Mobile IP for Data Network Mobility

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Agenda

- **Mobility Market Trends**

- **What is Mobile IP**

- **Mobility Networks**

  – **MSP Mobility Services**

  – **Mobility in Data Mobile Networks**

  – **Mobility in Enterprise Campus**

- **Summary**

Mobile Market in Asia Pacific

- Ending 2003, Asia Pac region emerged as largest mobile market worldwide. User base will grow from 551M in 2003 to 821M in 2008. By 2005, accounting for more than 1 in 4 mobile subscribers (28%)

- Service revenue will grow from $140.2B in 2003 to $249.7B in 2008 – representing significant growth at 12.2 CAGR

- ARPU declines through 2005 until lift from increased data traffic counteracts slide in voice revenue, pushing total mobile ARPU to $25.70 in 2008

- Data will contribute 34% of regional revenue in 2008, or $85 Billion. China market generates 81 Billion SMS in 2003.

- PWLAN forecasts in revenues will increase from $18M in 2003 to $558M in 2007, Korea, Japan, Taiwan & Singapore will lead market

Source: Yankee Group, UBS Warburg & Ovum 2003

Mobile - Market Drivers

- **Mobile systems are deploying packet data**
- **A foundation for integrating Mobile IP**

GSM → **GPRS** → **UMTS** → **3GPP**

Some Effort to do Circuit
    Switched Data

2G   **2.5G**   **3G**   **+ Mobile IP**

CDMA → **CDMA** → **CDMA** → **3GPP2**

Packet Switching
for Data Built-in   **2000**   **2000**

                           1xRTT   **3xRTT**

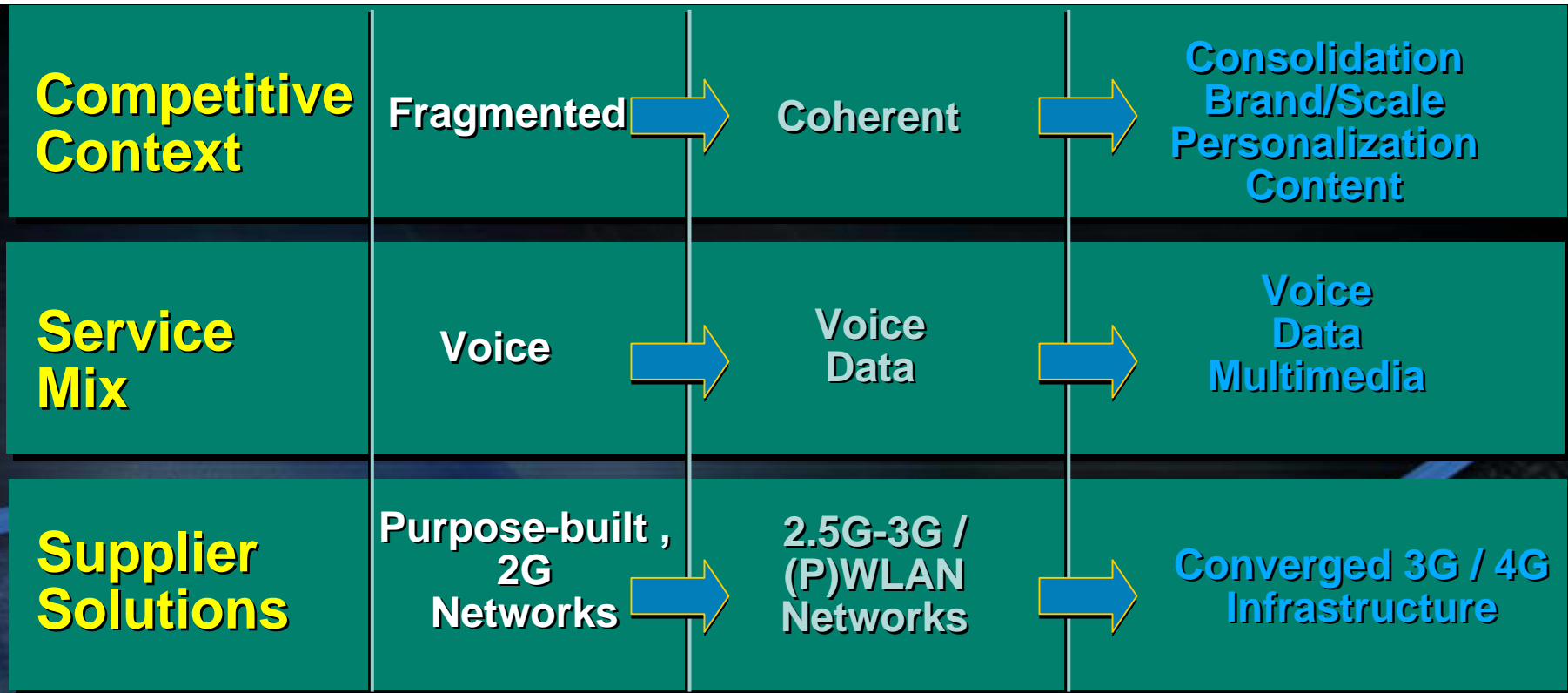# What are Emerging Mobile Data Services?

- **SMS,**

- **MMS,**

- **IMS, (Push-to-Talk)**

- **Online Gaming**

- **Video Applications**

    – **Video phone**

    – **Streaming Video**

      TV channels, Surveillance

- **Enterprise Mobility Services**

Cisco Mobility Vision

Office

Home

Conference Centre

Coffee Shop

Hotel

Train

Train Station

Plane

Airport Lounge

Car

VPN

LRE

Cable, ETTx, DSL

Ethernet

CDMA, 1xEV

Wireless LAN 802.11

UMTS, GPRS, GSM

Content & Billing Mgt.

Authentication Security

Mobile IP

Quality of Service

Translation & Optimisation

Mobile Industry Transitions

Competitive Context	Fragmented →	Coherent →	**Consolidation Brand/Scale Personalization Content**
Service Mix	Voice →	Voice Data →	**Voice Data Multimedia**
Supplier Solutions	Purpose-built , 2G Networks →	2.5G-3G / (P)WLAN Networks →	**Converged 3G / 4G Infrastructure**

Time →

7

Mobile Network Building Block
Evolving to an Open Architecture

Mobile Applications and Content

Application Aware
Mobile Services

Common **Management**

Multiple Mobile Client & Device Support	*Radio Access Agnostic Transport & Aggregation*	*Intelligent Mobile Service Edge*	*Multi-Service Core*

IP-Based **Signaling and Control**

End-to-End **Packet Intelligence**

Service Aware **Mobile Packet Infrastructure**

8
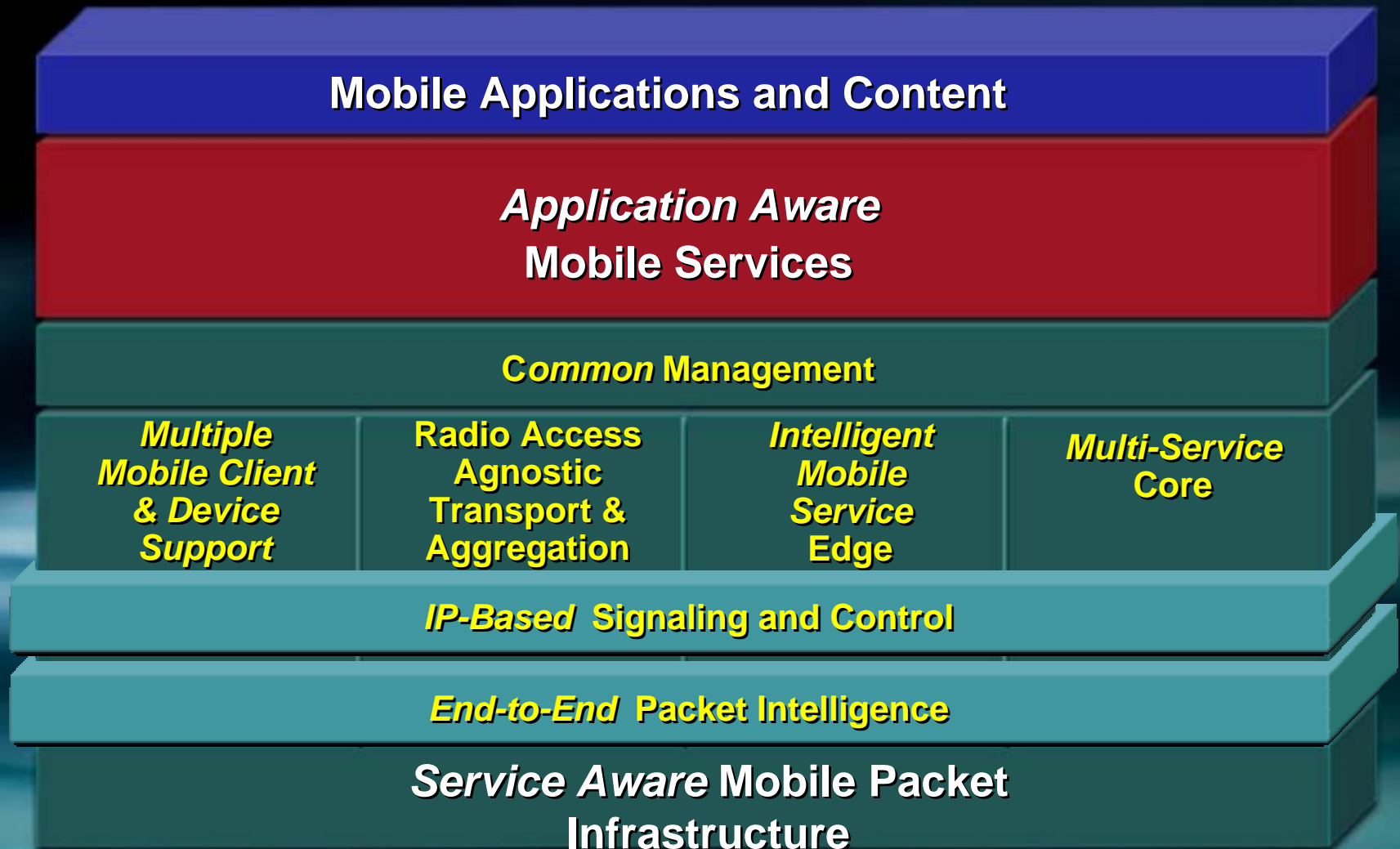
Cisco Mobile Solution
Value Proposition

