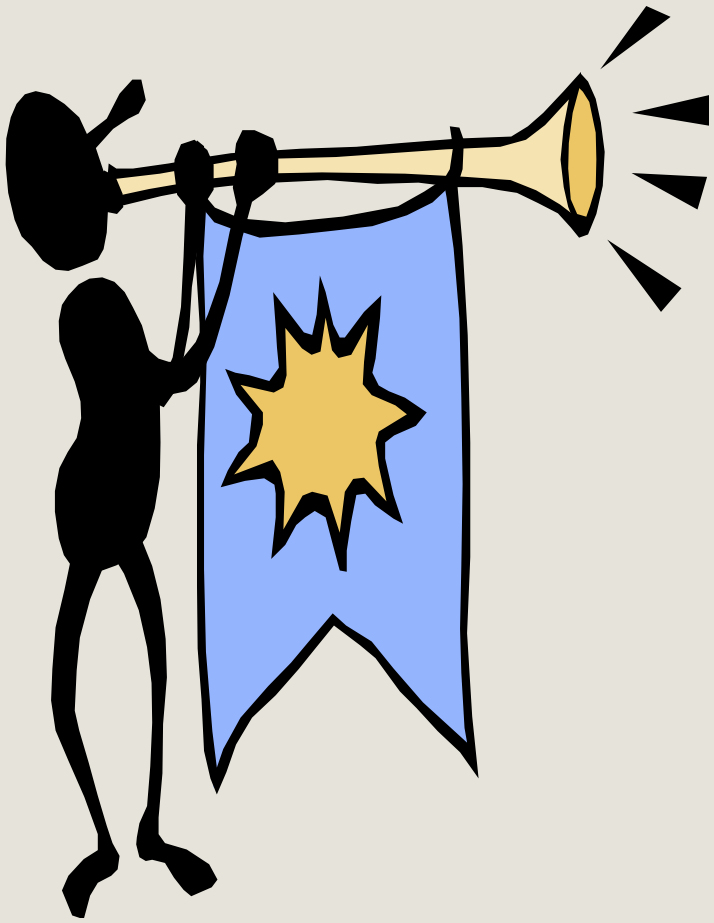
Circuit Switched Telephony and Related Architectures

INSE 7110 – Winter 2009

Value Added Services Engineering in Next Generation Networks

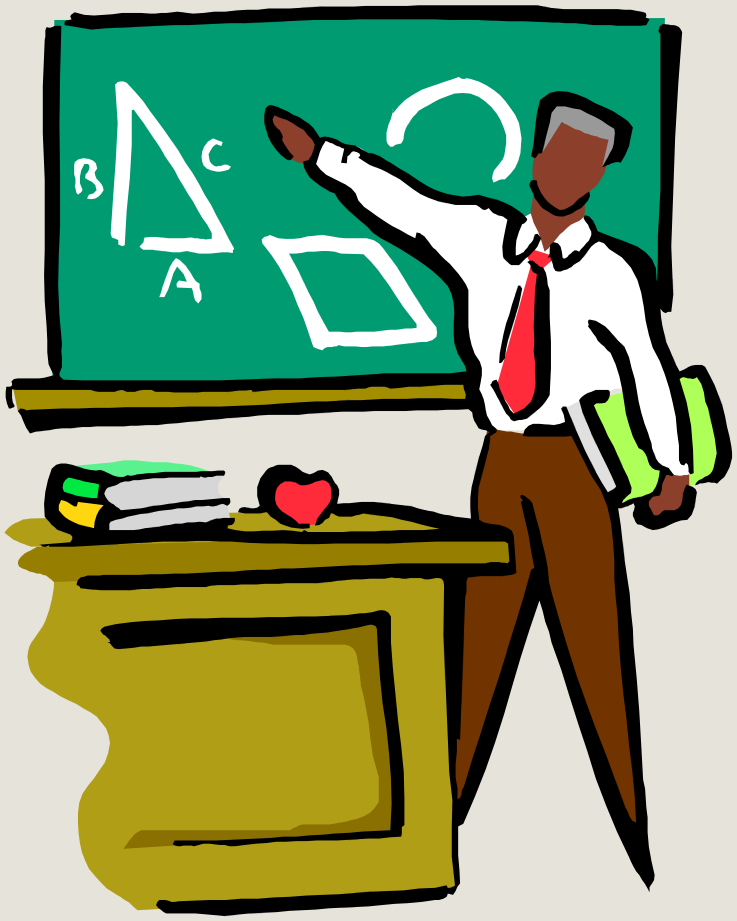
Week #1

Outline



1. Essentials of circuit switched telephony
2. Introduction to value added services
3. IN
4. WAP
5. TINA-C
6. References

Essentials of circuit switched telephony

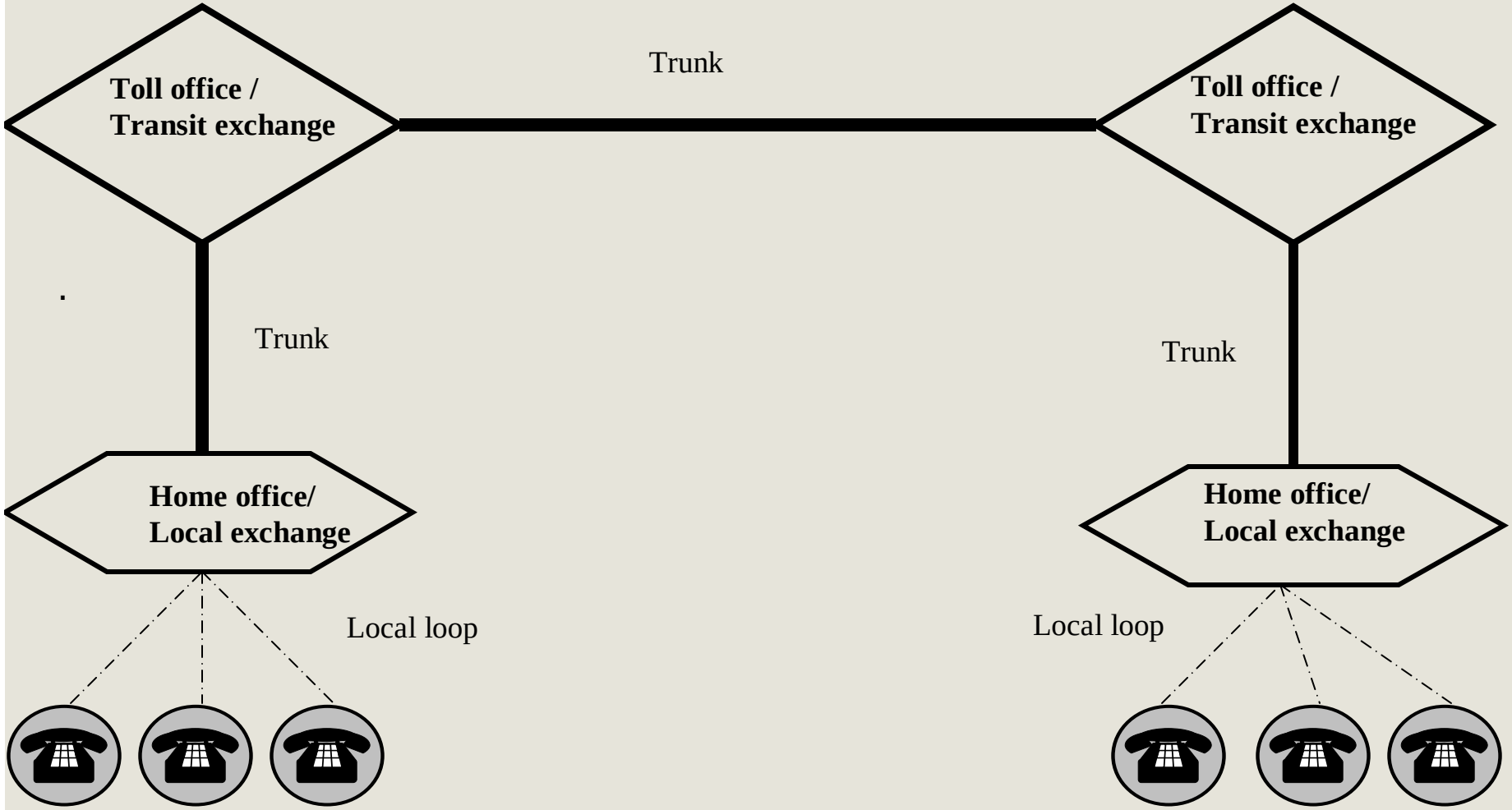


- Circuit switching vs. packet switching
- Local loops, telephone exchanges and trunks
- Signaling
- Beyond fixed telephony

Circuit switching vs. packet switching

Principal Criteria	Circuit switched	Packet switched
Dedicated Physical path	Yes/No	Yes/No
Derived criteria	Circuit switched	Packet switched
Call set up required	Yes/No	Yes/No
Possibility of congestion during communication	Yes/No	Yes/No
Fixed bandwidth available .	Yes/No	Yes/No
Non optimal usage of bandwidth	Yes/No	Yes/No

A simplified telephony network …



Signaling ...

