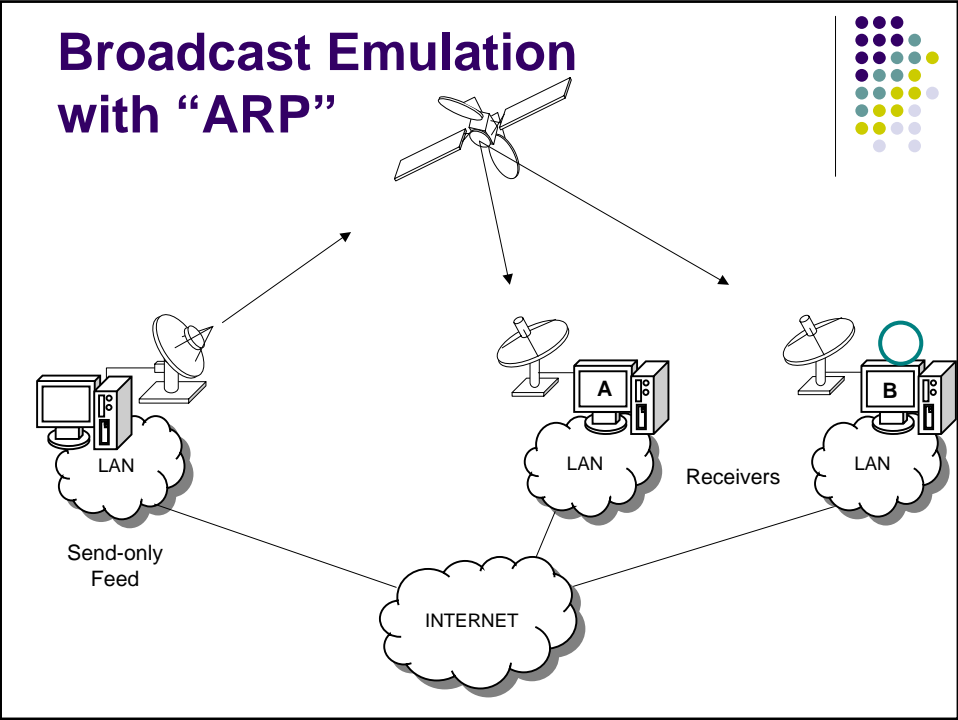
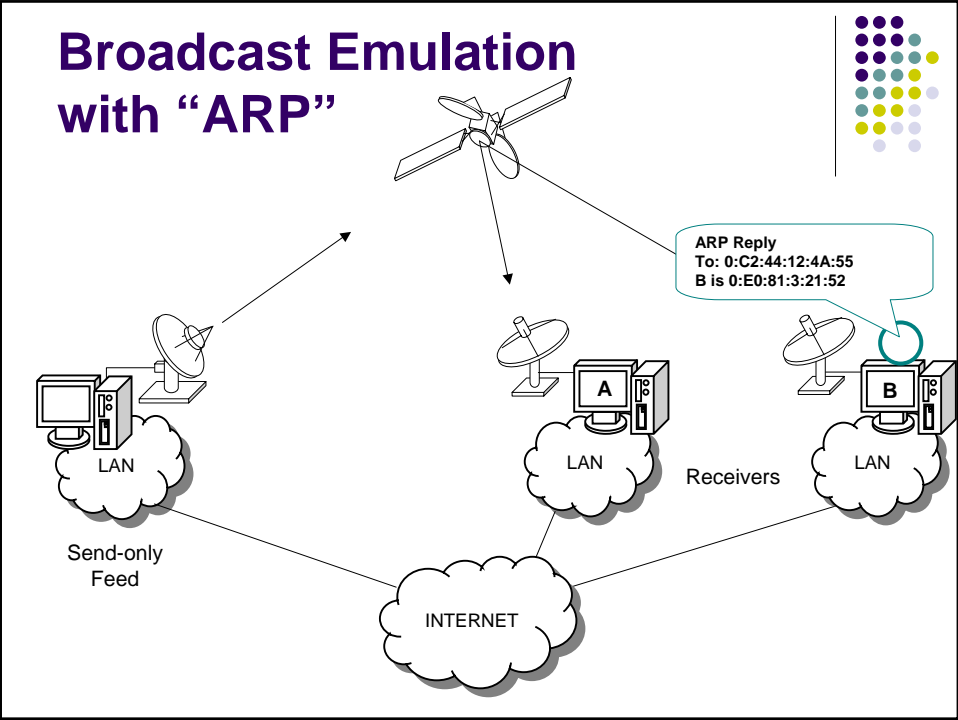