Metrics

- ARPU
- Sub Growth & Churn
- Free Cash Flow
- Debt Burden
- Valuation
- Risk

Strategy

Increase Revenue
- Increase Number of Subscribers
- Increase RGU/ARPU

Decrease Cost
- Manage CAPEX
- Decrease OPEX

Balance Risk/Reward
- Minimize Risk
- Maximize Potential

Focus

Increase Number of Subscribers:
- Transport Capacity Improvement
- Eliminate IN bottleneck
- Reduce Churn thru bundles

Increase RGU/ARPU:
- Mobile Data Services Content-based billing HotSpots

Manage CAPEX:
- Optimize investment
- Improve Asset Utilization

Decrease OPEX:
- Improve Bandwidth efficiency
- Consolidate networks

Minimize Risk:
- Network Migration
- Legacy where appropriate

Maximize Potential:
- Multi-purpose network
- Scalability

Value Proposition

- IT Network, e-Optimisation
- IP/ATM Backbones
- Data Centers and Storage
- Cell Site Router, SS7oIP
- Service Edge / CMX / Security
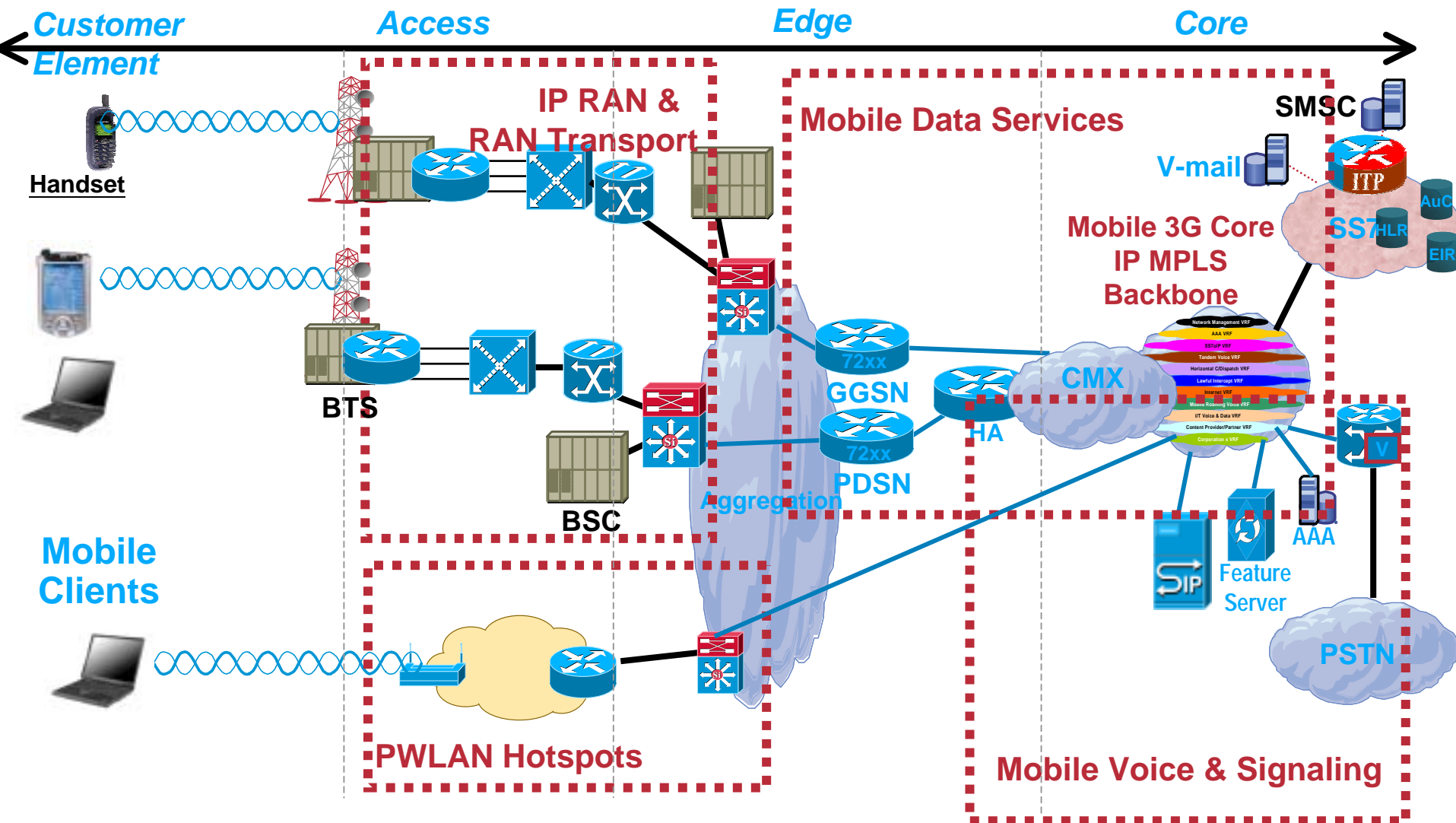- WLAN and Public WLAN
- Mobile Data Services
- Media Gateway
- Backhaul from Radio over IP
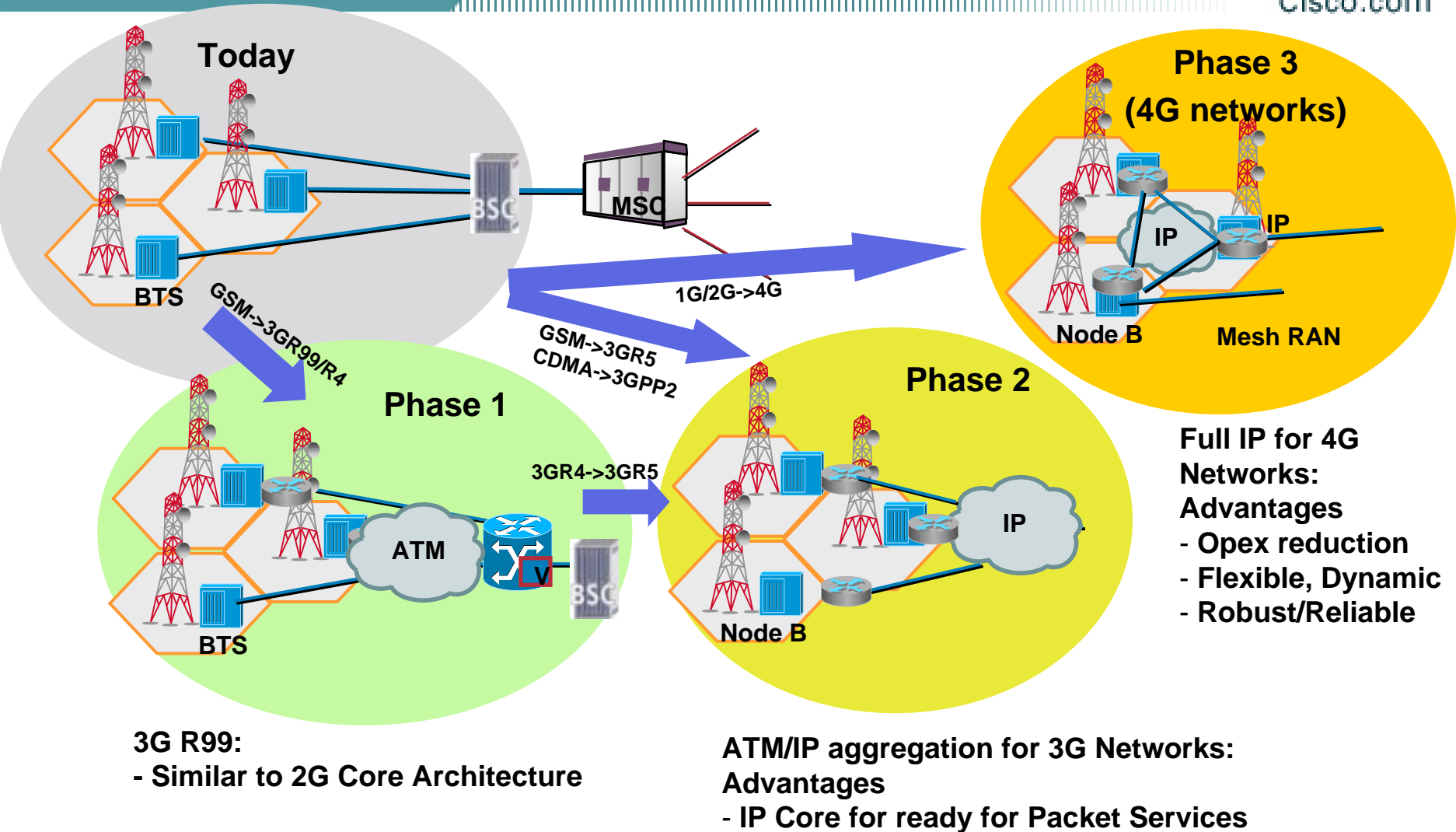- Joint Service Development & Marketing Programs

Mobile IP

Mobile Reference Architecture
Solutions to Evolve Mobile Network

Customer Element

Access

Edge

Core

IP RAN & RAN Transport

Mobile Data Services

SMSC

V-mail

ITP

Mobile 3G Core IP MPLS Backbone

SS7

AuC

HLR

EIR

Handset

BTS

BSC

72xx

GGSN

72xx

PDSN

HA

CMX

Aggregation

Mobile Clients

PWLAN Hotspots

Feature Server

AAA

PSTN

Mobile Voice & Signaling

Radio Access Network (RAN) Evolution

Today

BTS

GSM->3GR99/R4

**Phase 3
(4G networks)**

IP

IP

Node B

Mesh RAN

1G/2G->4G

GSM->3GR5
CDMA->3GPP2

Phase 1

ATM

V

BSC

3GR4->3GR5

Phase 2

IP

Node B

**Full IP for 4G Networks:
Advantages**
- **Opex reduction**
- **Flexible, Dynamic**
- **Robust/Reliable**

3G R99:
- Similar to 2G Core Architecture

**ATM/IP aggregation for 3G Networks:
Advantages**
- IP Core for ready for Packet Services

Mobile IP

Definition of Mobility

Nomadic – Connectivity before and after move. Change IP address -> Sessions are reset after move.