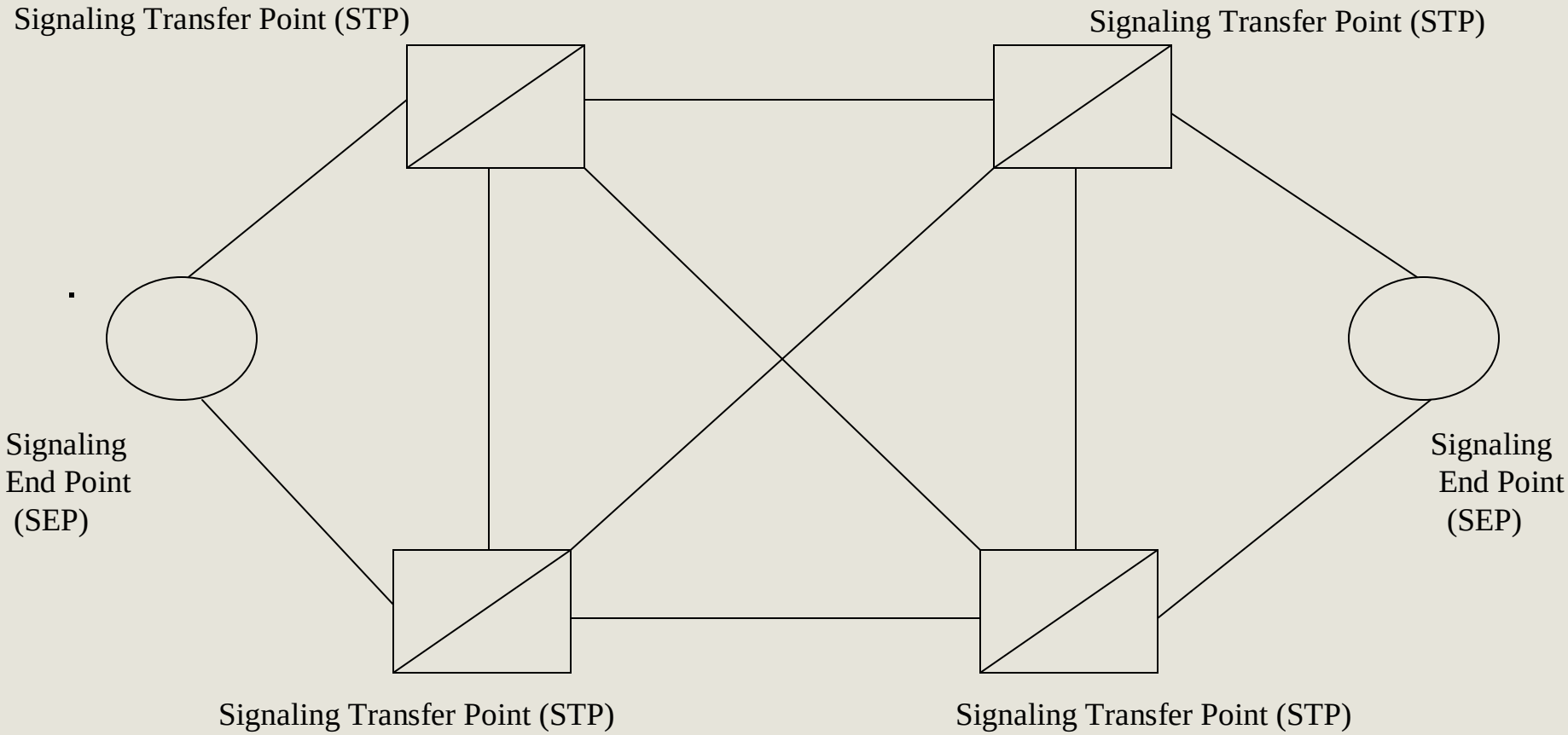
Establishment, modification and tear down of calls

- **User Network Signalling**
  - Between user and home office
  - On/off hook, dial tone …
  - Carried over local loops
- **Network – Network signalling**
  - Between telephone exchanges
  - Initially in-band (Same trunks as voice)
  - Out-band in modern circuit switched telephony
    - Signalling data carried over a separate and overlay packet switched network (Signalling System no7 – SS7)

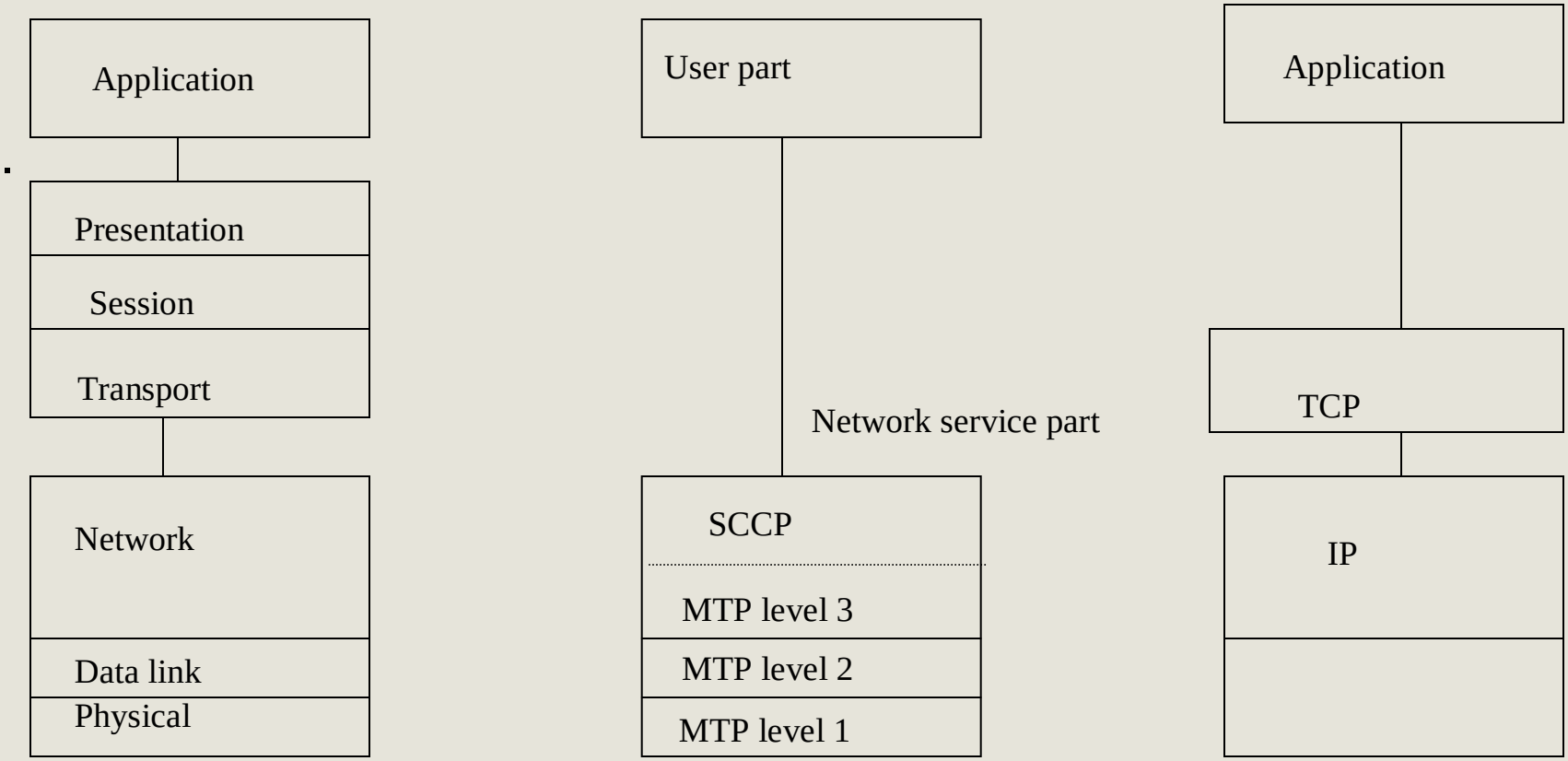
Signaling ...