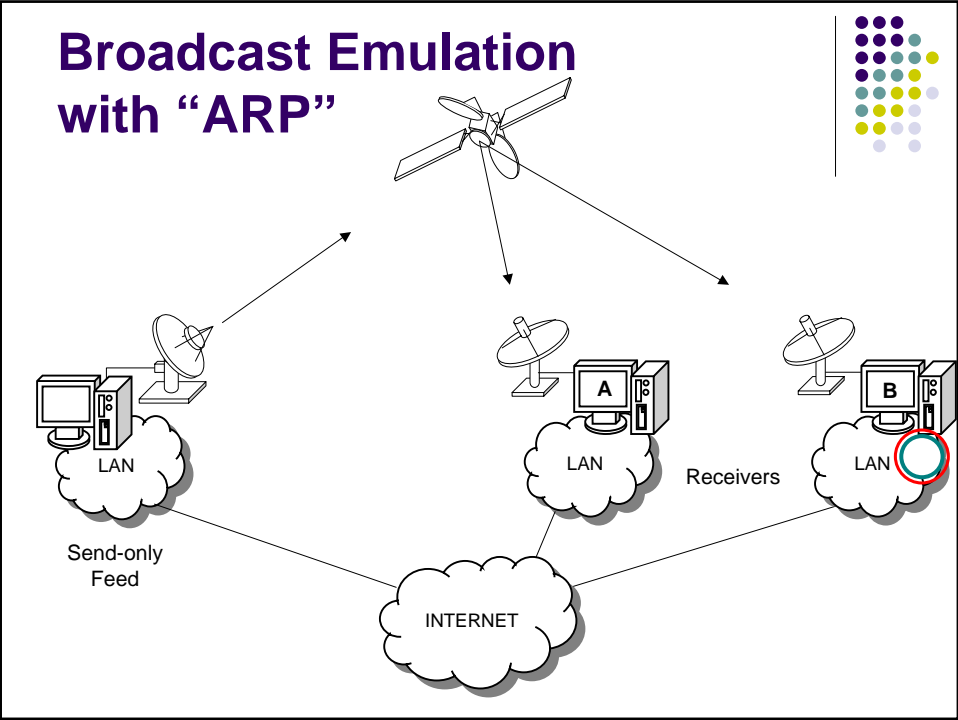
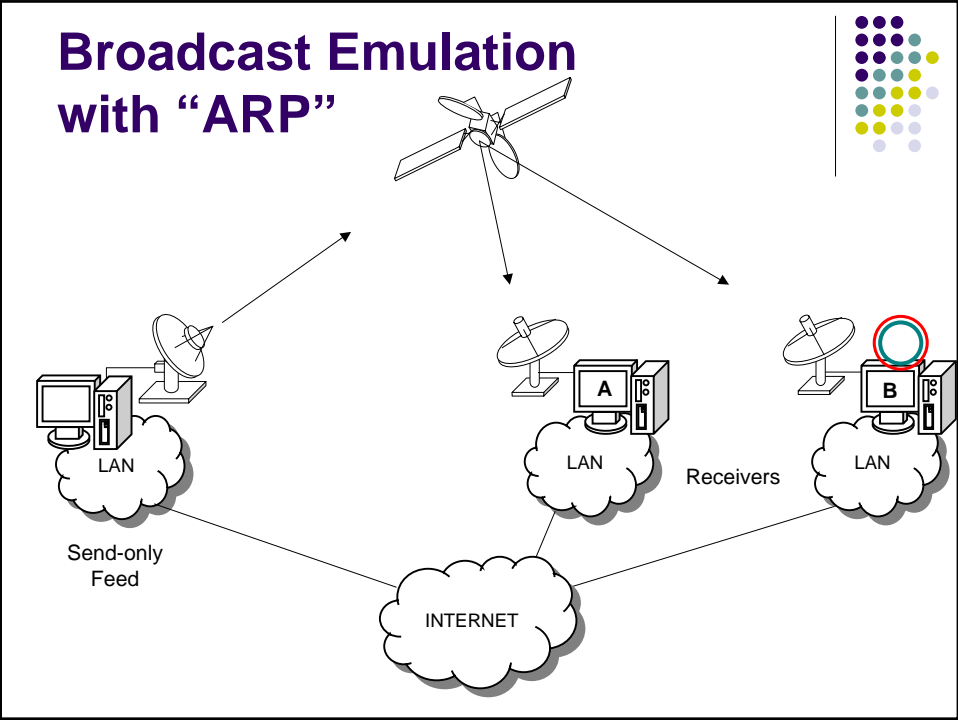


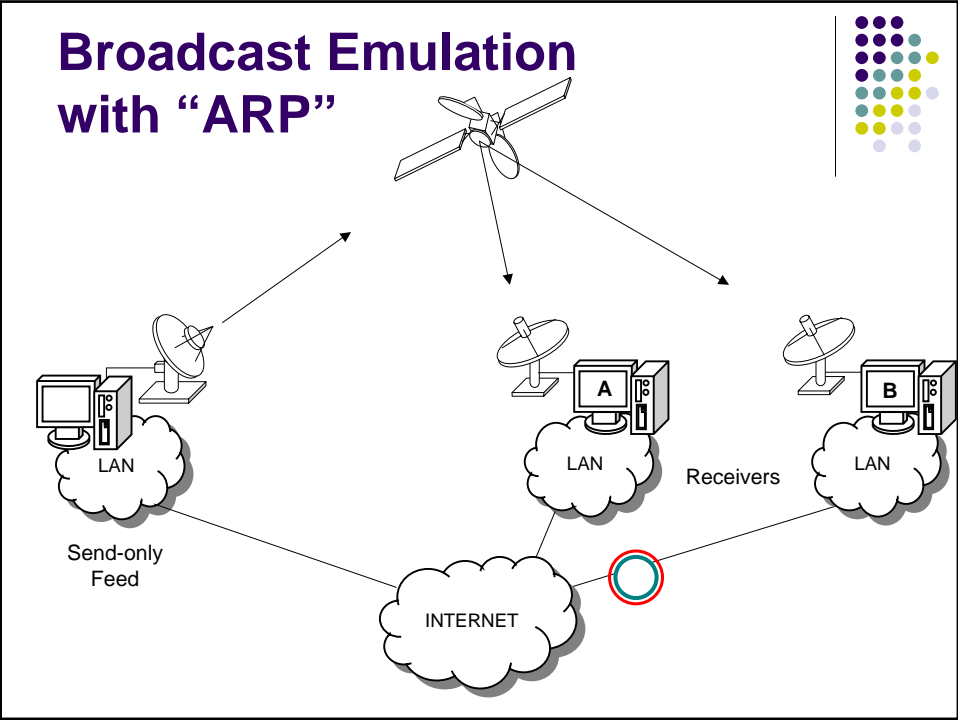
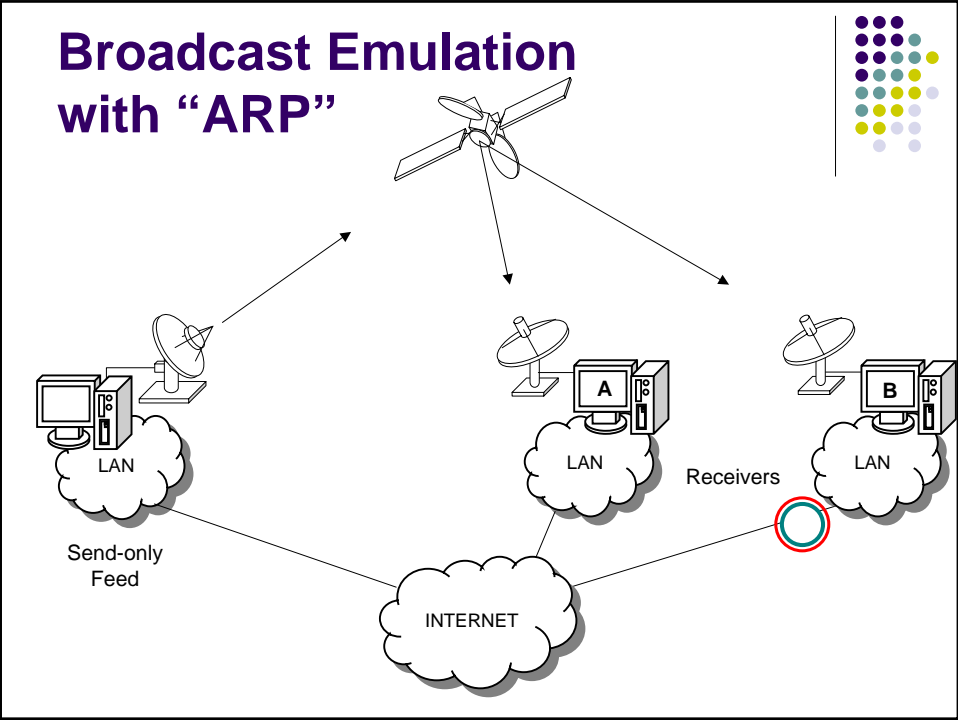