Mobility – Connectivity before and after move. No change in IP address -> Sessions are not reset after move.

What is Mobile IP ?

"Mobile IP provides an IP node the ability to retain the same IP address and maintain uninterrupted network and application connectivity while traveling across networks "
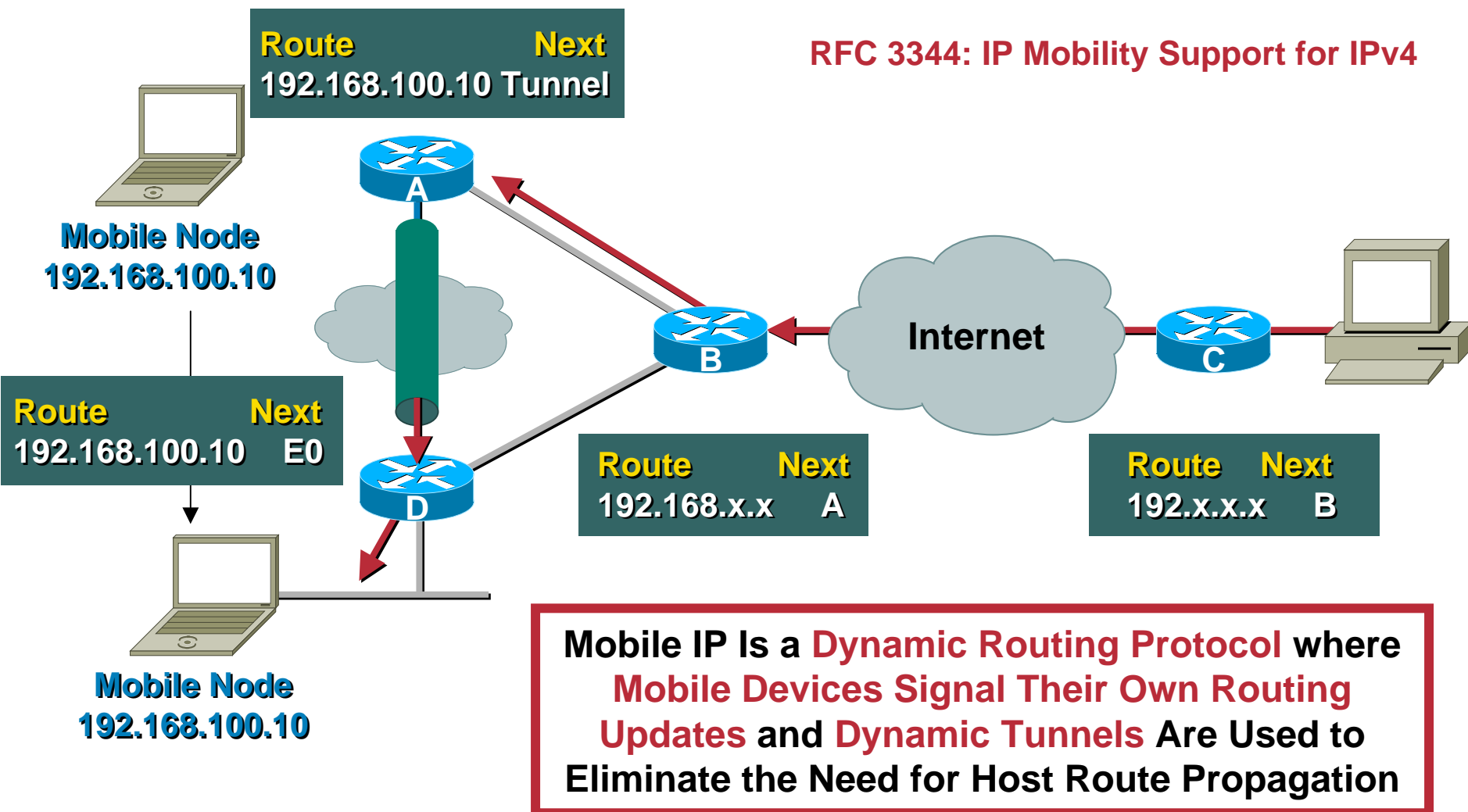
An "always on" IP service availability independent of location, movement or infrastructure

Basic Concept of Mobile IP

RFC 3344: IP Mobility Support for IPv4

Route	Next
192.168.100.10	Tunnel

Mobile Node
192.168.100.10

Route	Next
192.168.100.10	E0

Mobile Node
192.168.100.10

Internet

Route	Next
192.168.x.x	A

Route	Next
192.x.x.x	B

Mobile IP Is a Dynamic Routing Protocol where Mobile Devices Signal Their Own Routing Updates and Dynamic Tunnels Are Used to Eliminate the Need for Host Route Propagation
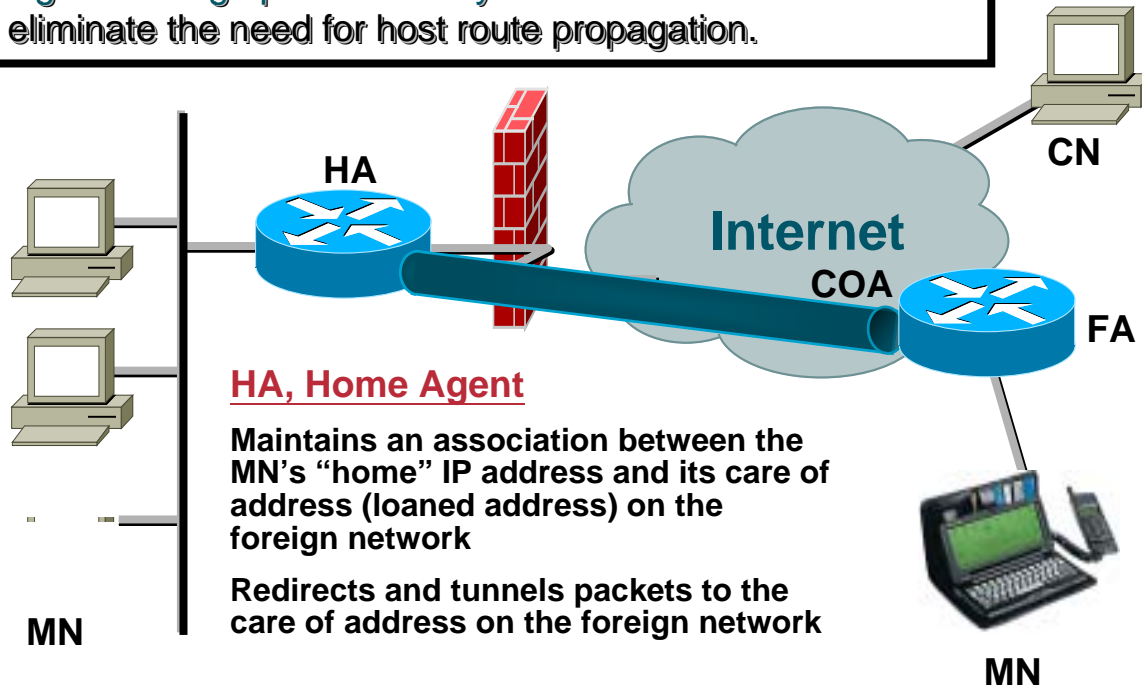
Mobile IP
Key Components

Mobile IP is comprised of three components:

1. **Mobile Node (MN):** IP clients: notebooks, cell phones, PDAs (Updates CoA via RRQ)

2. **Home Agent (HA):** Mobile IP enabled gateway (acts as location database for MNs)

3. **Foreign Agent (FA):** Mobile IP enabled gateway [Optional] (Off-loads CPU processing of encapsulation/decapsulation, Enforces local network administration policy, Allows for billing of MNs, Conserves IP address space, Enables Local authentication)

Mobile IP in a Nutshell

Mobile IP is a dynamic routing protocol where end devices signal routing updates and dynamic tunnels are used to eliminate the need for host route propagation.

Internet

HA

COA

FA

CN

MN

MN

CN, Correspondent Node

Destination IP host in session with a Mobile Node

FA, Foreign Agent

Provides an addressable point of attachment to the MN called Care Of Address (COA)

Maintains an awareness for all visiting MNs

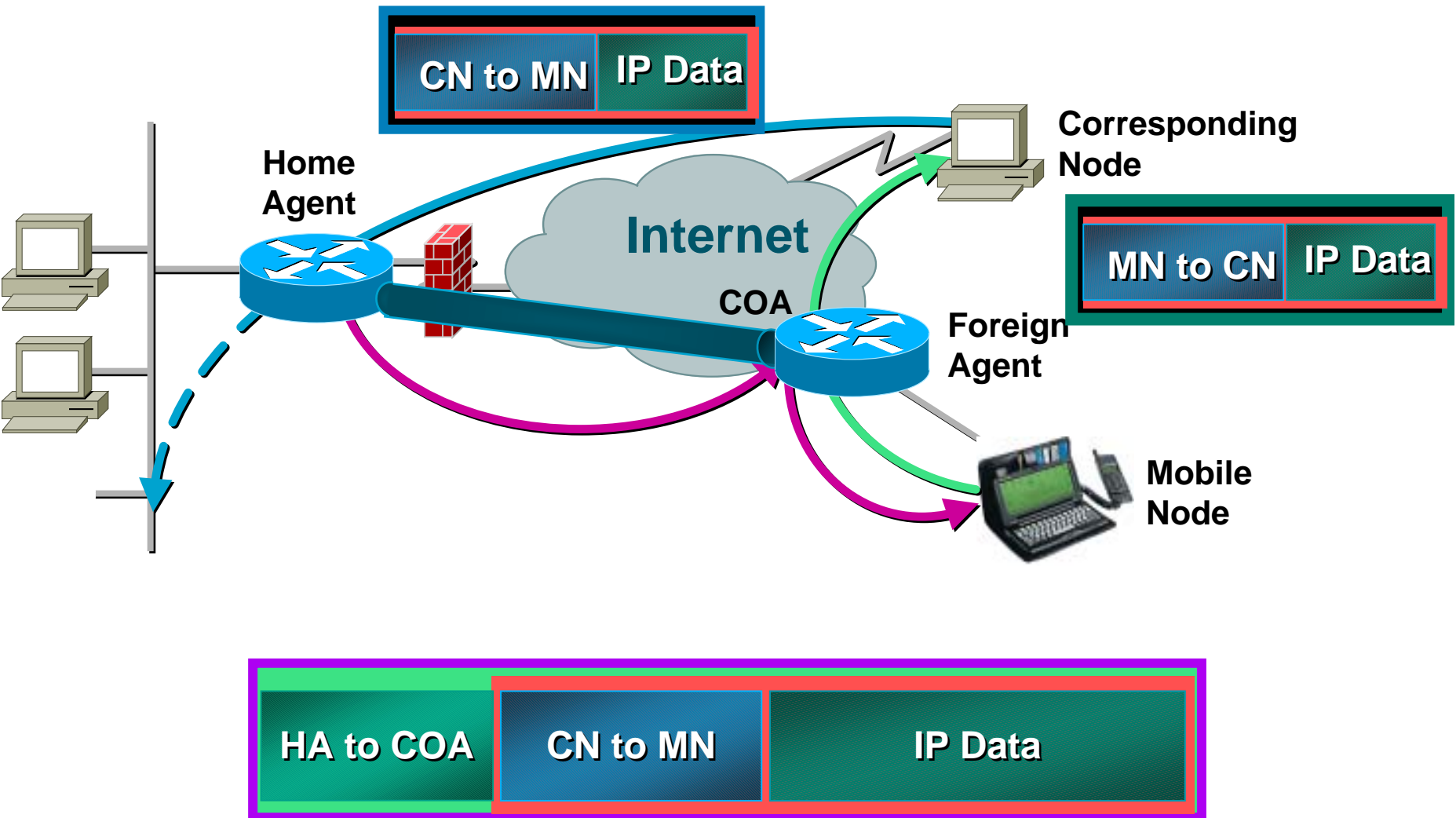**Acts as a 'relay' between the MN and its Home Agent**