Criteria	In-band signaling	Out-band Signaling
Potential capacity	More / less	More / less
Potential speed	More/less	More/less
Room for fraud	More/less	More/less
Flexibility (e.g. mid-call signaling)	More / less	More / less

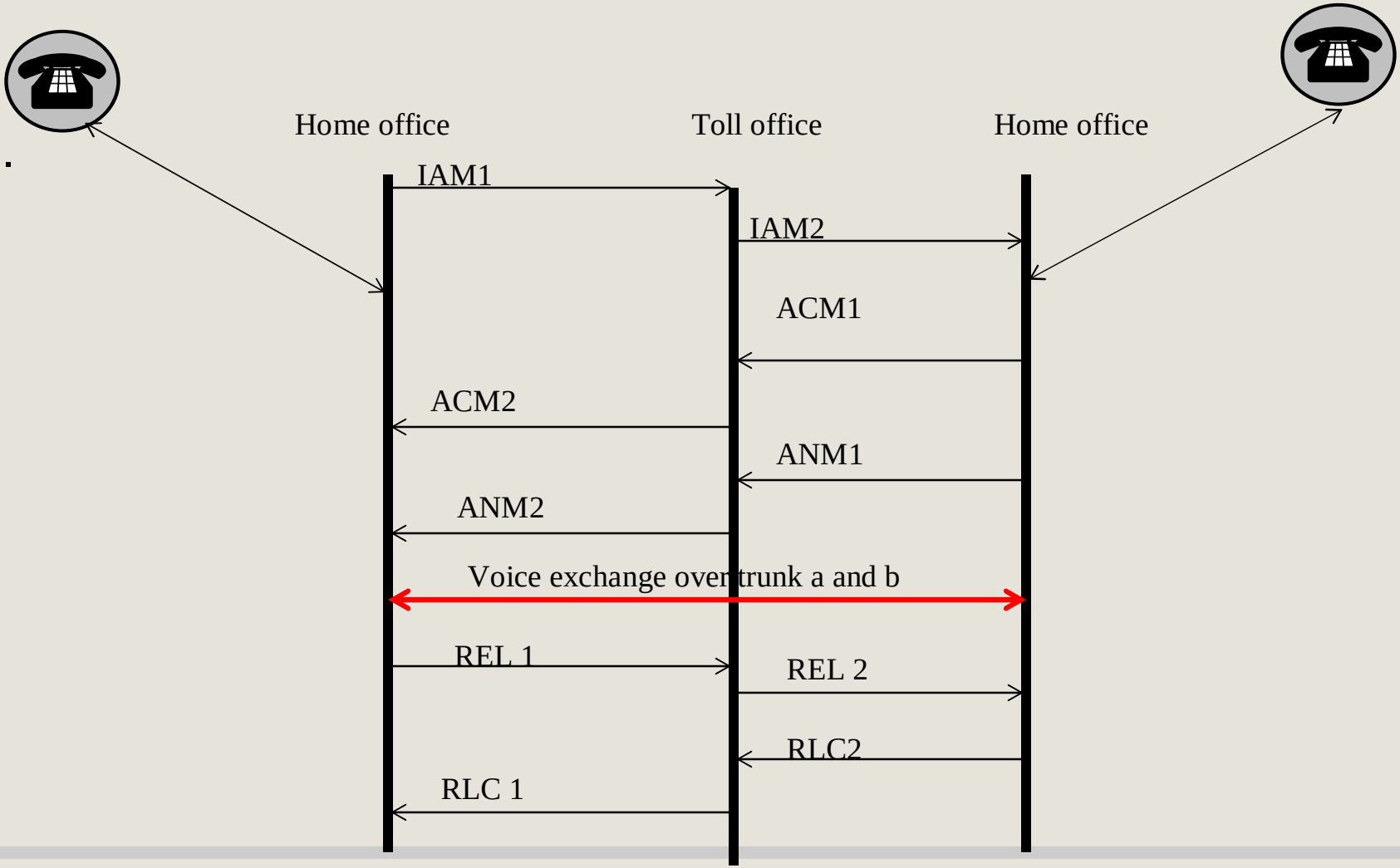
A Simplified SS7 network architecture ...



SS7 Protocol stack ...



Integrated Service Digital Network (ISDN) - User Part

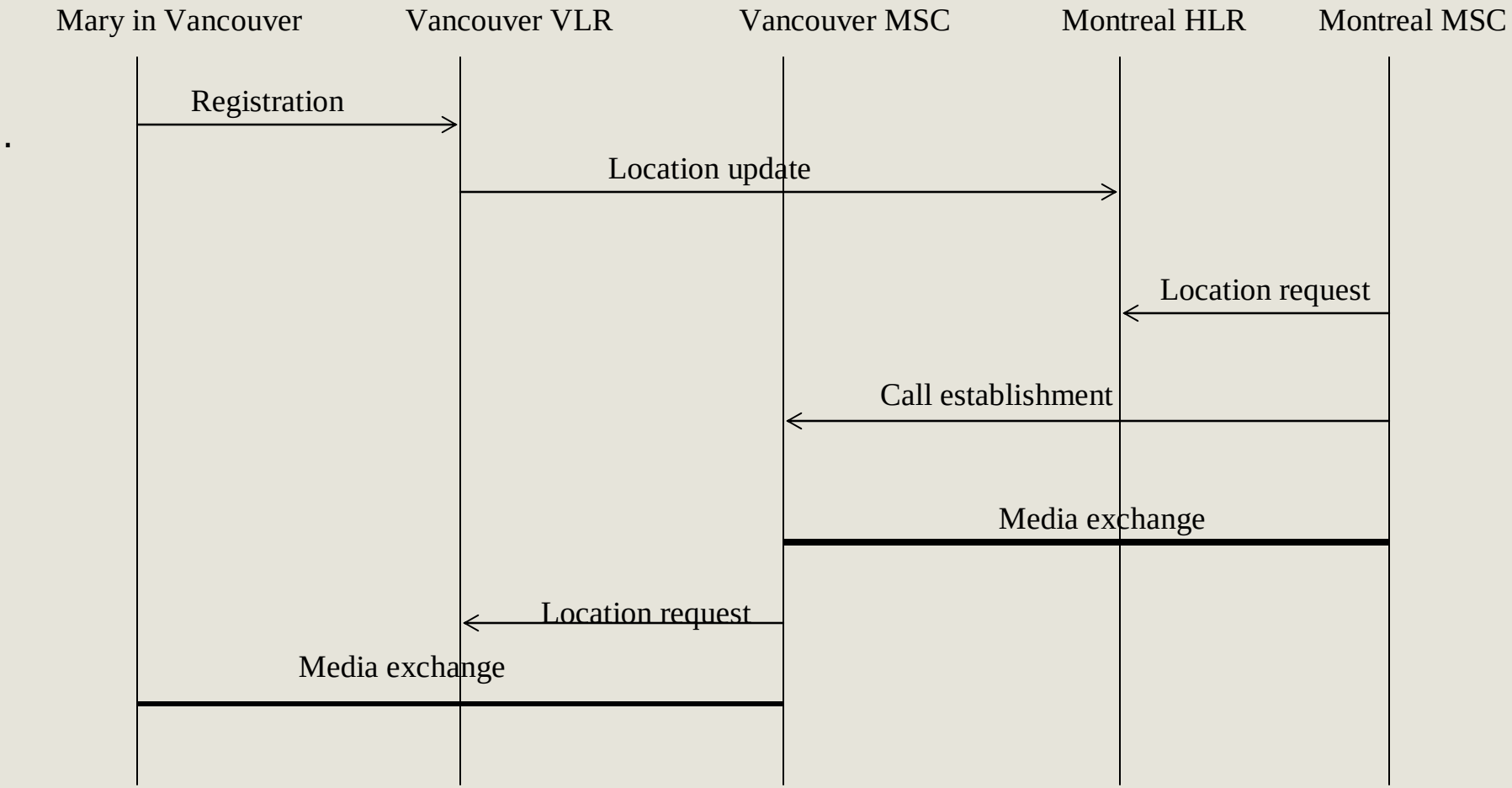


Beyond fixed telephony ...

Cellular telephony

- Mobile Switching Centre
  - Switches used in cellular telephony – Additional features for mobility management
- Home location register (HLR) /Visitor location register (VLR)
  - Keep information on user location
- Base stations
  - Access point to cellular networks
  - Communicate with end user terminals
  - Control cells
- Signalling in cellular networks
  - SS7 based

Mary a Montreal subscriber receives a call while in Vancouver



Beyond fixed telephony ...

First generation cellular networks (70s – 80s)

- Analog systems, circuit switching based
  - Total Access Communications Systems (TACS) – UK
  - Advanced Mobile Phone Systems (AMPS) – USA/Canada
  - Nordic Mobile Telephone System (NMT) – Scandinavia

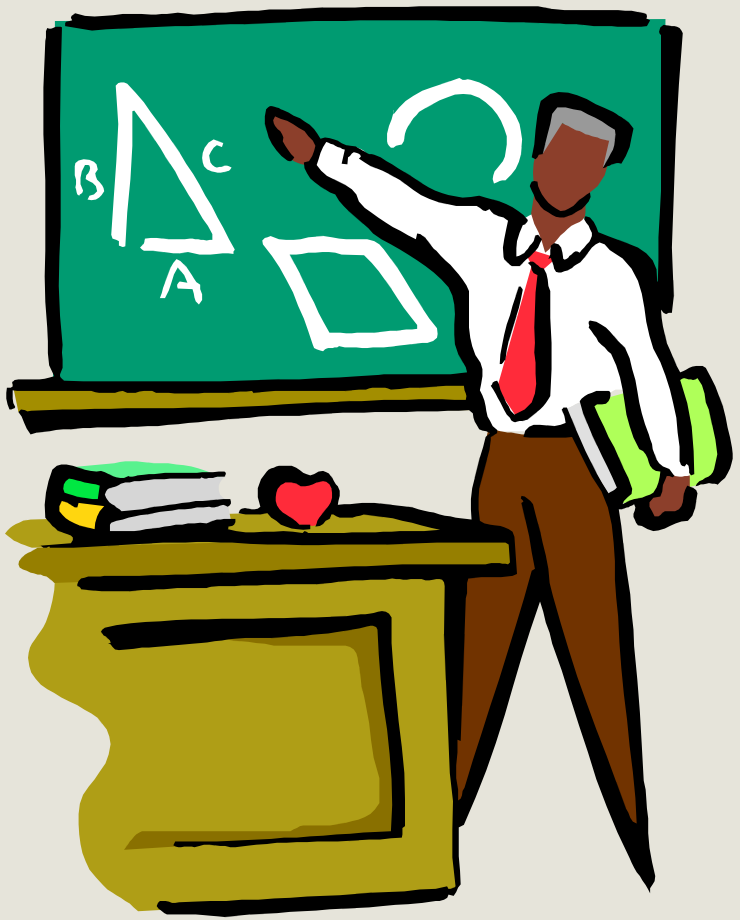
Second Generation (90s – early 00s)

- Digital systems, circuit switching based
  - GSM – Europe mainly – However, gaining ground in North America
  - D-AMPS (Digital version of AMPS)
  - PDC (Japan)

Third Generation (early 00s –)

  - Still digital, but more capacity
  - Packet switching based
  - Two main standards
    - UMTS
    - CDMA 2000

Introduction to value added services …



1. Services
2. Life Cycle
2. Service Engineering

Services ...