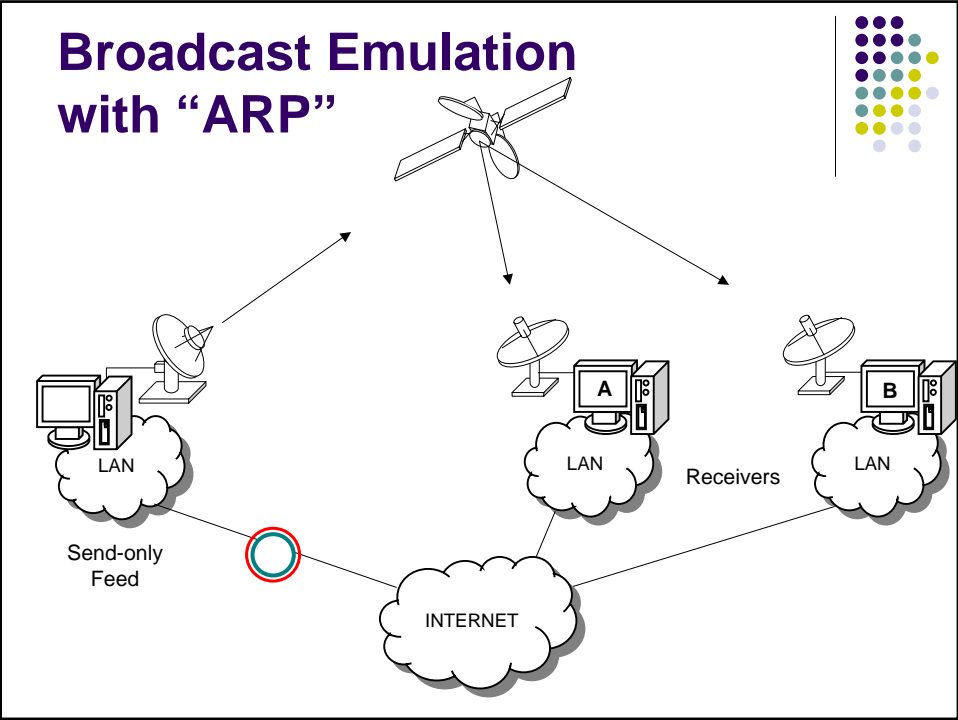
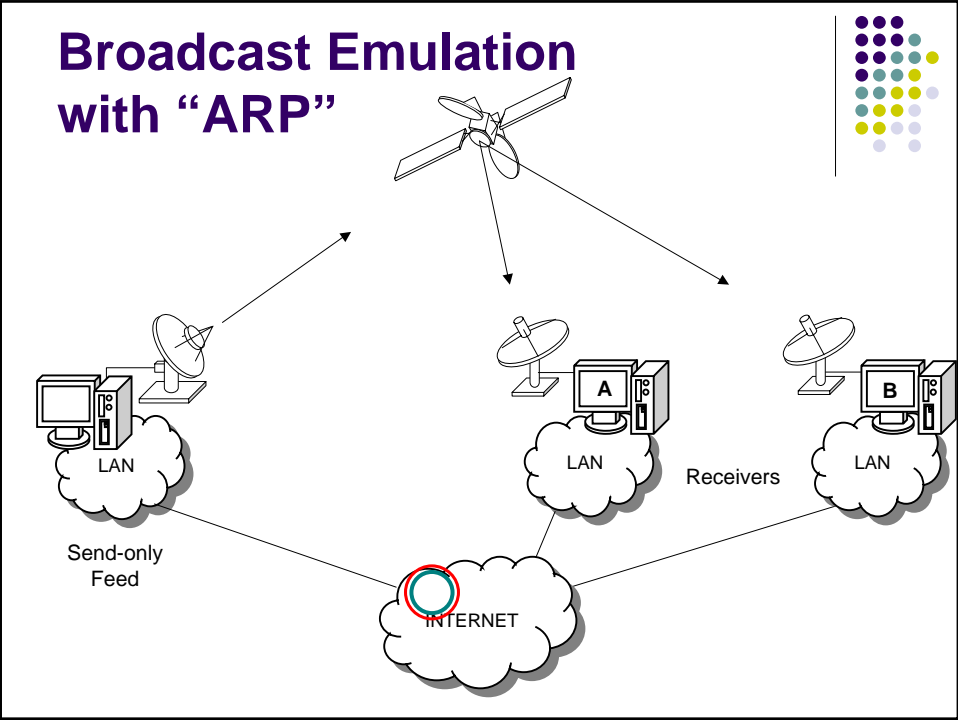