Receives all packets for the MN from the MN's Home Agent

HA, Home Agent

Maintains an association between the MN's "home" IP address and its care of address (loaned address) on the foreign network

Redirects and tunnels packets to the care of address on the foreign network

MN, Mobile Node

An IP host that maintains network connectivity using its "home" IP address, regardless of which subnet (or network) it is connected to

Typical Packet Forwarding
"Triangle Routing"

CN to MN	IP Data

Corresponding Node

Home Agent

Internet

MN to CN	IP Data

COA

Foreign Agent

Mobile Node

HA to COA	CN to MN	IP Data

Alternate Packet Forwarding "Reverse Tunnel"
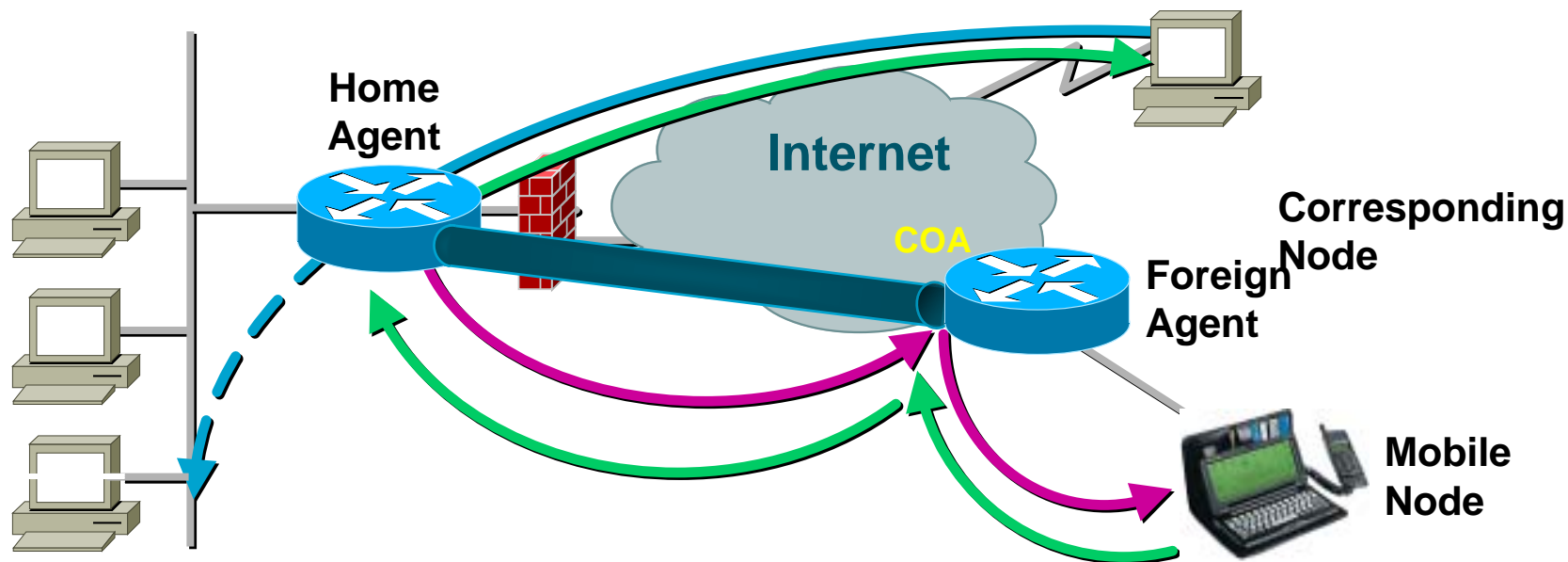
- **Ingress filtering will drop packets that have topologically incorrect source address**

Roaming with Mobile IP

Mobility Binding Table:

MN	COA
1.1.1.3	10.31.1.1
1.1.1.7	~~10.31.1.1~~ – 10.31.2.1
1.1.1.8	10.31.2.1
1.1.1.5	10.31.3.1

1.1.1.7

MN

FA

10.31.2.1

FA

10.31.3.1

MN

FA

10.31.1.1

New Data Path

Old Data Path

HA

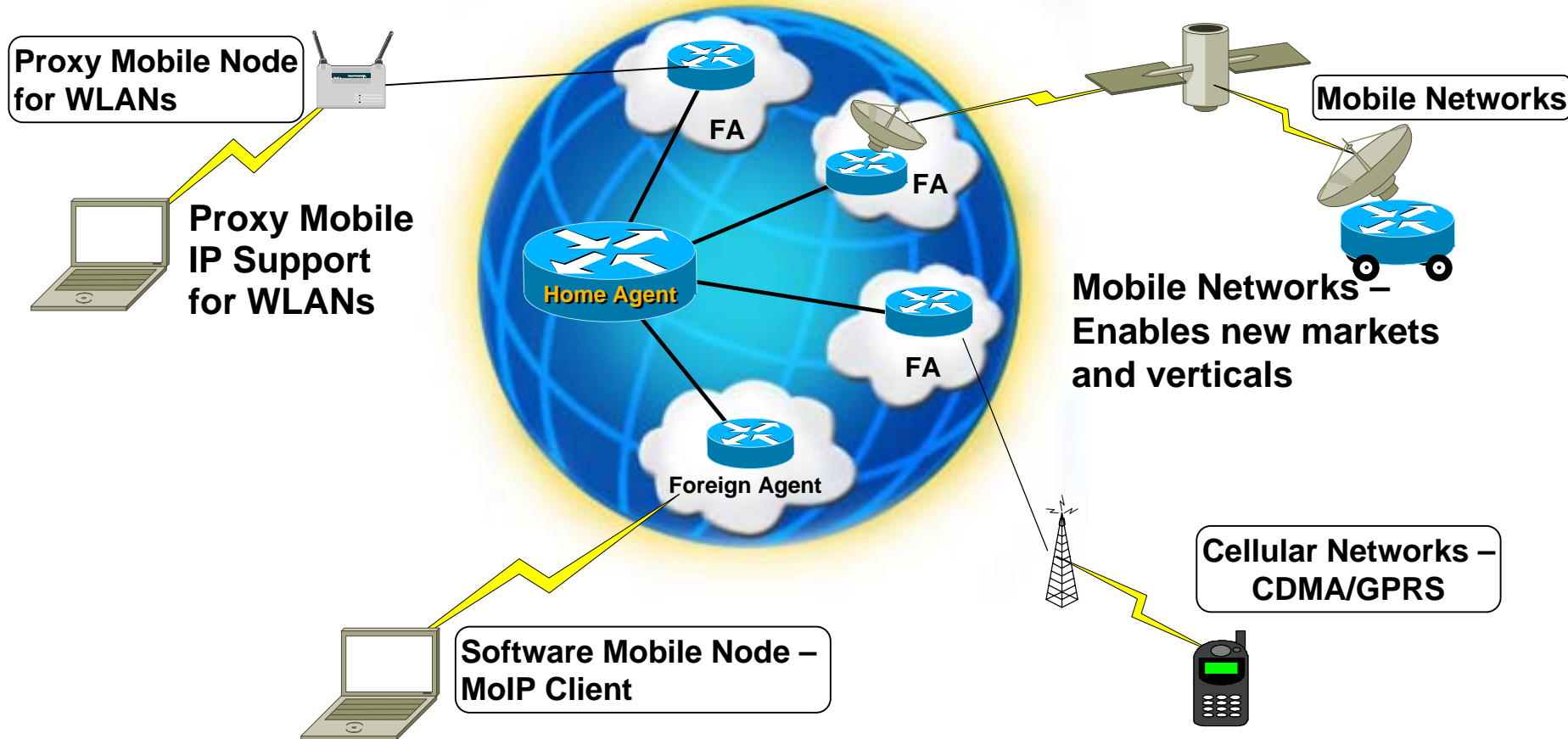**No change is propagated to corresponding nodes**