Basic service offered by circuit switched telephony:
Two party voice call

Value added services

Anything that goes beyond two party voice call

- Telephony services
  - interact will call control
    - » Call diversion
    - » Call screening
- Non Telephony services
  - Web access from a cell phone
    - » Surfing
    - » Email

Service life cycle ...

Four phases

- **Creation (also known as construction)**
  - Specification, design/coding, and testing
- **Deployment**
  - Service logic (or executable) resides on specific node(s) and needs to be deployed there
- **Usage**
  - Subscription/billing, triggering, features interactions
- **Withdrawal**
  - Removal from network

Service Engineering ...

Key issue: How to engineer "cool" services

- **In more academic terms**
  - Issues related to the support of all the phases of the life cycle.
    - Creation
    - Deployment
    - Usage
    - Withdrawal
  - These issues are architectural issues
    - Concepts, principles, rules
    - Functional entities, interfaces and algorithms

Service Engineering ...

Why is it an important discipline?

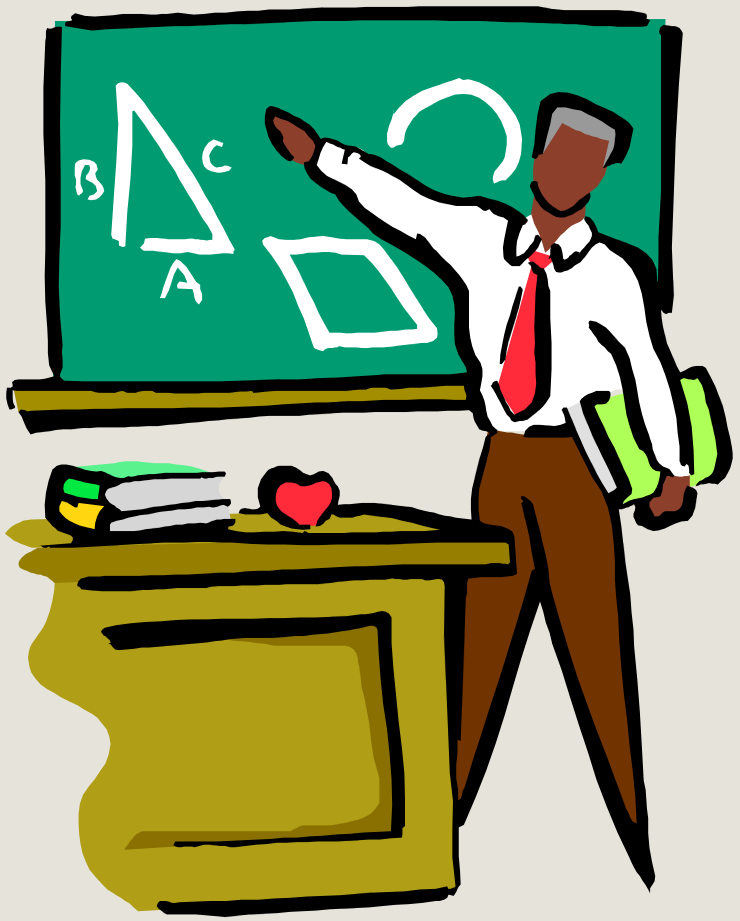
- **Business standpoint**
  - High quality two party voice call is now a commodity
  - Value added services are needed to attract subscribers and generate revenues.
- **Engineering standpoint**
  - It is less than trivial
  - Example: Service creation
    - Secure and selective access to network resources is required
    - Related issues: Level of abstraction, security framework, service creation tools …etc.

Service Engineering ...

Architectures for circuit switched telephony

- Intelligent Network (IN)
- Wireless Access Protocol (WAP)
- Telecommunication Information Network Architecture (TINA)

Service architectures for today's networks



1. IN
2. WAP
3. TINA-C

Introduction to IN …

The pre-IN era

- Service logic embedded in switching software

IN

- Has emerged in the ITU-T based on work done at Telcordia (alias Bellcore), in the late 80s
- Basis for:
  - AIN (North America - fixed network)
  - Wireless Intelligent Networks (WIN) - (D-AMPS - wireless network)
  - Customized Application Mobile Enhanced Logic (GSM - wireless network)

IN: Fundamental Principles

1. **Separation of switching software and service logic**
   - Main implication: Need for an interaction model between switching and service
     - Functional entities / nodes
     - Protocols

2. **Standardization of capabilities for building services**
   - Main implication: Need for “components” that can be used in various ways for building services

IN: Fundamental Concepts

Call model

Phases for setting up and tearing down calls

- **IN call model or basic call process: call model with the possibility to invoke service**
  - » **Point of invocation**
  - » **Point of return**

Service independent building blocks (SIB)

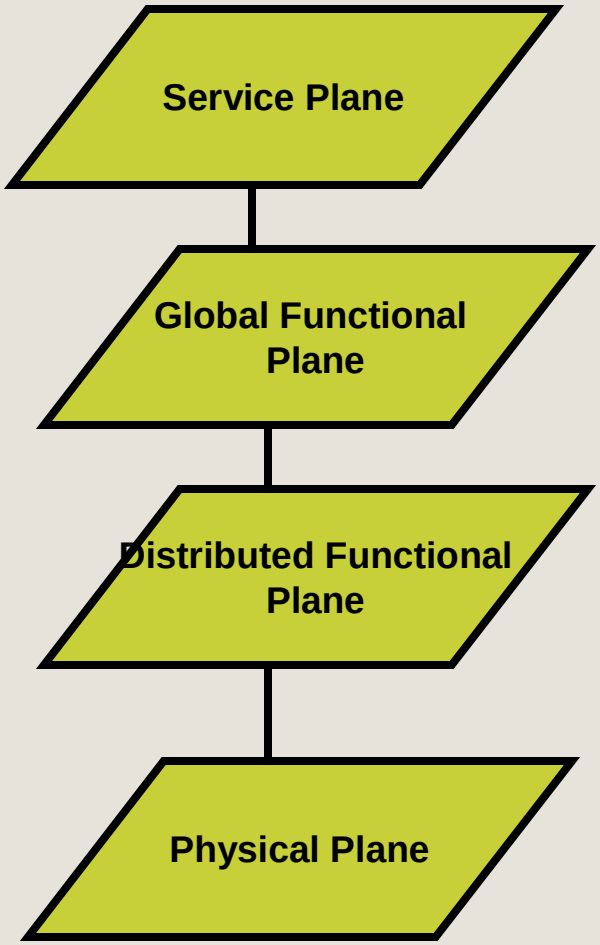
Components used to build services

- Have a logical start and one or more logical ends
- Are chained to build services

Capabilities set

- A set of potential services
- A given call model
- A set of SIBs
- A set of functional entities
- A protocol

IN: A four planes conceptual architecture



Services as seen by end-users

Functionality required to build the services (e.g. Service independent building blocks)