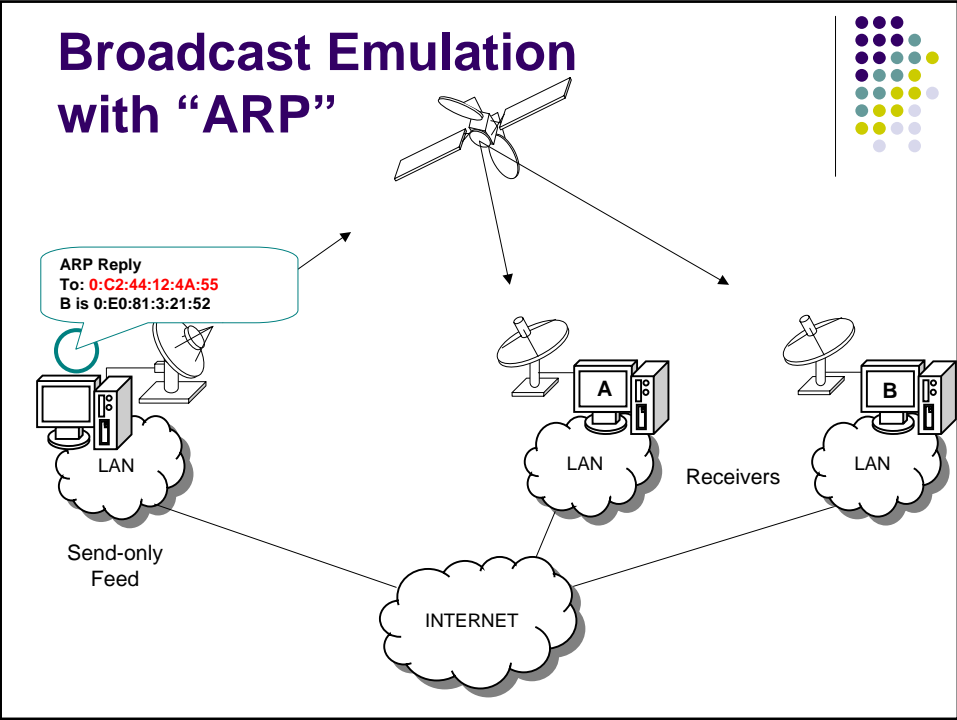
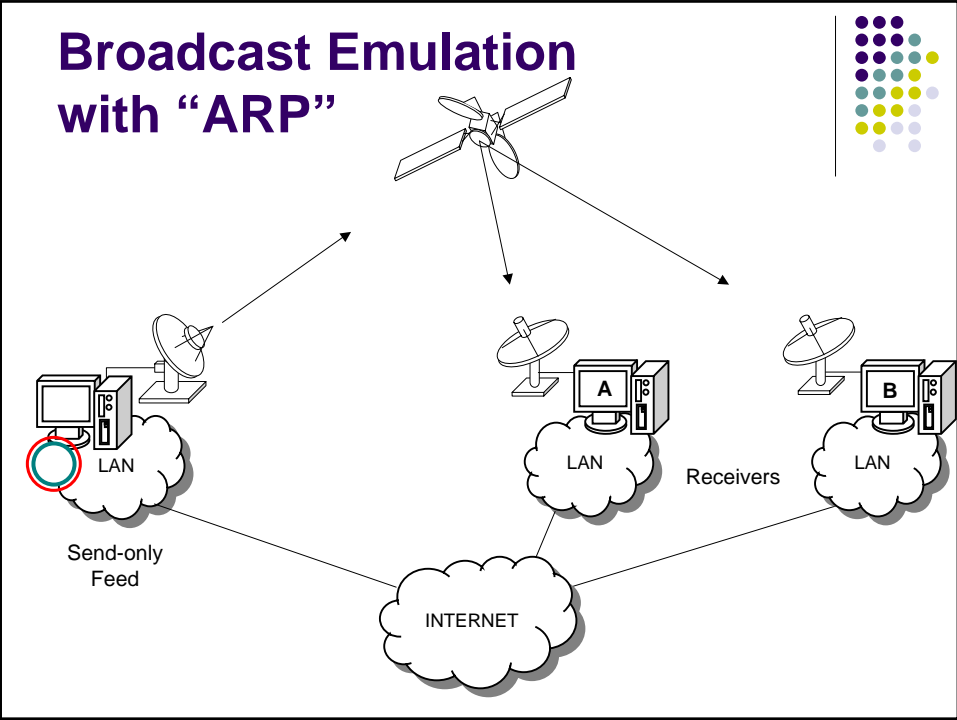


