

Telecoms And Data Network Management, Services And Billing

T-110.300/301

The FCAPS Model

- **F**ault Management
 - **C**onfiguration Management
 - **A**ccounting
 - **P**erformance Management
 - **S**ecurity Management
-
- Part of Telecommunications Management Network (TMN) standard from ITU
 - Same concepts are also important for data networks



Fault Management

- Detect, isolate, repair abnormal network behavior
- Monitor network status
 - SNMP, CMIP, TMN standards
 - Commercial and homebrew tools
 - On traditional telco side the most important part of FCAPS
- Long term aim of the fault management is to:
 - Recognize trends
 - Find better solutions



... Fault Management

- The immediate fault handling process is
 - Receive an alarm
 - Identify the symptoms of the problem
 - Open ticket
 - Send an immediate report if needed
 - Detect the actual cause
 - Fix the problem
 - Document the solution
 - Report and close the ticket



Configuration Management

- Physical and logical network configuration
- How to
 - Add, remove and update equipment
 - Install it physically
 - Configure the equipment
 - Manage versions of the configuration and
 - Fall back to a previous configuration
 - Keep track of the equipment
 - Do preventive maintenance
- Configuration and change management is a very important part of network management
- Autoconfiguration is often preferable, especially when the hardware is physically located in a separate place
 - E.g. cable modems, plug and play components



Accounting

- Collect and analyze information about resource usage
- Monitoring the usage and charging for it is often an important requirement
 - Like, companies that don't make a profit don't live long
- High detail level accounting is very expensive
 - E.g. each transaction in a web proxy
 - This is the specialty of telcos
- Accounting is related to financial functions, mostly billing
- Produces also internal data
 - Required for performance monitoring
 - Also used for fraud monitoring



Performance Management

- Collect and analyze throughput and statistical info
- How to ensure then enough capacity is available for services
 - Network bandwidth
 - Over each link, taking latency into account
 - Router memory and CPU
 - Disk space
 - etc.
- How to optimize the usage of available capacity
 - 90% optimal is generally good enough
 - Perfect is the worst enemy of good
 - Planning for faults
 - Extra capacity, redundancy
 - Change of operations mode



...Performance Management

- How to find other solutions for providing performance
 - besides adding capacity
 - Smarter router interface cards instead of adding CPU
 - HTTP caches
- Performance management is constant tuning and monitoring
 - Like how much to pre-fetch to the HTTP cache
- The requirements must be planned beforehand
 - Sometimes an order can take years to complete (undersea cables)
- Differences in performance can make or break an operation



Security Management

- Control access to resources through authentication and authorization policies
- The production network must be protected
 - The security must be incorporated in the design
 - On IP based networks separate management and user data networks (like telco user and control planes)
 - Implementation is important
 - Constant monitoring
 - Constant design review
 - Practical issues, like key and password distribution
- Security can also be provided to the customers as a service
 - Virtual Private Networks
 - Firewalls
 - Content filtering



Telecoms Network Management Logical Layered Architecture

- TMN is a standard from ITU
- Business Management Layer
 - Vaguely defined, business strategic goal setting
- Service Management Layer
 - QoS management, customer configuration, accounting etc.
- Network Management Layer
 - Routing and dedicated network paths, link utilization monitoring, optimizing etc.
- Element Management Layer
 - Collects information from individual network elements and sets the configuration in NEs
- Network Element Layer
 - Contains the actual network elements (switches, SS7 components etc.)



TMN In Practice

- Concepts are currently in use
- Only a few network equipment manufacturers are actually implementing CMISE/CMIP
 - Common Management Information Service Element
 - Common Management Information Protocol
 - E.g. latest Nokia GSM networks
 - Much of current infrastructure relies on SNMP or proprietary protocols
 - Simple Network Management Protocol, uses UDP/IP
- HP Open View is often used to implement the higher level functionalities
 - Implements the idea of unified, advanced network management system
 - Supports SNMP, CMIP and other protocols