Functional entities that make the IN network

Physical nodes

IN: Service Plane

Examples of services made of specific features

Free phone

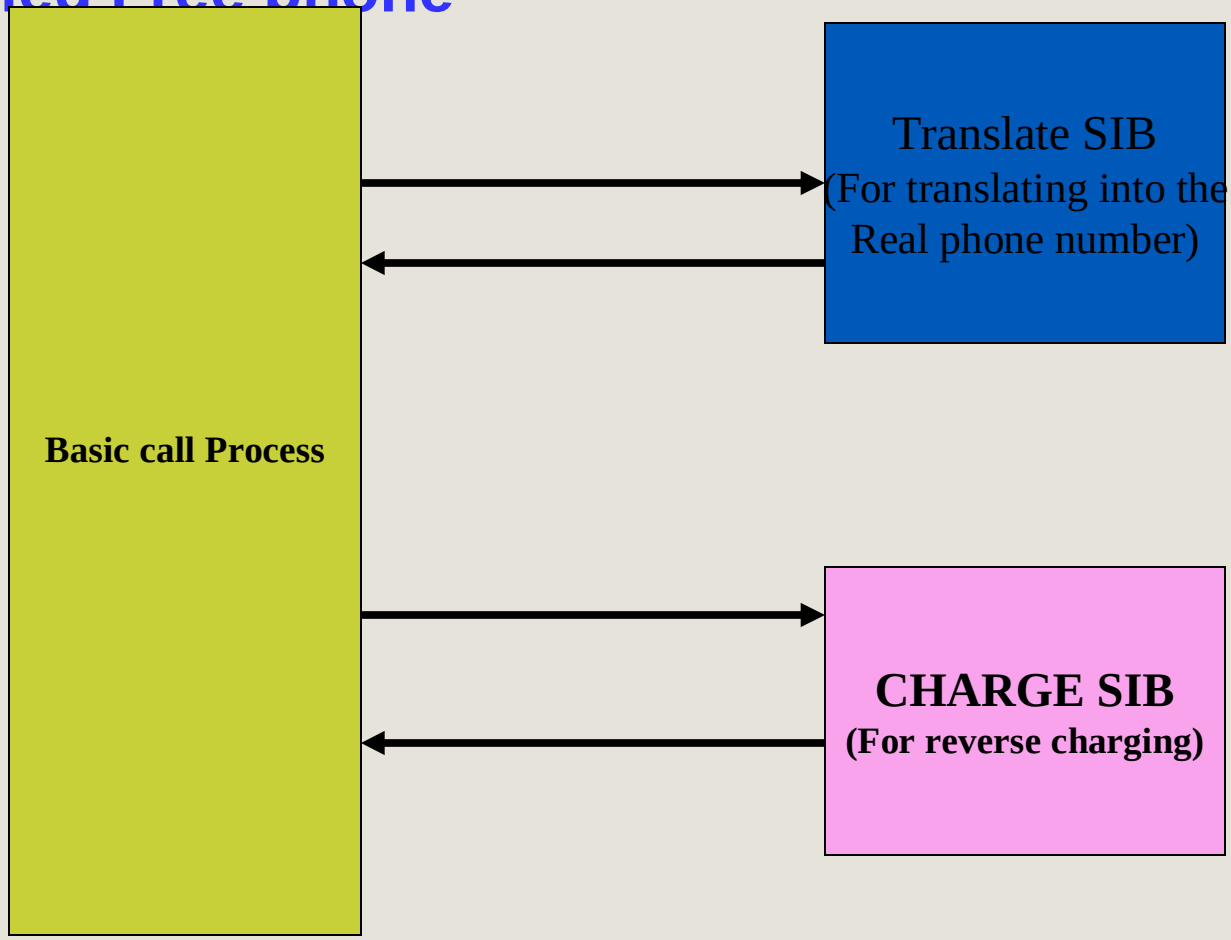
- One number (800 in North America) feature
- Reverse charging feature

Calling card

- Charging feature
- Originating user prompting

IN: Global Functional Plane

…Simplified Free phone



IN: Physical Plane ...

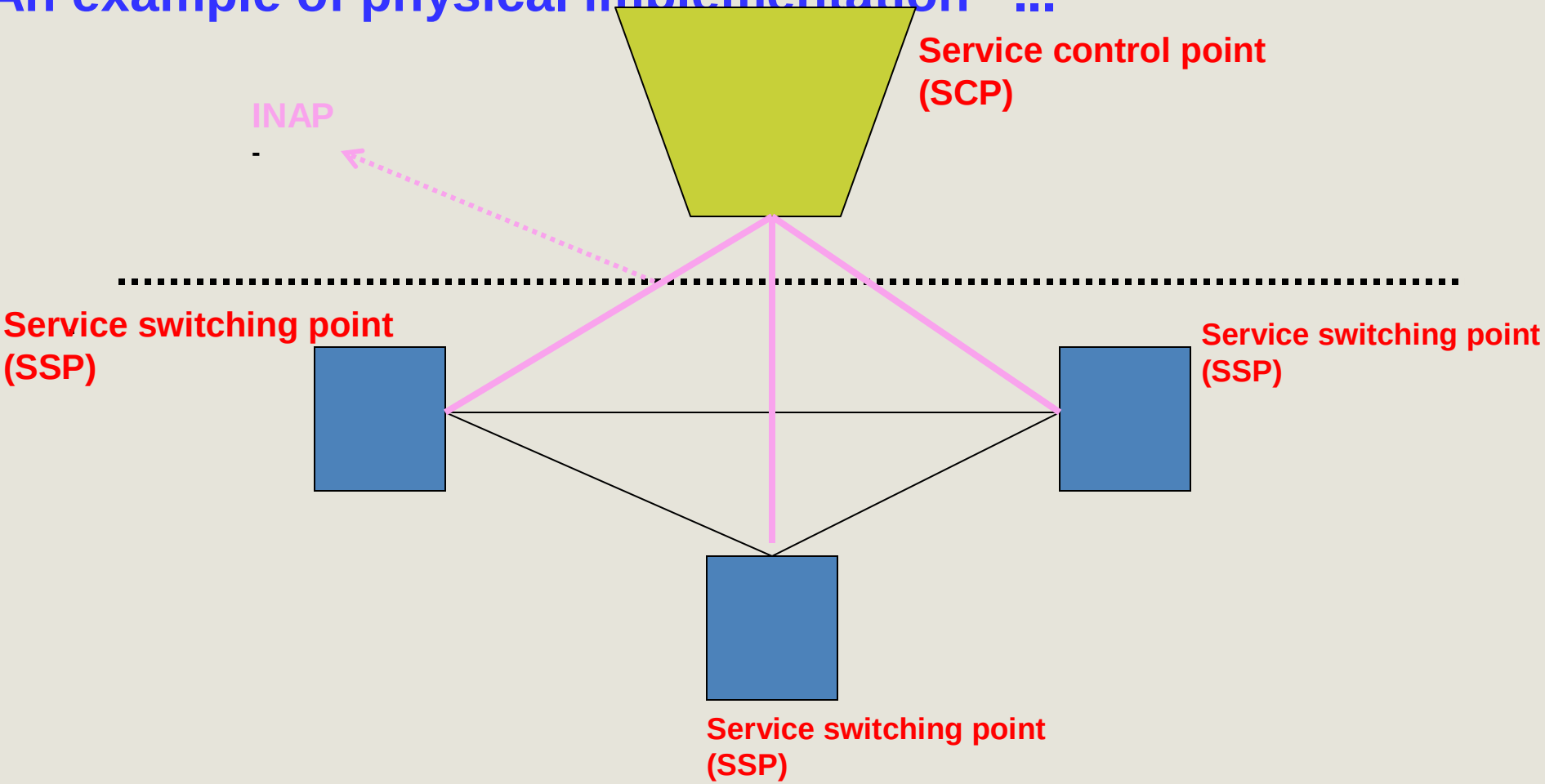
Functional entities can be grouped in nodes as manufacturers wish

The Intelligent Network Application Protocol (INAP) is used for communications between nodes.

- Request / Reply application level protocol
- Messages transported over SS7
- SS7
  - Overlay packet switched networks
  - Used for outband signalling
  - Made of
    - Message transport part
    - Application part

IN: Physical plane

An example of physical implementation ...



IN: Retrospective ...

A revolutionary concept

- Separation between service logic and switching software
- Standardisation of service capabilities instead of services

With mixed results

- Reasonable installed basis, but
- Lack of openness
  - Standardised building blocks (e.g. SIBs) did not open telecommunication networks to third parties
    - Components are not interfaces
    - Too many “proprietary” SIBs
- Service creation and deployment remain relatively slow
    - Immaturity of methodologies and tools
    - New service logic in SCPs often required “adjustments” to call model in SSP

WAP: Introduction

Product of an industry consortium, the WAP forum

- First release 1998 (WAP 1.0)
- Second release 2002 (WAP 2.0)
- Now transferred to the the Open Mobile Alliance (OMA)

Main objective: bring non telephony services to wireless users ...