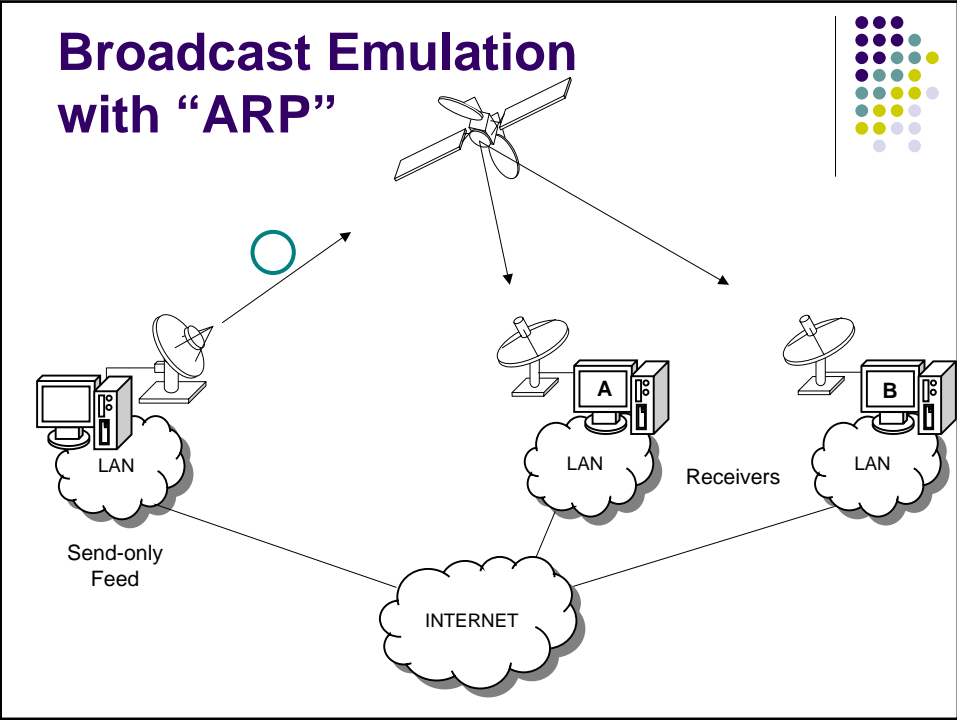
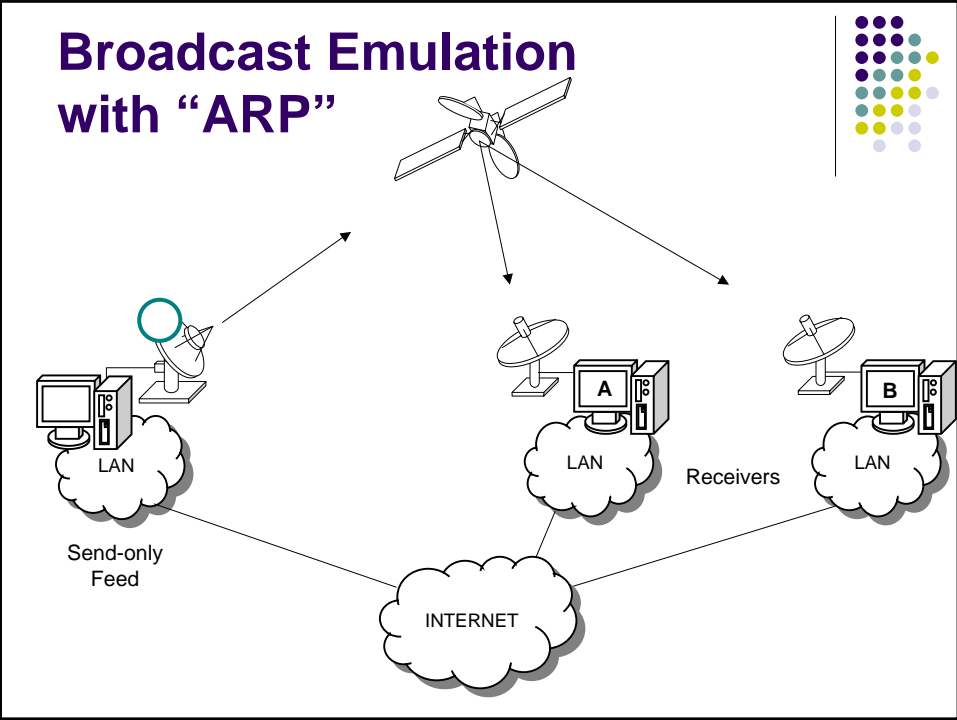