1.1.1.7
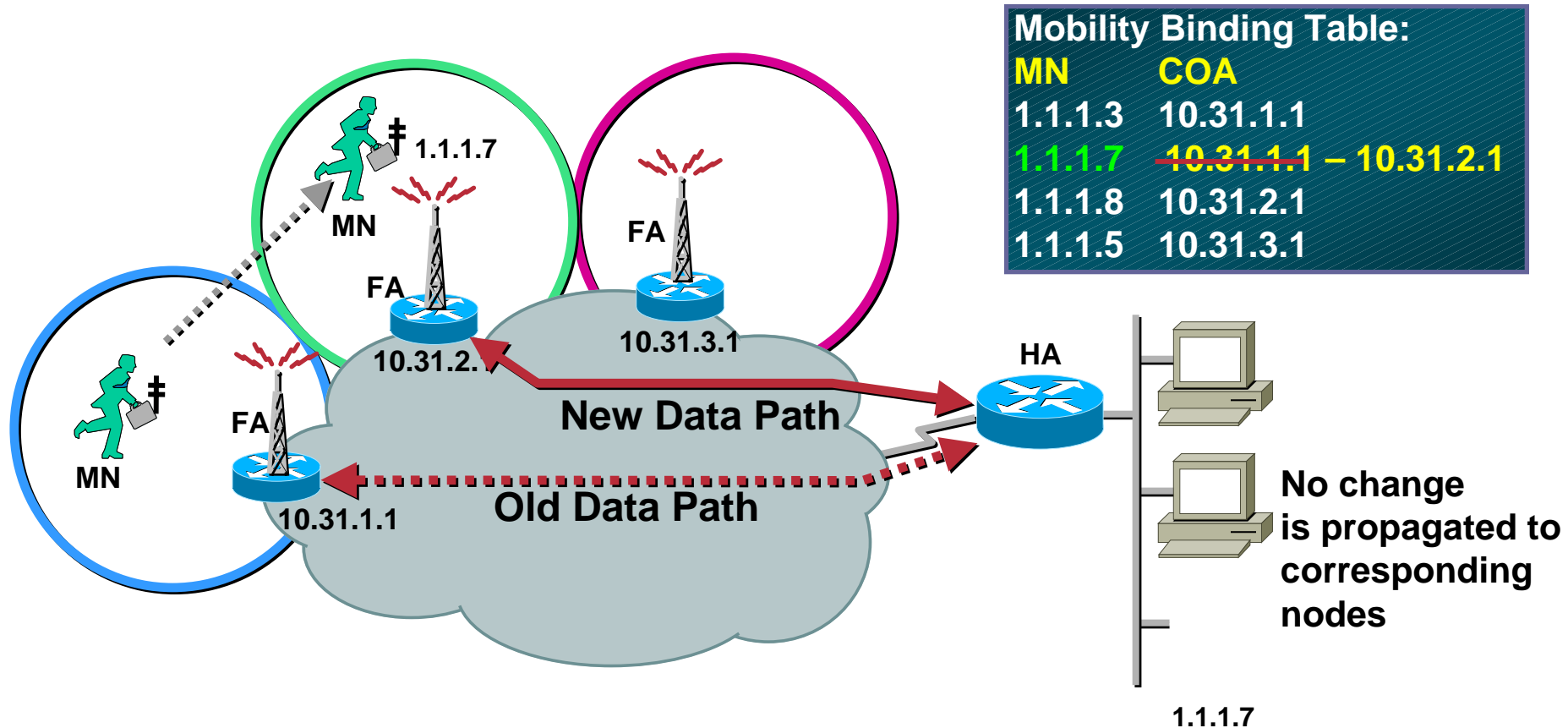
The movement is transparent to all other devices

Mobile IP – Service Architectures

IP Service Integration – Integrate Mobile IP with IPSec VPNs, Multicast, QoS etc. Pushing the edge of the network out to the Mobile environment

Proxy Mobile Node for WLANs

Proxy Mobile IP Support for WLANs

FA

FA

Home Agent

FA

Foreign Agent

Mobile Networks

Mobile Networks – Enables new markets and verticals

Cellular Networks – CDMA/GPRS
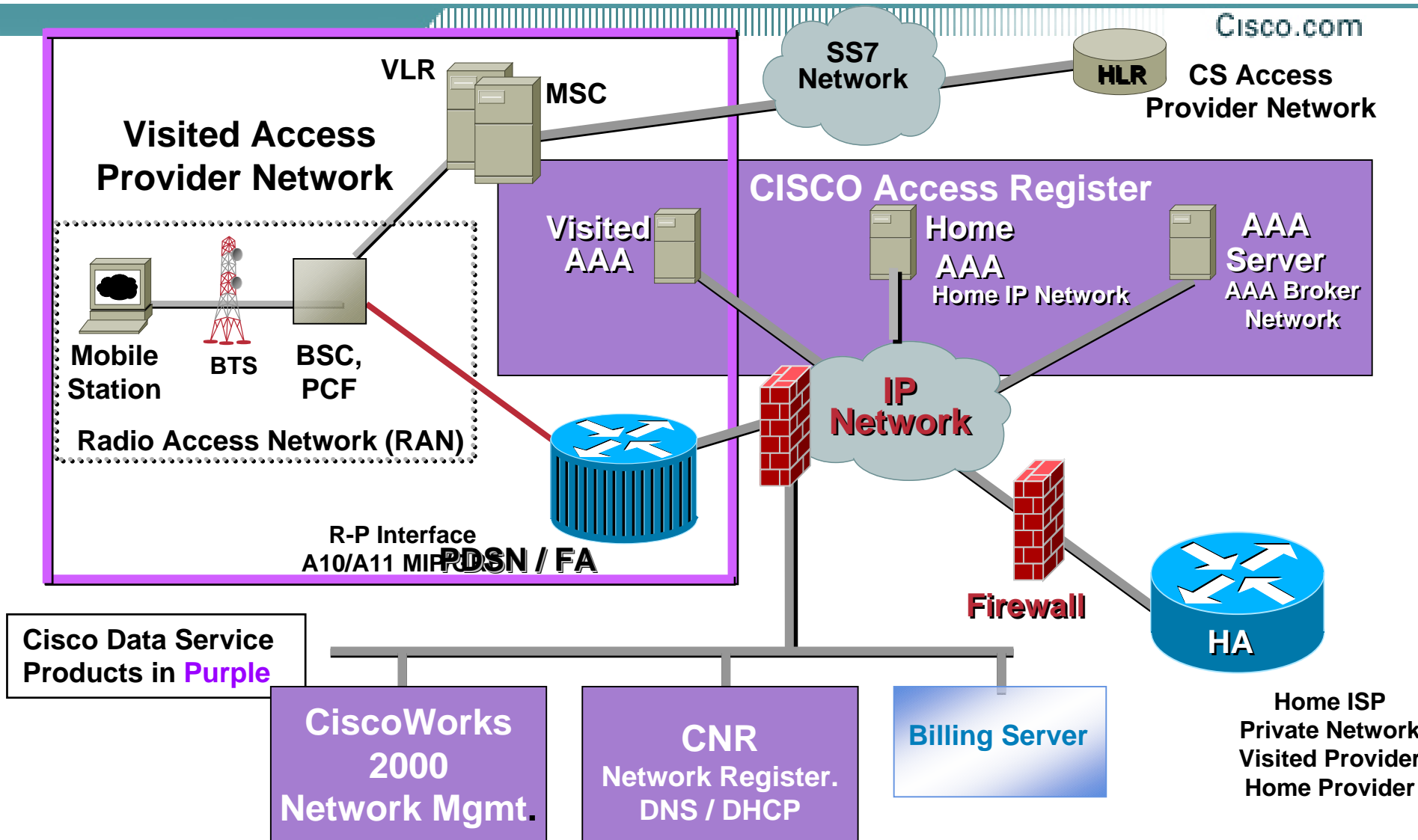
Software Mobile Node – MoIP Client

Mobility Data Networks

Data Network Mobility Opportunities

- **MSP Mobility Services**
  - **Cellular, beyond Simple IP; 2.5G and 3 G**

    Hot-spot mobility 'WLAN – Cellular'
  - **CDMA2000,**
  - **VoIP Over 2.5G (GPRS/CDMA1x/EVDO)**
- **Mobility in Data Mobile Networks**
  - **Entire subnets that are mobile**

    Automobiles, Trains, Planes, Boats
- **Mobility in Enterprise Campus**
  - **In building and between building movement,**

    Movement between multiple connection types

Cisco's CDMA2000 Solution

Visited Access Provider Network

VLR

MSC

SS7 Network

HLR

CS Access Provider Network

CISCO Access Register

Visited AAA

Home AAA
Home IP Network

AAA Server
AAA Broker Network

Mobile Station

BTS

BSC, PCF

IP Network

Radio Access Network (RAN)

R-P Interface
A10/A11 MIP

PDSN / FA

Firewall

HA

Cisco Data Service Products in Purple

CiscoWorks 2000 Network Mgmt.

CNR
Network Register.
DNS / DHCP

Billing Server

Home ISP
Private Network
Visited Provider
Home Provider

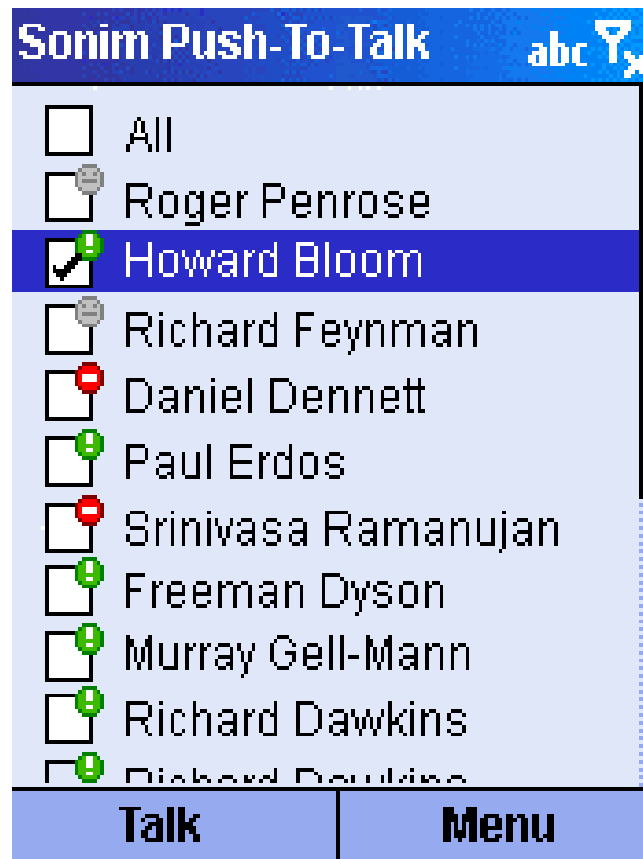# Nextel Online – Wireless Internet Runs over Mobile IP

- **Wireless Internet Service**

  Internet e-mail, news, financial, receive alerts, …

- **Mobile IP end to end**

- **Nationwide deployment today**

  Int'l deployment starting "Mexico, Brazil, Argentina, Peru, Chile, Phillipines"