- Web browsing
- Email

Raison d'etre

- Limitations of cellular phones(Power, memory, battery)
- Limitations of today's wireless networks (Scarce bandwidth, unreliable links)

WAP: Fundamental principles

Optimal usage of "scarce" air interface resources

- Implications
  - Less bandwidth hungry protocols
  - binary encoding instead of text encoding

Optimal usage of "limited" terminal capabilities

- Implications
  - New description language(s)
  - New browser(s)

Independence of underlying bearer (e.g. GSM, TDMA, PDC)

Fundamental concepts

WAP Micro browser

- Browser adapted to limited terminal capabilities

WAP proxy/gateway

– Gateway between the Internet and operator's domain

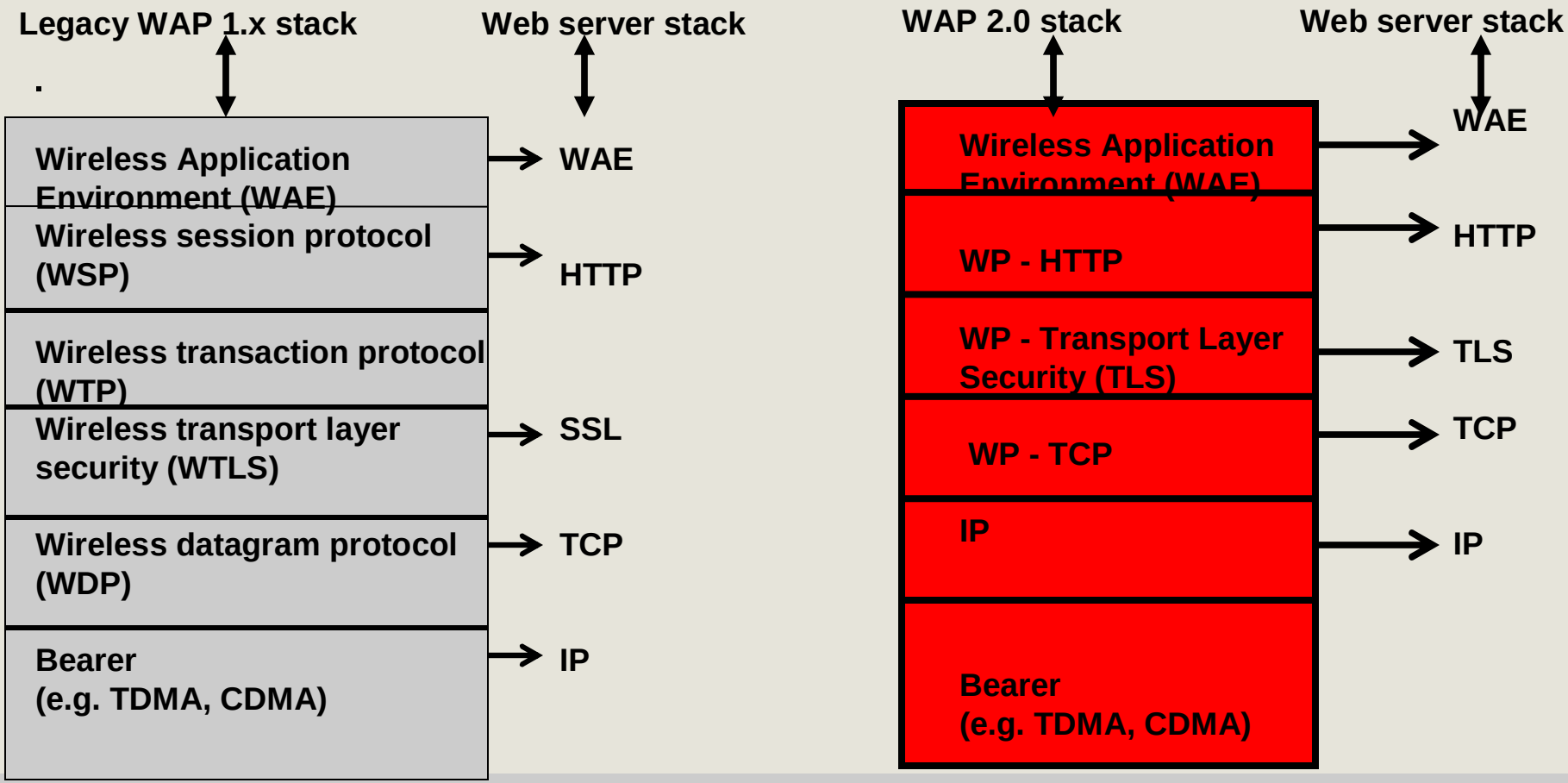
- Protocol gateway
- Content adaptation
- New description language(s)
- New browser(s)

Application framework

- Application development / execution environment
  - APIs
  - Mark ups
  - Scripting

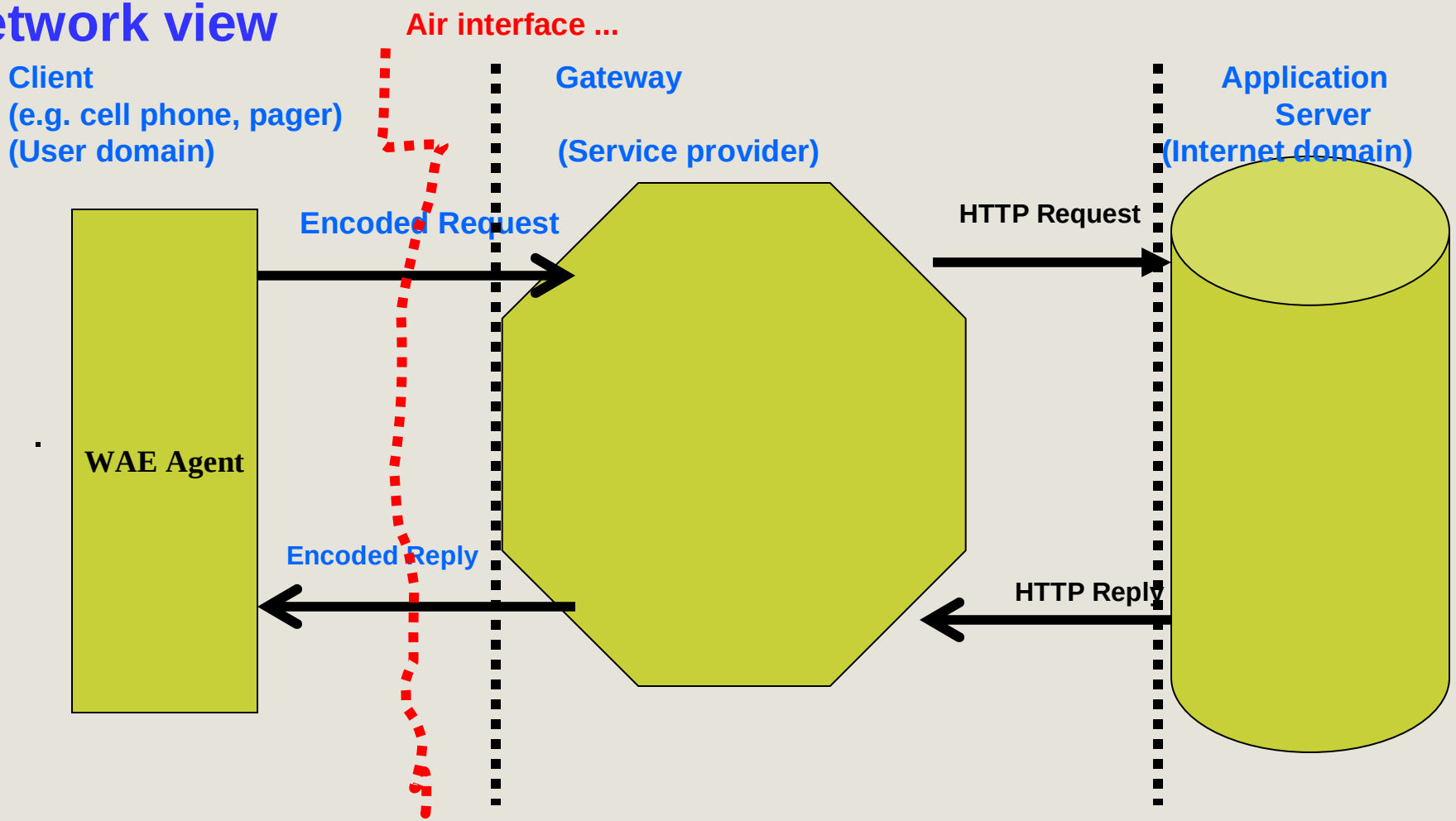
WAP: Basic Architecture

Protocol stacks (Legacy WAP 1.x stack + WAP 2.0 Internet protocol stack) ...



WAP: Basic Architecture

Network view



WAP: Beyond Internet wireless access ...

Push

- Information pushed to wireless device instead of the classical Internet pull model
  - Notifications (e.g. voice messages waiting to be retrieved)
  - News, traffic information