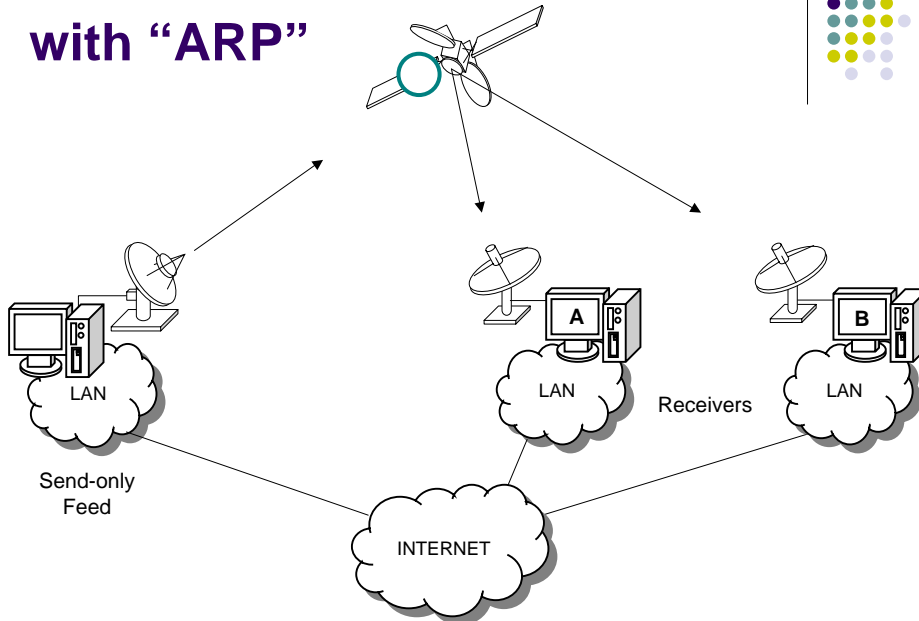




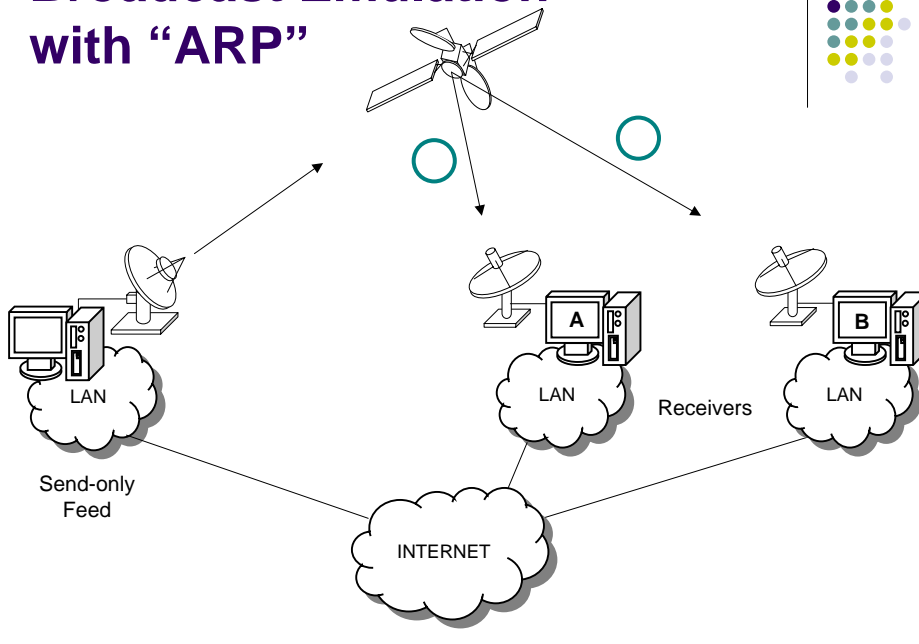


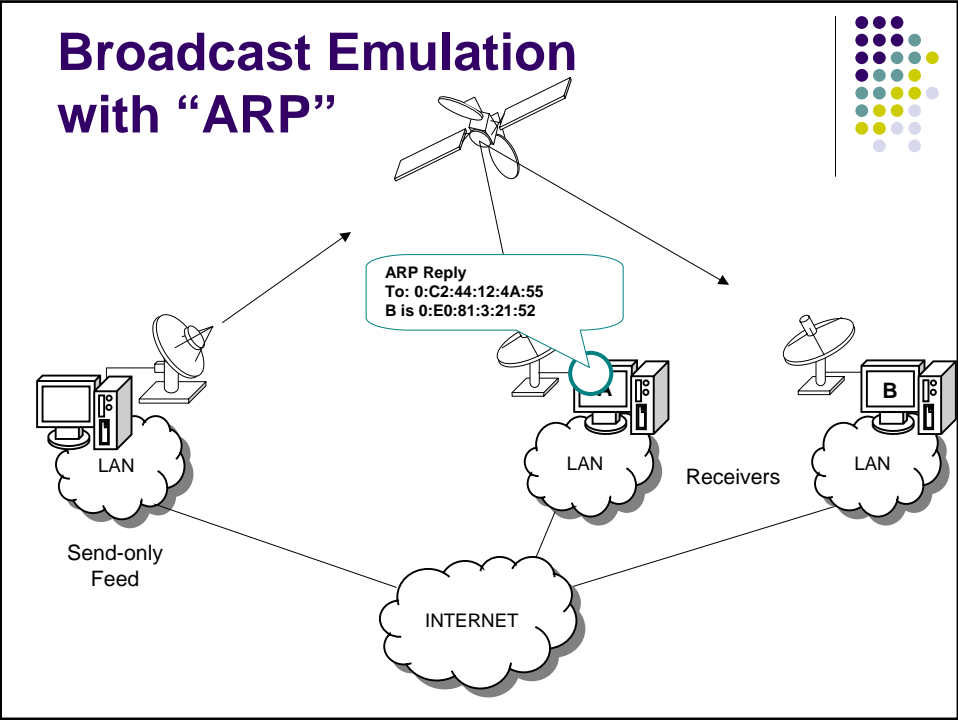
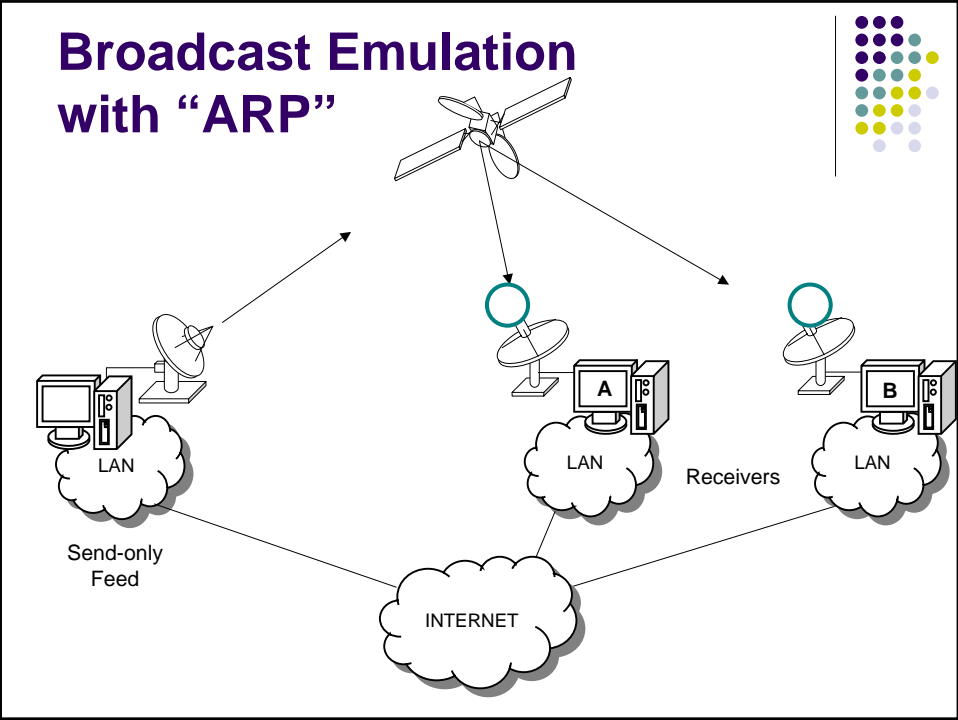