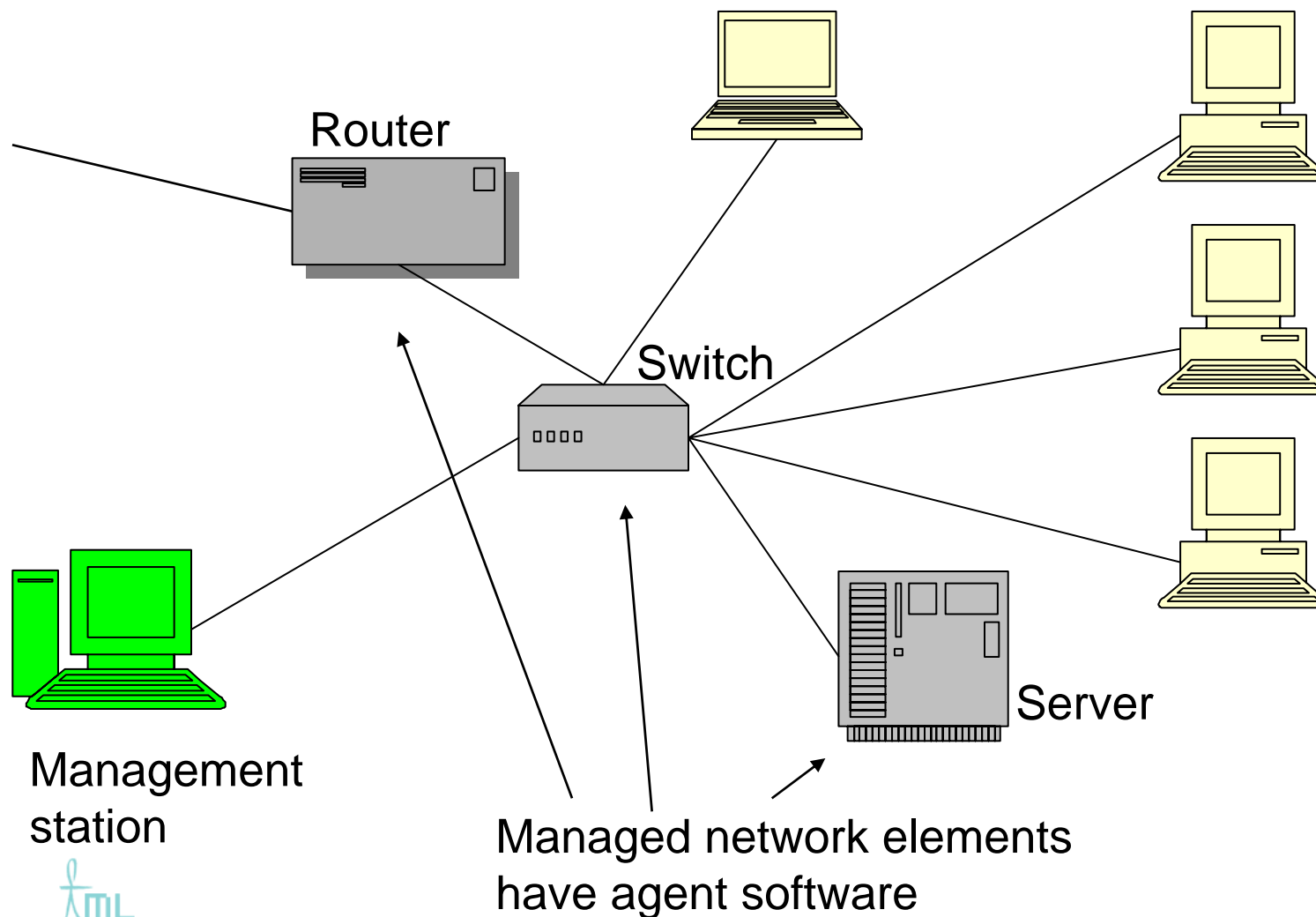


Network Management With SNMP

- Simple Network Management Protocol
 - Defined in RFC-1157
- Network elements (routers, hosts, printers etc) have a SNMP agent
- Management station queries network elements for information
 - The agent is a server, the management station is the client
- Management Information Base (MIB) describes the information served by SNMP agents
 - A specification

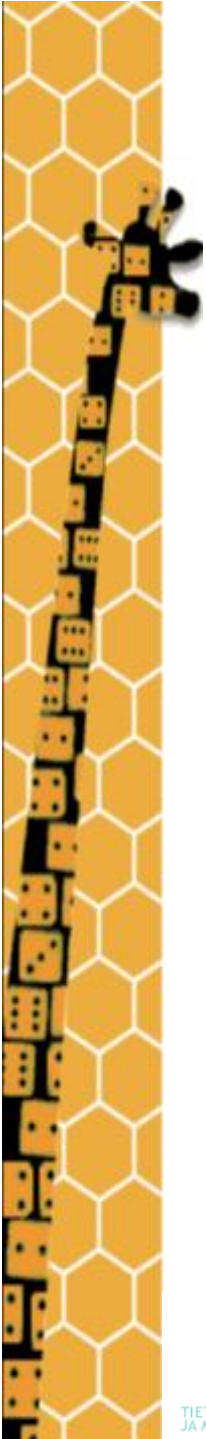


...Network Management With SNMP



Management Information Base

- Specifies what variables the network elements maintain
- Variables are the information that can be queried and set by the manager
- Specifies standardized object identifiers
- Variables are named using a scheme that is hierarchical and is unlimited in expansion,
 - E.g. iso.org.dod.internet.mgmt.mib-2
- There is a branch in the naming tree for private enterprises (usually manufacturers of network hardware) to locate their own MIBs