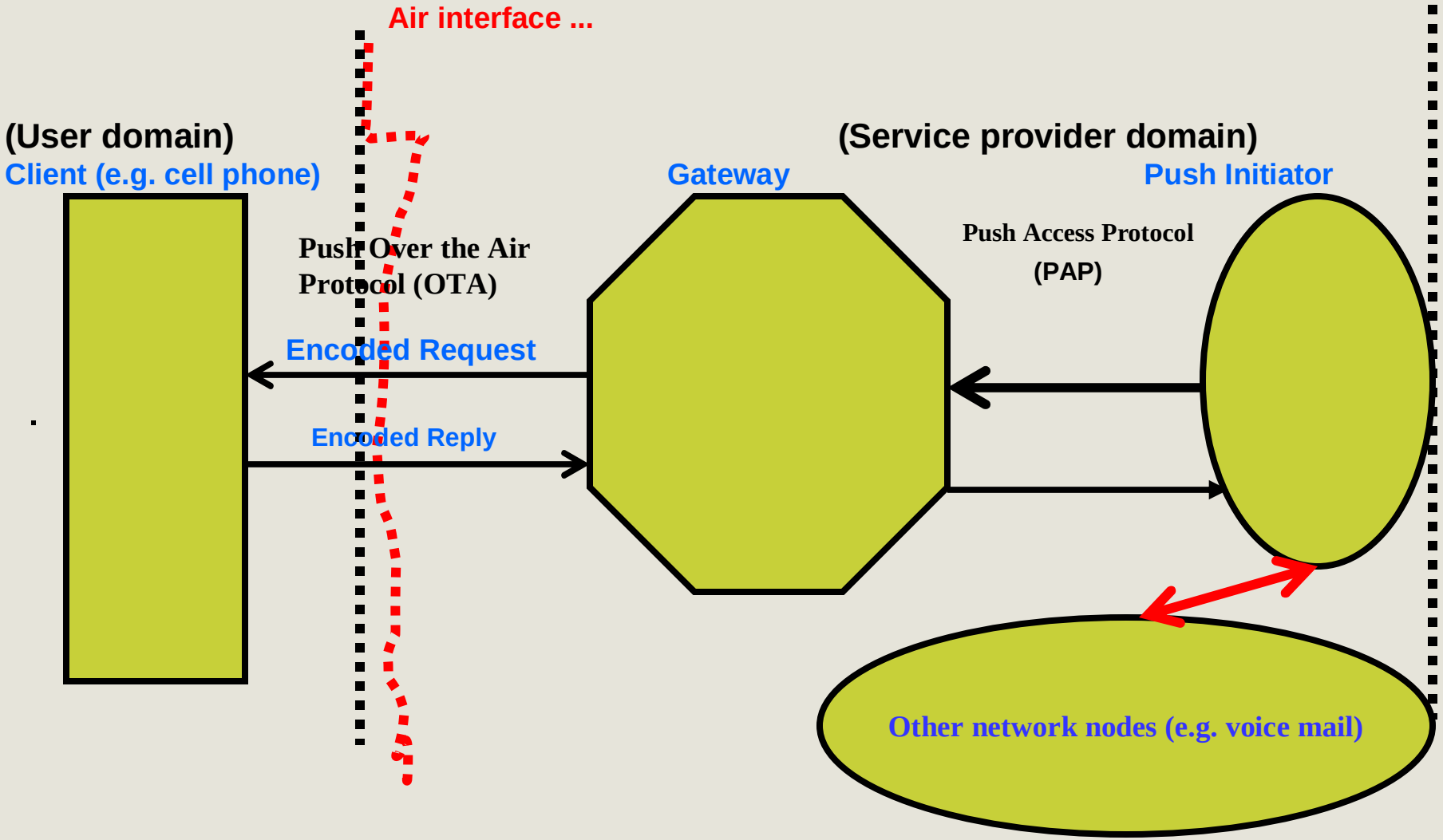
Wireless Telephony Applications

- Enhancements to call control services
  - Call initiation using an electronic agenda
  - On-line selection of how to handle a call (accept, reject, forward)

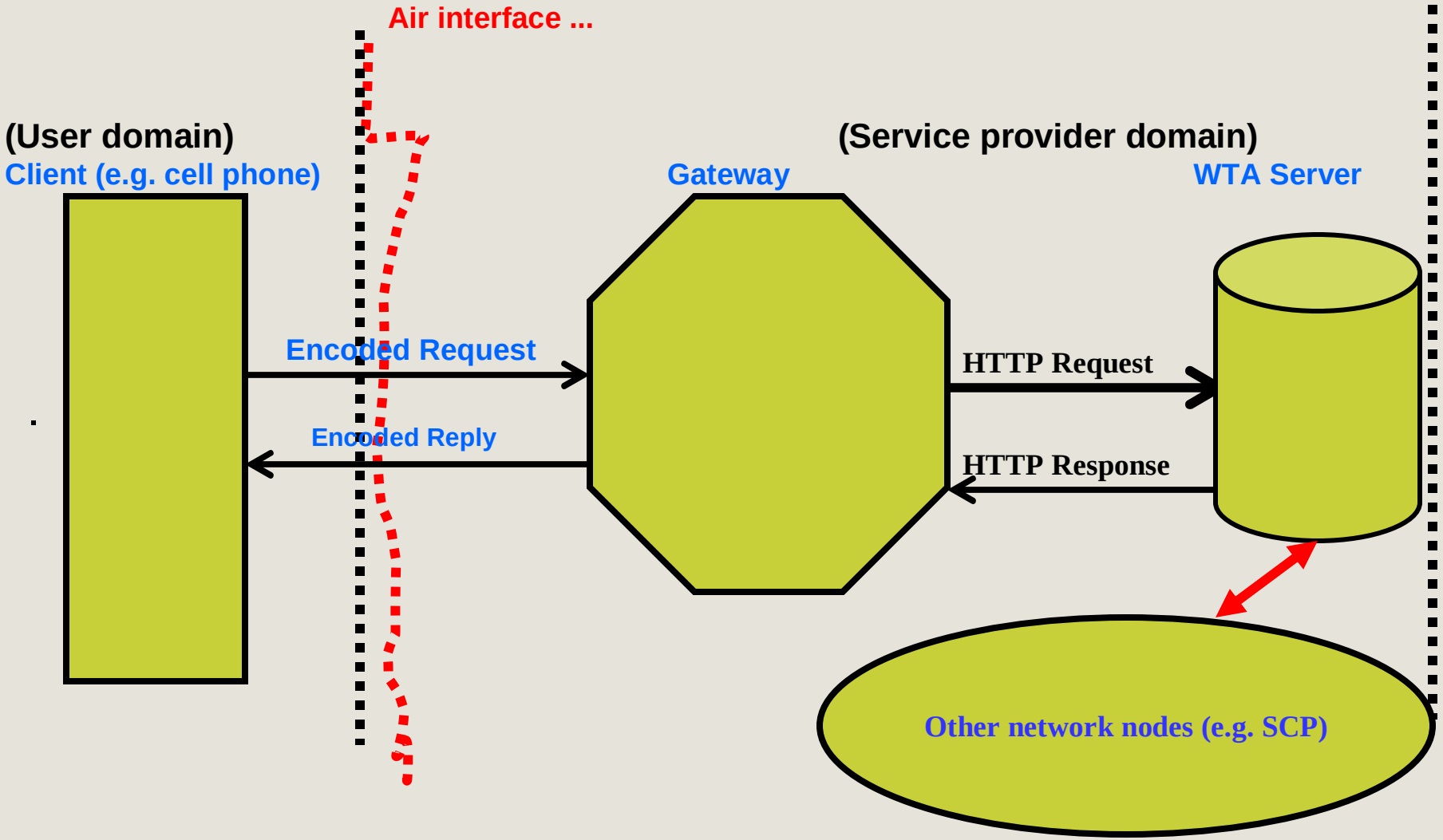
Multimedia messaging

- Interface between the client and the messaging server

WAP: Simplified Push

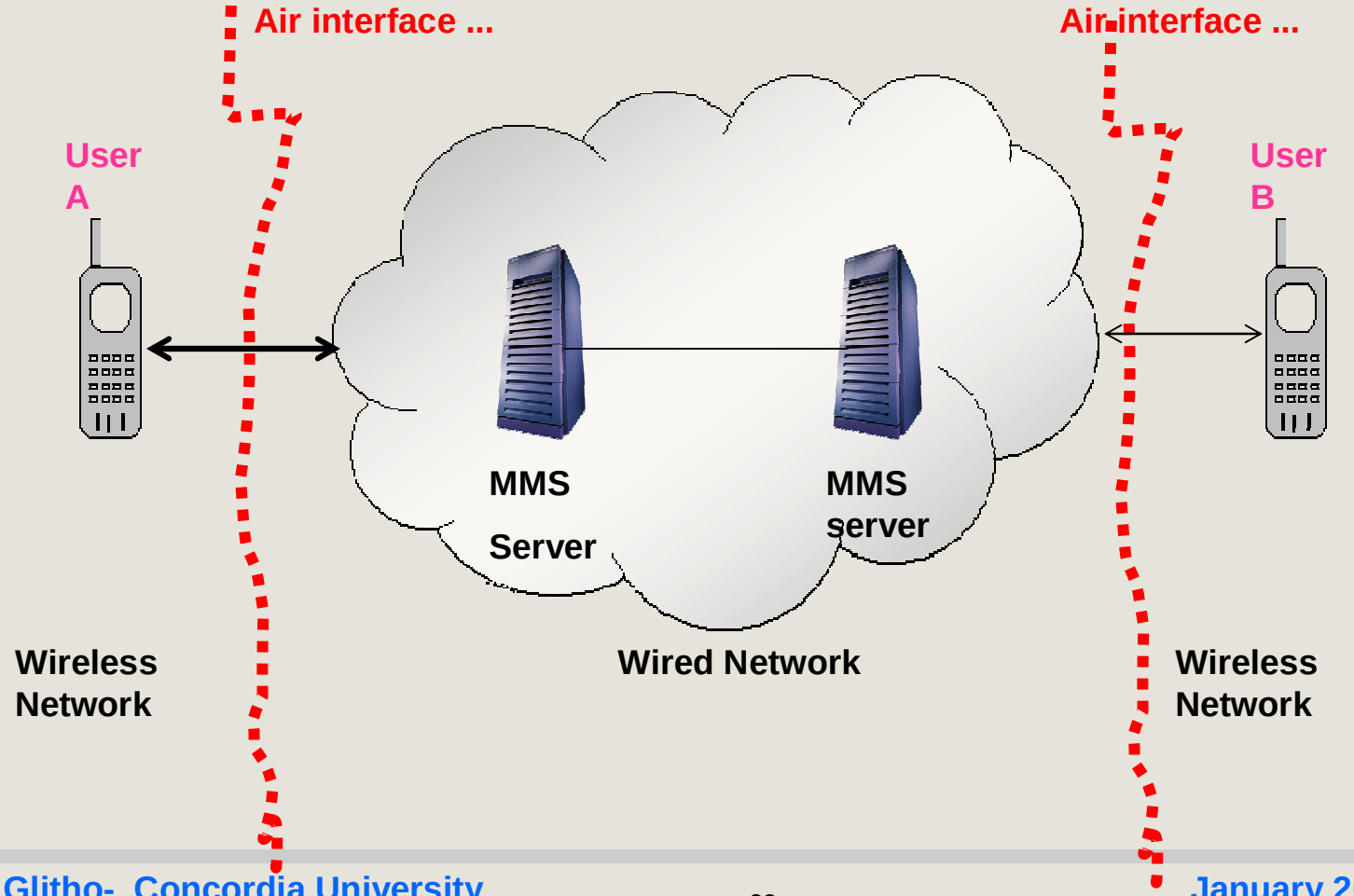


WAP: Simplified WTA



WAP: MMS

MM1 interface



TINA: Introduction

Product of theTINA consortium (TINA-C)