## Broadcast Emulation with "ARP"



## Broadcast Emulation with "ARP"





# Dynamic Tunnel Configuration Protocol

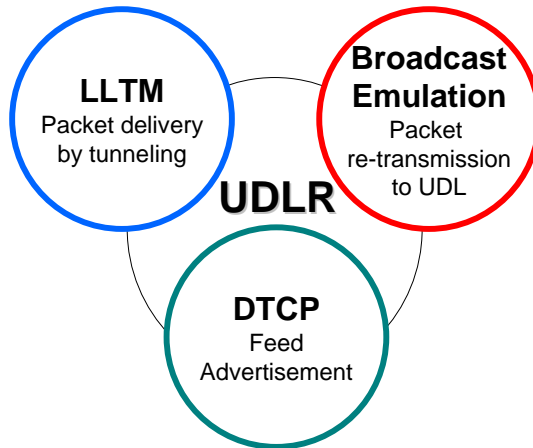


## What is DTCP?

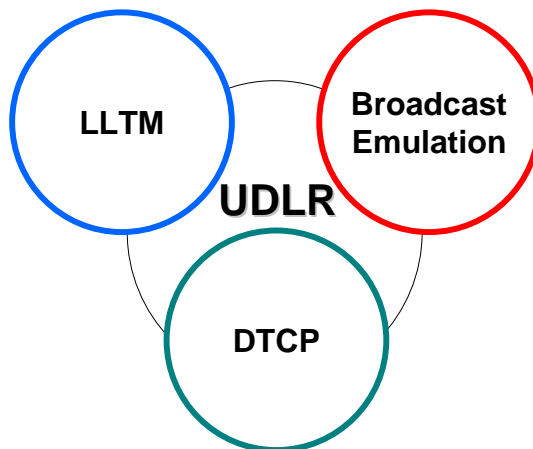


- One-way Protocol
  - Send-only Feed advertises the end point of LLTM to Receivers
  - Receivers learn the end point of LLTM to send the GRE packets
- DTCP HELLO Packet
  - Advertise IP Address of BDL I/F on UDL Feed
  - Periodic
    - Feed Up / Down, Join / Leave
    - UDL Up / Down
  - Destination IP Address: 224.0.0.36
  - Destination Port: 652

## UDLR Review! (original)



## UDLR Review!



# UDLR in SOI-Asia Network

Implementation



## Difference between Specification and Implementation



- Specification: Send-only Feed
- Implementation: Satellite Feed + Feed Router
  
- Specification: Receiver
- Implementation: Satellite Receiver + Receive Router

## Satellite Receivers (original)



- A satellite receiver for SOI Asia Network
  - Input radio wave from satellite UDL on Coax. Interface
  - Output Ethernet frames from LAN Interface
  - Provide Receiver functions of UDLR
    - GRE encapsulation
    - DTCP client
  - UDBox, SONY-BOX

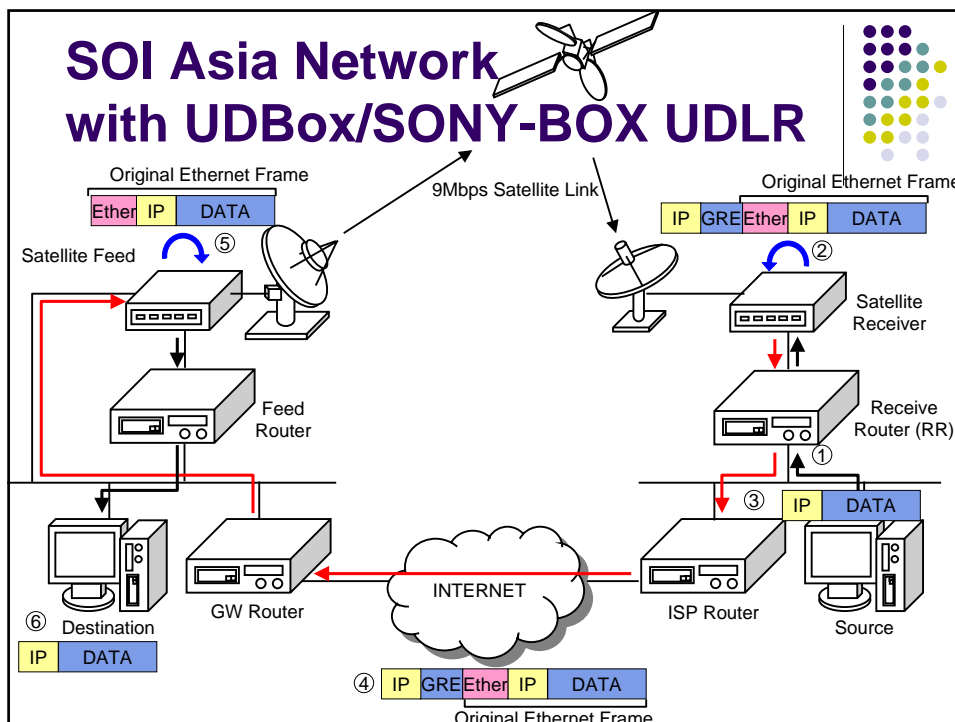
## Satellite Receivers



- A satellite receiver for SOI Asia network
  - Input radio carrier from satellite UDL on Coax. Interface
  - Output Ethernet frames from LAN Interface
  - Provide Receiver functions of UDLR
    - GRE encapsulation
    - DTCP client
  - UDBox, SONY-BOX