- **~2k users a day being added**

  - **Flat fee revenue model**

- **Cisco and Motorola Mobile IP interoperability**

- **Information can be pulled by and pushed to the user**

Push-To-Talk Services – Ad hoc Conferencing over IP

- **Always-on**
- **Instance Voice**
- **Click to Call**

Sonim Push-To-Talk   abc

- All
- Roger Penrose
- **Howard Bloom**
- Richard Feynman
- Daniel Dennett
- Paul Erdos
- Srinivasa Ramanujan
- Freeman Dyson
- Murray Gell-Mann
- Richard Dawkins

Talk   **Menu**

Push-To-Talk Offered by Mobile Carriers

- **Nextel: 94 % of Nextel customers use Direct Connect^{TM} (push-to-talk service) since Mid 2003.**

- **Verizon Wireless, US largest wireless service provider, offers Push to Talk service nationwide on August 18, 2003.**

- **Orange Launch Push-To-Talk Wireless worldwide, British and France 2Q, 2004, and 10 countries by the end of Year 2004.**

- **Many other carriers are following to offer Push-to-Talk service**

# Mobile Access Router for Mobility Network

The Cisco Solution – The New Cisco 3200 Mobile Access Router

New Cisco IOS router platform that extends the IP frontier to mobile vehicular environment

- **Small Footprint & Low Power consumption**

- **Ruggedized**

- **Performance comparable to 3640**

- **Optimized for embedded applications**

- **Utilizes Cisco IOS, Mobile IP & Cisco Mobile Networks**
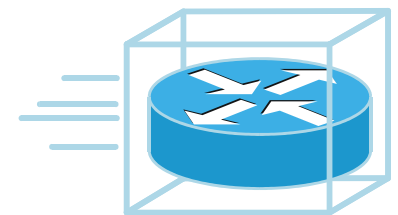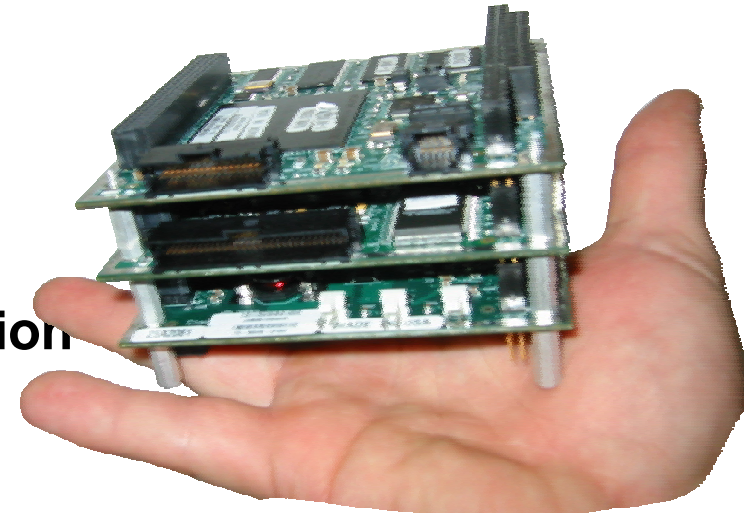
Vertical Market Applications
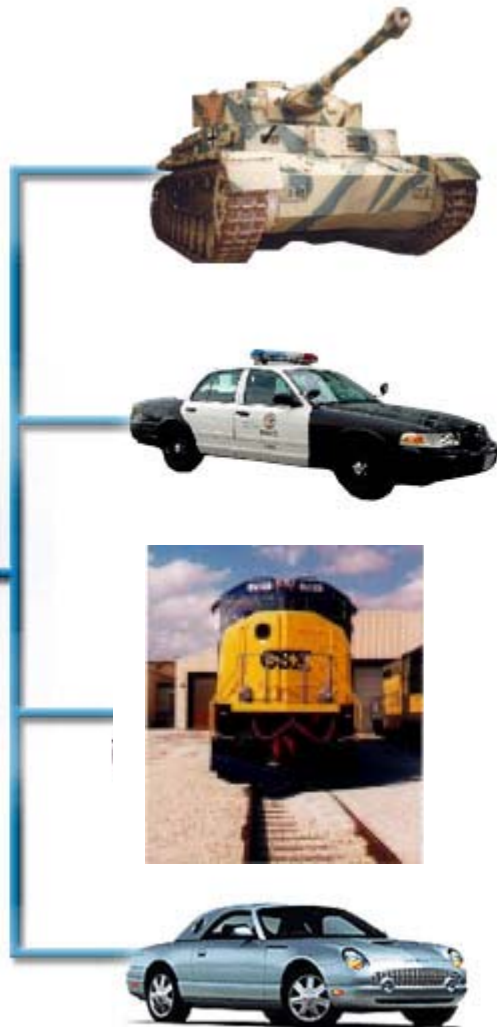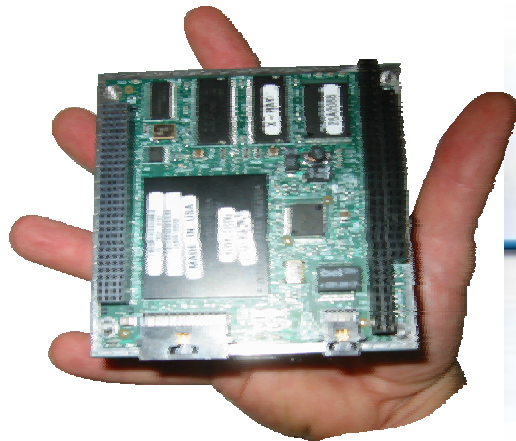
Defense
- Army, Navy, Marines, Air Force, NATO, UK DoD, etc.

Public Services & Homeland Security
- EMS
- Police
- Fire Fighters

Commercial Markets
- Mass Transit
- Rail & Airlines
- Rental fleets
- Commercial aircraft
- Heavy equipment, logistics

Consumer Automotive
- Telematics
- Infotainment

Networks in Motion (tm)

Seamless Mobility…Network of Networks

Mobile Router inside a tank

Satellite Coverage

Radio Coverage

Mobile Router

Wireless LAN Coverage

IP

N
W — E
S

Uninterrupted Access = Coverage + Bandwidth
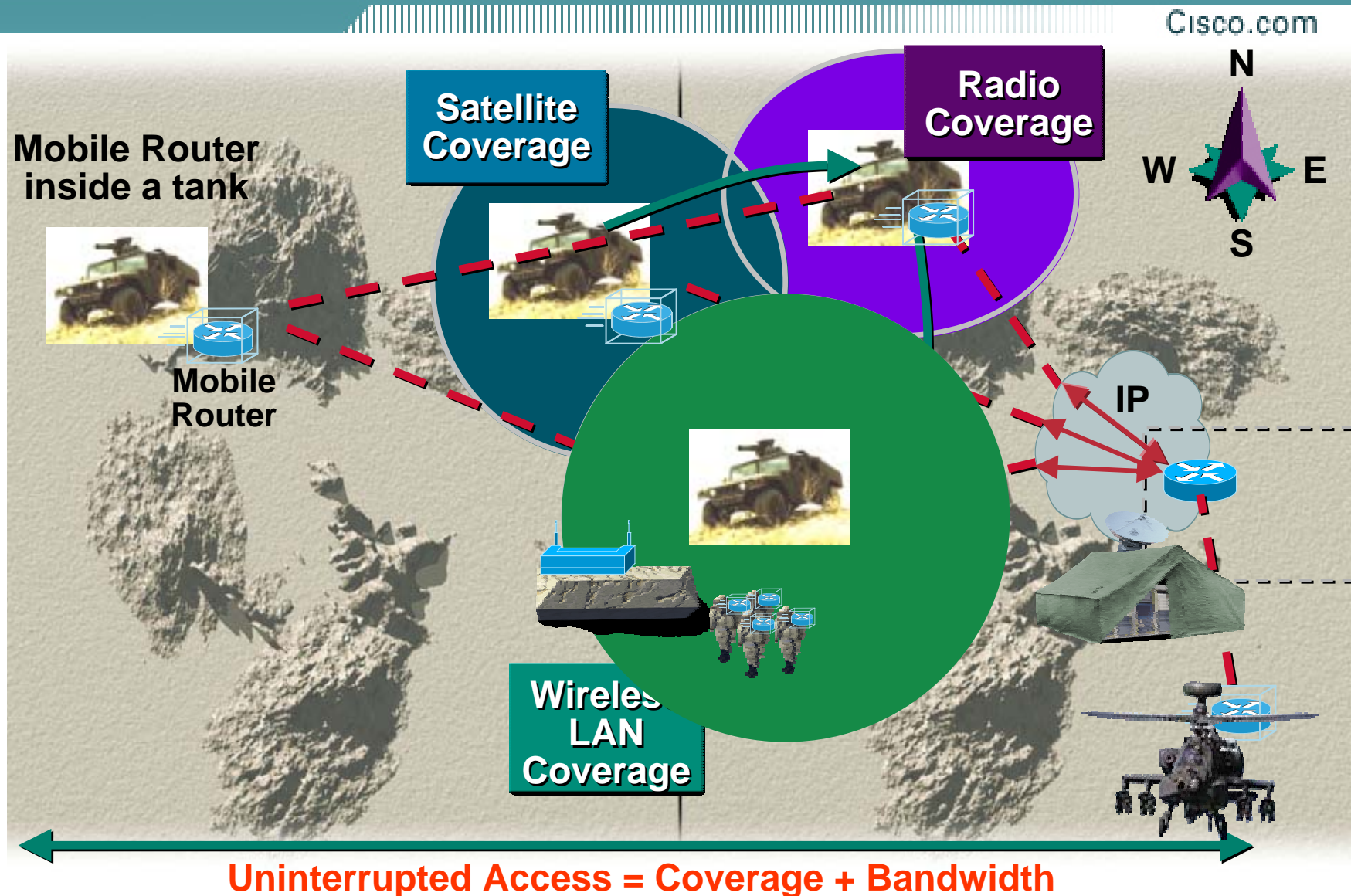
LifeLink™ Concept Developed by SwRI
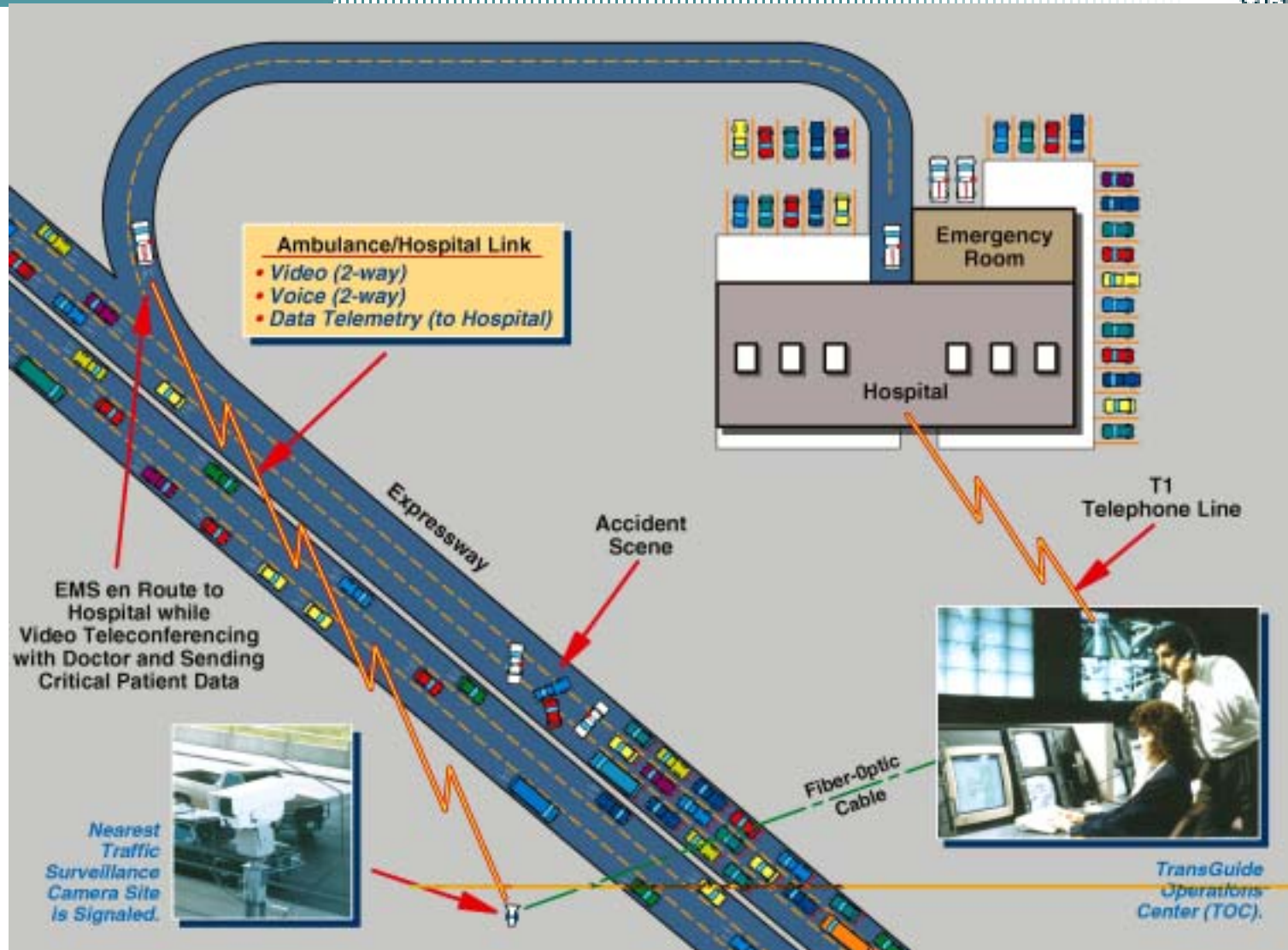
Cisco and Telematics