- **First phase: 1993 - 1998**
  - Production of specifications by a core team based in same location (NJ, USA)
  - Validation (e.g. prototyping) by associated projects
- **Second phase: 1998 - 2000**
  - Special projects
  - Results promotion in various standards bodies
- **2000: Mission considered accomplished and dismantling of consortium**
  - Note: Many of the first phase participants did not join the second phase

TINA: Introduction

The context in the early 90s

- **Emergence of new technologies**
  - Object oriented technology
  - Distributed processing
    - Open Distributed Processing (ODP) specifications
  - **Emergence of standards relying on different principles**
    - Intelligent Networks (IN)
    - Telecommunications Management Network (TMN)
      - Management of telecommunications network
        - » FCAPS

TINA: Fundamental principles

The separation principle

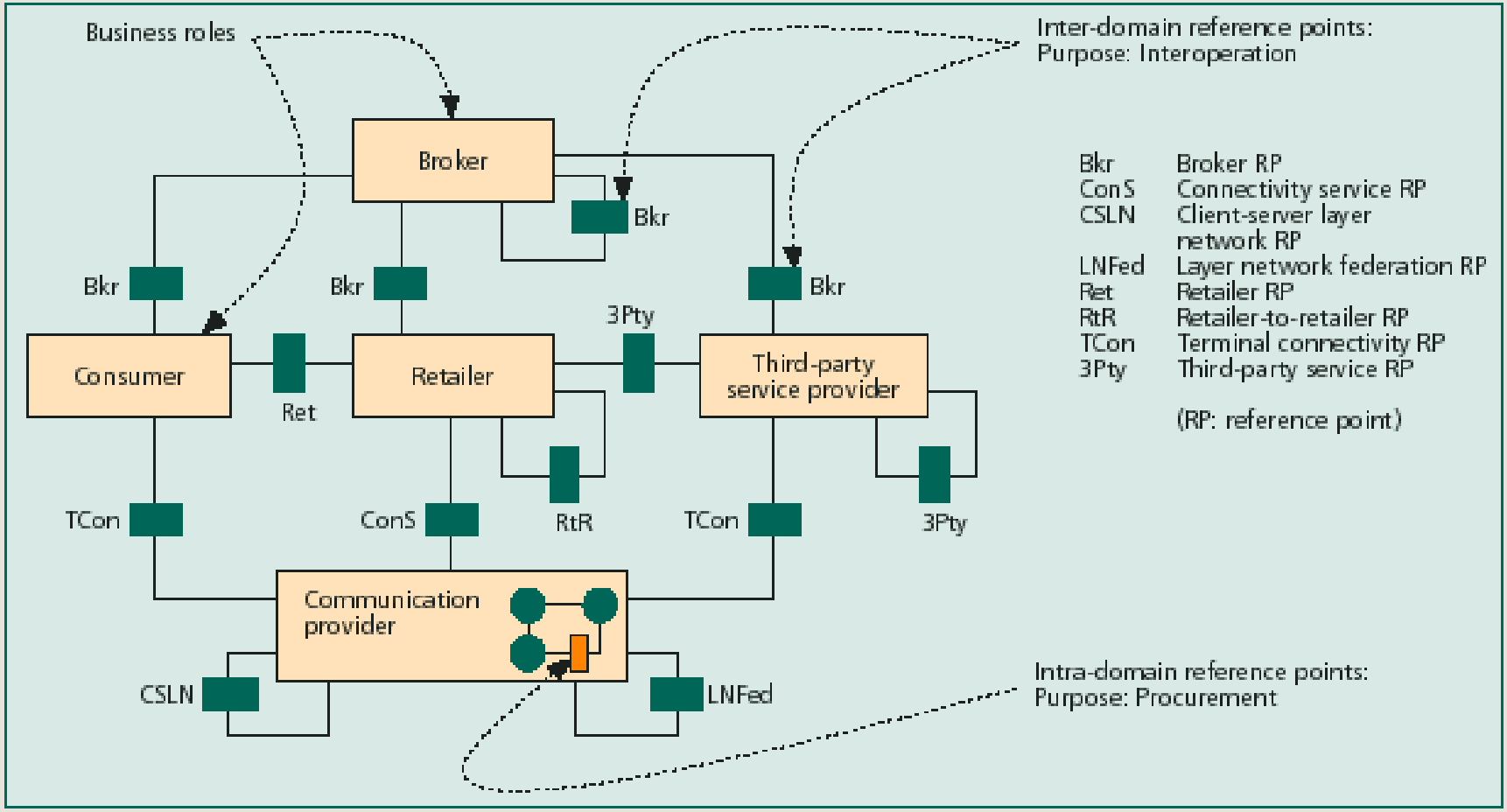
- Infrastructure
  - Service
  - Network
- Service
  - Subscription
  - Access
  - Usage
  - Service usage

Business model as starting point for specifications

- Roles
- Interfaces

TINA: Fundamental principles

Business roles / interfaces



Note: Taken from IEEE Communications Surveys & Tutorials (Reference [x])

TINA: Fundamental principles

Roles

- **Consumer**
  - End-user: Actual user of the service
  - Subscriber: Entity having the business agreement for service usage
- **Retailer**
  - One stop shop
  - Entity which provides the services and which has the business agreement with the subscriber
  - Can provide own services or services subcontracted from third parties
- **Third party service provider**
  - Has business agreement with retailer and no direct business agreement with subscribers
- **Communication/connectivity provider:** “Pipe” provider
- **Broker:** Ensure fair information distribution to all parties

TINA: Fundamental concepts

Service life cycle

- Construction
- Deployment
- Usage
- Withdrawal

Session

- Generalization of the call model concept
- Access session:
  - Activities involving consumer and retailer for selecting, and initiating the use of a service (e.g. subscription, authentication)
- Service session
  - Activities involving consumers and retailer for the actual usage of the service – Keep track of the parties involved in the usage of a service and the connectivity between them (e.g. feature interactions)
- Communication session
  - Activities involving the actual usage of network resources (e.g. QoS)

TINA: Service Architecture

1. Support for a wide range of services
2. Rapid service creation and deployment
3. Tailored services
4. Independent evolution of network and service infrastructure
5. Support for multiparty environment
6. Service manageability
7. Universal access
8. Inter-working with legacy

TINA: Service Architecture

Architecture made of:

- Computational objects accessible via CORBA interfaces
- No protocol

Computational objects in the consumer domain:

– Provider agent (PA): Proxy through which the retailer makes service offer to the consumer

– Service session user application part (ssUAP): Service control interface in the terminal

TINA: Retrospective ...

A seminal service architecture

- Many sound concepts (e.g. service life cycle) and principles (e.g. separation of concerns) widely re-used
- A sound business model widely re-used

But, a commercial failure

- Lots of prototypes and trials, but very very few commercial deployment due to a wide range of factors
  - Too far ahead its time
  - Complexity
  - Too high level of ambition (e.g scope encompasses everything from networking to service engineering)
  - Too little weight to other important technological developments (I.e. Internet)
  - Too little consideration to installed basis

To probe further ...

1. On circuit-switched telephony

A. Tanembaum, Computer Networks, 4th edition, Prentice Hall 2003 (Chapter 2.5 – The public switched telephone system network)

A. R. Moderassi and R. Skoog, Signaling System No7: A Tutorial, IEEE Communications Magazine, July 1990, available at:http://www.comsoc.org/livepubs/surveys/public/4q98issue/reprint4q.html

2. On intelligent networks

R. Glitho and Th. Magedanz, guest editors, Intelligent Networks in the new Millennium, IEEE Communications Magazine, June 2000 Vol.38 No6

3. On WAP

WAP 2.0 Technical white paper, http://www.wapforum.org

4. On TINA

H. Berndt, T. Hamada, and, P. Graubmann TINA: Its Achievements and its Future Directions, IEEE Communication & Surveys, 1Q 2000,