## Receive Router

- PC-based router for Unicast / Multicast routing
- Relationship with Satellite Receiver
  - Forward packet from Receive-only network to UDL (Satellite Receiver)
  - Forward GRE packets from Satellite Receiver to BDL (LAN connection to the Internet)

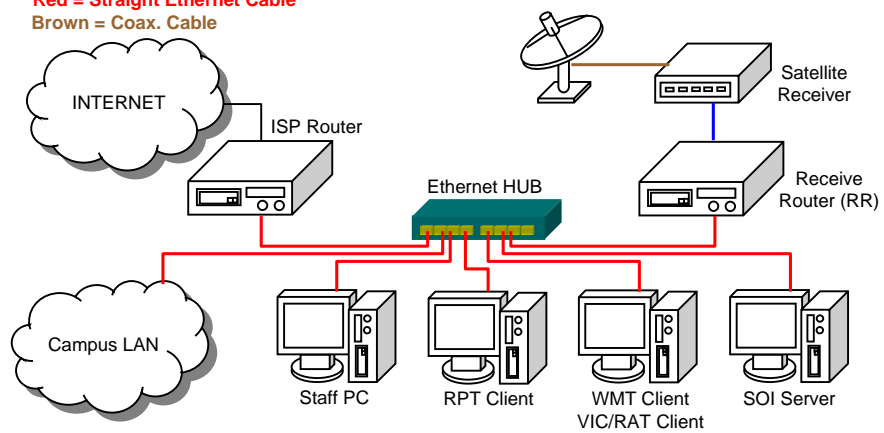


# Requirements for Developing SOI-Asia Network



## Connecting Devices

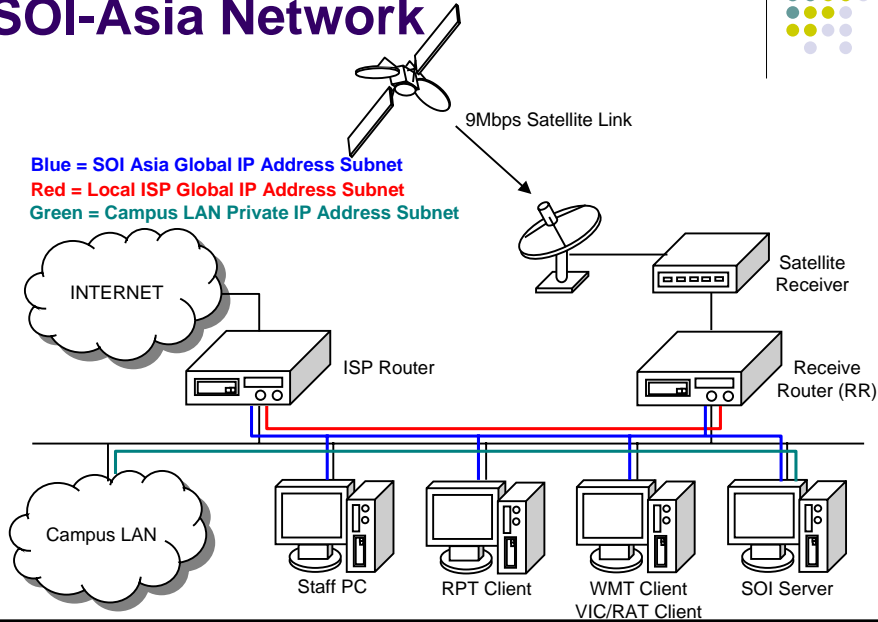
Blue = Cross Ethernet Cable  
Red = Straight Ethernet Cable  
Brown = Coax. Cable



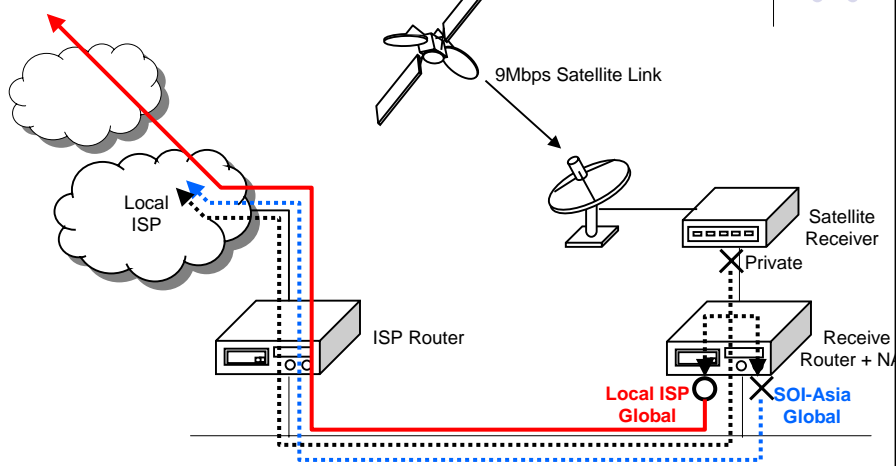
# Logical Subnets in SOI-Asia Network



Blue = SOI Asia Global IP Address Subnet  
 Red = Local ISP Global IP Address Subnet  
 Green = Campus LAN Private IP Address Subnet



# NAT in SOI-Asia Network



# Receive Router Configuration



## SOI-Asia Network Routing Configuration Outline



- Routing in the SOI-Asia Network
  - Unicast IPv4···Static Routing
  - Unicast IPv6···**Dynamic** Routing using OSPF
  - Multicast IPv4···Dynamic Routing using PIM-SM
  - Multicast IPv6···Dynamic Routing using PIM-SM
- Unicast IPv4
  - sfc-udl-feed advertises each route to each partner site

## Steps to Install Receive Router



- Kernel Configuration
- IPv4 Address Configuration
- Unicast Routing
- **NAT** Configuration
- IPv4 Multicast Routing
- IPv6 Address Configuration
- Unicast Routing
- Multicast Routing