In-vehicle Environment

To
- J1850
- CAN
- J1939

Serial / USB

Ethernet

Black box recorder

Serial

PCMCIA

802.11

Cellular WAN

Mobile SOHO Router

Serial

GPS

Data Entry

Vehicle Environment

Service Provider

•Navigation
•MP3, video
•Concierge
•Emergency

Satellite   **GPS**

Cellular Network

2G, 2.5G, 3G

802.11

Home

•Email
•MP3, video
•News, weather
•Traffic

IP Network

802.11

Intranet

•eCRM
•Secure VPN
•Email, calendar
•PBX extension
•Location track

802.11

802.11

BT

Corporate Site

Vehicle Subnet

Business

•eCommerce
•MP3, video
•Diagnostic info

Telematics Food Chain

Figure 5 Players Seeking Consumer Relationships And Dollars

Wireless carriers
ex: Sprint PCS, Verizon
• Connection fees
• Commerce revenue split
• Subscription fees for services

Service providers
ex: OnStar, ATX, Wingcast
• Subscription revenue
• Share of pay-per-use fees
• Commerce revenue split

Retailers
ex: Circuit City, Best Buy
• Equipment sales
• Installation fees

Consumer

Automakers
ex: Ford, GM
• Extend relationship with consumers
• Increase ongoing revenue and margins

Content companies
ex: Yahoo!, ESPN, WSJ
• Ad revenue from marketers
• Share of subscription fees
• Pay-per-use fees
• Commerce revenue split

Hardware vendors
ex: Delphi, Visteon, InfoMove
• Hardware revenues from dealer and after-market sales
• Revenue from hardware bundling by service providers

Source: Forrester Research, Inc.

Static Network
Mobile Network Routing

Mobile Network

Node on MR

Roaming
Interface

Mobile Router

HA-MR Tunnel

FA WAN

HA-FA Tunnel

Foreign Agent

Internet WAN

Internet

Internet WAN

Home Agent

Mobile Network
appears to be here

Correspondent Node
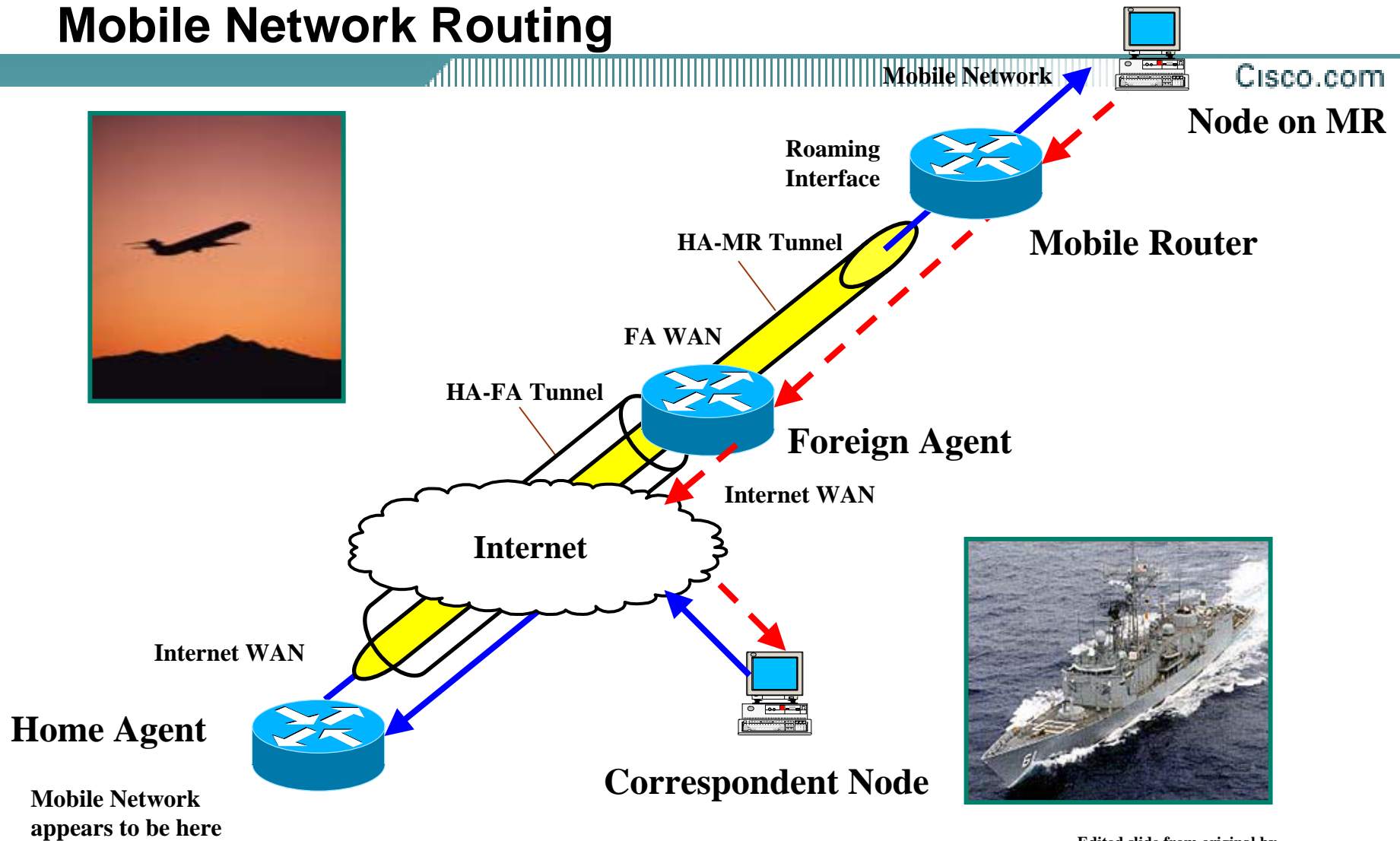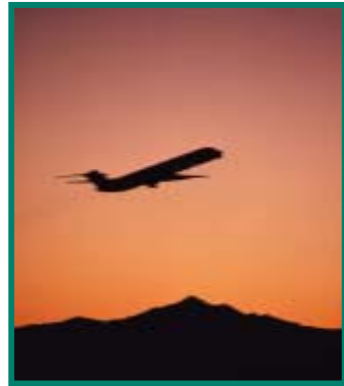
Edited slide from original by
William D. Ivancic, NASA Glenn

Mobile Access Router - Typical Application

Cisco IOS Mobile Networks Software Creates Appearance of Always on Connection to Applications

In-Vehicle Network

Police Headquarters

Portable

Hand Held

Mug Scanner

Video Camera

Mobile Router

Fixed IP Addresses

802.11

PMR/ GPRS/ CDPD

Any Wireless Network

Crime Database

Dispatch
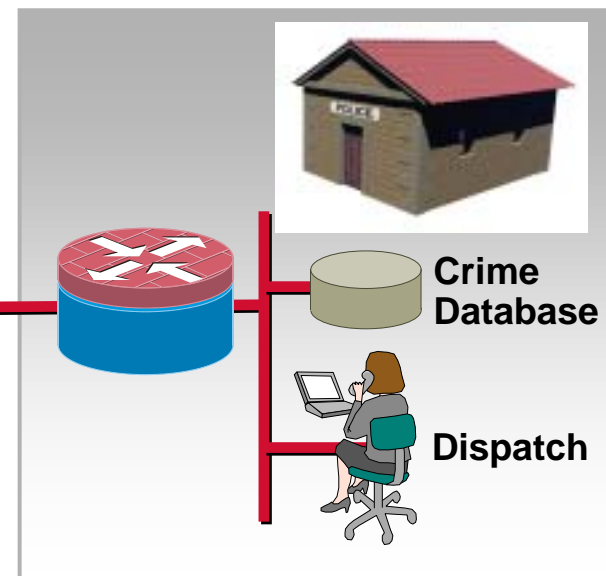
User-Defined Network Selection based on:

- **Cost**
- **Bandwidth**
- **Availability**

Proxy Mobile IP

- **Issue: IT must install extra software on all mobile nodes**

- **Solution: Use proxy mobile IP to allow seamless roaming**

  Extra equipment (APs) or FA to be proxy for mobile nodes

  Such as 802.11 APs, GGSN, PDSN..

Proxy Mobile IP for the MN

Subnet	HA address	AP address
10.2.1.0	10.2.1.1	10.2.1.8
10.10.1.0	10.10.1.1	10.10.1.5
10.20.2.0	10.20.2.1	10.20.2.6
10.30.3.0	10.30.3.1	10.30.3.7

Subnet	HA address	AP address
10.10.1.0	10.10.1.1	10.10.1.5
10.20.2.0	10.20.2.1	10.20.2.6
10.30.3.0	10.30.3.1	10.30.3.7
10.2.1.0	10.2.1.1	10.2.1.8

HA/FA

HA/FA

AP-1
10.2.1.8

10.2.1.1

10.10.1.1

MN
10.20.2.58

10.10.1.5

AP Config	
authoritative-1	10.10.1.5
Authoritative-2	10.20.2.6
authoritative-3	10.30.3.7

HA/FA

10.20.2.1

10.20.2.6

HA/FA

10.30.3.1

10.30.3.7

FA inserts visitor into FA Visitor table and forwards reply to AP.

AP periodically renews registration as long as MN is associated.

Mobile IP for WLAN of Enterprise

Every AP have a Voice QoS enbable;

Voice/Video terminal will keep same IP address which get from Home Network

For Big Campus, Customer can use Outdoor AP for Outdoor covering;

Bottlenecks in Mobile Network

Uu

Iu

Access Network

Core Network

Services/Operations

UTRAN

RNC

Node B

Iu-r

Node B

RNC

1941

CN CS Domain

3G MSC

MSC Srv

HLR/AuC/EIR

CN PS Domain

SGGN

GGSN

CSG

Service and Control Domain

SMSC
MMSC
IMSC

Billing

NOC

IP Core Network

Packet Signaling Network

Abis Backhaul Suppression over IP

BTS

PWLAN

Reduce Bandwidth Required per Digital Voice Call

OAM

BSC/RNC

Microwave equip
LBS

BTS

RS-232

MTSO

RAN Core

AAA, HA, Server farms

PC

Web Cam

T1/E1

GW

IP Core Network

BTS

T1/E1 TDM

PDSN/GGSN

PSTN

Cisco MWR 1941-DC

Internet

- **Lowers backhaul costs— the largest operating expense in the network**

- **Increase call density on T1/E1s or free up capacity for other uses**

Cell Site DCN

BTS /Node B

OpEx Reductions:

- **Remote cell site access reduces expensive truck rolls**

- **Cell site LAN extension improves staff efficiency**

- **Enables new apps and services**

T1/E1 voice circuits

Drop and Insert Additional DS0(s)

Cisco MWR 1941-DC

BSC/RNC

RS-232

T1/E1 voice circuits

T1/E1 voice circuits

Management data traffic DS0(s)

RF Monitoring Unit
Microwave Equipment
Tower Light Controller
Battery System
Alarm Monitoring
Contact Closures

10/100 Base-T

10/100 Base-T

Technician Laptop (Email for trouble tickets, network access, etc.).
Web Camera for Security
Location-Based Server
WLAN
Cell Site IT Network connectivity
VoIP Softphone
Access to inventory databases, technical knowledge databases, manuals, update techniques
Local data archival

Network Operations Center

Multi-Purpose RAN Backhaul for PWLAN and Other 3G/4G Data Overlays

PWLAN, IP Wireless, Flarion

OAM

BSC/RNC

• **Re-use existing backhaul to transport PWLAN, 3/4G IP bearer traffic, and other services, in addition to traditional 2/3G voice and data**
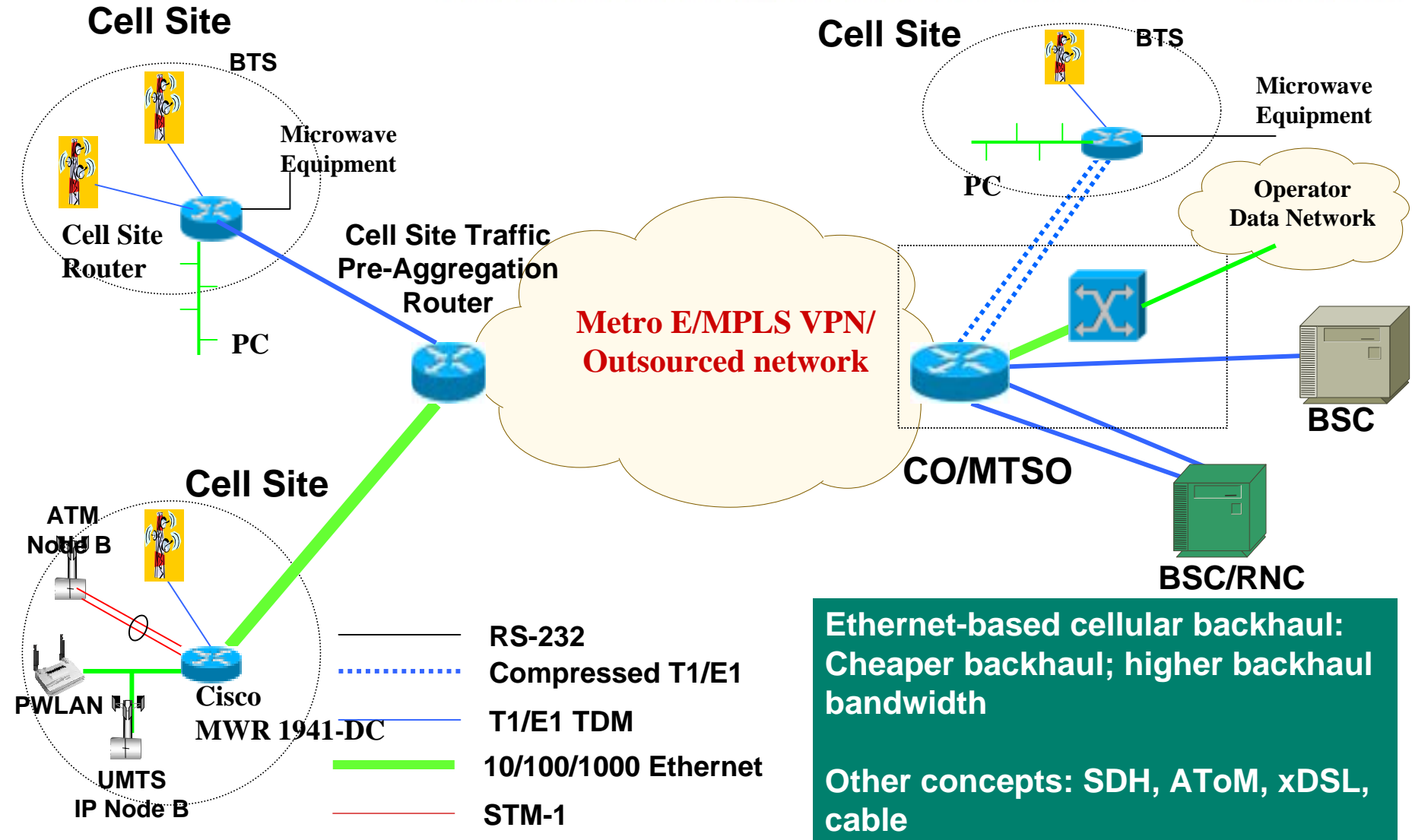
Microwave equip LBS

RS-232

MTSO

RAN Core

AAA, HA, Server farms

Drop and Insert Additional DS0(s)

PC

Web Cam

PWLAN, IP Wireless, Flarion

T1/E1

GW

IP Core Network

PWLAN, IP Wireless, Flarion

PDSN/GGSN

T1 TDM

PSTN

BTS/Node B

Cisco MWR 1941-DC

Internet

Alternative Backhaul

Cell Site

BTS

Microwave Equipment

Cell Site Router

PC

Cell Site Traffic Pre-Aggregation Router

Metro E/MPLS VPN/ Outsourced network

Cell Site

BTS

Microwave Equipment

PC

Operator Data Network

CO/MTSO

BSC

BSC/RNC

Cell Site

ATM Node B

PWLAN

Cisco MWR 1941-DC

UMTS IP Node B

————	RS-232
··········	Compressed T1/E1
————	T1/E1 TDM
━━━━	10/100/1000 Ethernet
————	STM-1

Ethernet-based cellular backhaul: Cheaper backhaul; higher backhaul bandwidth

Other concepts: SDH, AToM, xDSL, cable

Cisco.com

Summary

Mobile IP for Data Mobility Network

- **The growth of 2G Mobile Service depends on voice mobility. Future Mobile Service growth will rely on mobile data.**

- **Regardless of different radio access technologies, Mobile IP is an essential component to maintain data mobility value.**

- **Foreseeable future, there will many new Integrated Multimedia Services take advantages mobility provided by Mobile IP.**

Cisco Systems

Empowering the Internet Generation℠

Cisco.com