MIB Example

```
sysUpTime OBJECT-TYPE
    SYNTAX      TimeTicks
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The time (in hundredths of a second) since
         the network management portion of the sys-
         tem was last re-initialized."
    ::= { system 3 }
```

- ASN.1 is used for the definition
- Data types: Integer, DisplayString, TimeTicks, ..
- More complex data types can be constructed from the basic types

SNMP Network Management In Action

- Network manager software is configured with the network layout and the MIBs of different network elements
- Network manager regularly queries the network elements and displays the information to human supervisor
- When the management software finds something wrong, for example a router does not reply to queries for a while, the software alerts the human supervisor
- Network manager may set variables in a network element, e.g.. the address of a DNS server
- A network element may send a "trap", for example a printer may signal that it is out of paper



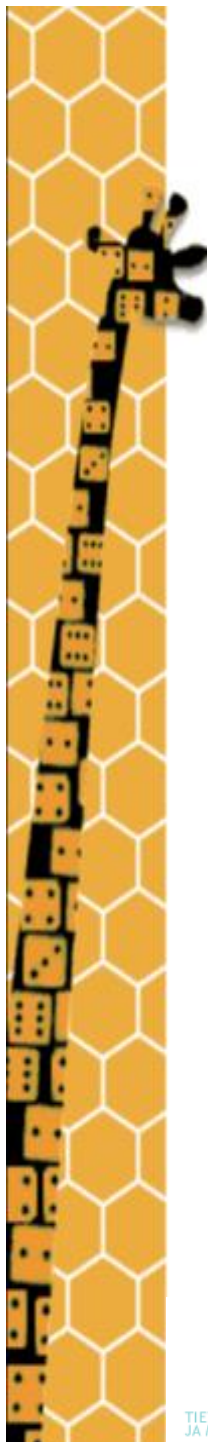
CMIP

- Common Management Information Protocol
- A more complex and capable protocol comparable to SNMP
- Addresses many of the shortcomings of SNMP, is also more complicated and requires more resources
- In many cases agents might be too heavy for practical use as compared to SNMP
- Currently should be considered only if network management is of serious importance



Other Network And Service Monitoring Tools

- SNMP is oriented towards collecting data on network equipment
 - A MIB and an agent is needed for each service to be monitored
- Often services can be monitored with simpler tools
- Example: Big Brother, <http://www.bb4.org>
 - Unix based collection of scripts, that connect the servers on the network and gather data
 - A Web based display that shows if everything is working OK or not
 - The source code is included (priceless!)
- Independent and homebrew tools provide more depth for analysis
 - Duplicate measurement using dissimilar methods help to separate actual problems from problems in the measuring system



Solving Network Problems

- Things will go wrong
 - Make a checklist beforehand
 - Try to have diagnostic tools for all possible problems
- Never confuse a measurement with the thing being measured
 - Tools show what they think is the fault
- Stay calm, focused and methodical
 - Check the cables
- If you spend all your time handling problems, something is wrong
 - Stay on the ball instead of chasing it



Service Management

- Services are above the network layer, they are what the users see
 - Properly configured networks with redundancy might experience partial failure without affecting the services
- Managing and monitoring services is not as well standardized and layered as the network level
 - This is becoming an important business area
 - There is a strong trend towards allowing the users configure the services themselves
 - "self provisioning"
- After the service management is figured out, business management is the next level



Providing And Managing Services

- Know your services, the network is only the delivery mechanism
- Generally the services drive the network design
 - How much bandwidth needed and where?
 - How many servers, how to balance the load?
- Sometimes network problems can be solved by adapting the services
 - One solution to web user overload (flash crowd) is to make the service require less bandwidth
 - Eg. the CNN "war mode" with less graphics



Content Delivery Networks

- How to provide a very popular (Web) service to all the users of the Internet?
- The content is distributed to several web servers in different physical (or network topological) locations
- Domain Name System (DNS) is used to direct the traffic to the server considered nearest
- Content can be duplicated to different servers
- Managing a CDN is quite complex
- Currently Akamai is the market leader



Network Management Thoughts

- When designing a network:
 - Think about the big picture, what is the reason for this network
 - Think about the future
- When maintaining the network daily:
 - Think about making your work easier
 - Take care of the details
- When solving a network problem:
 - Think calmly and methodically
 - Do not rush, if the first three attempts do not fix the problem, go get a cup of coffee



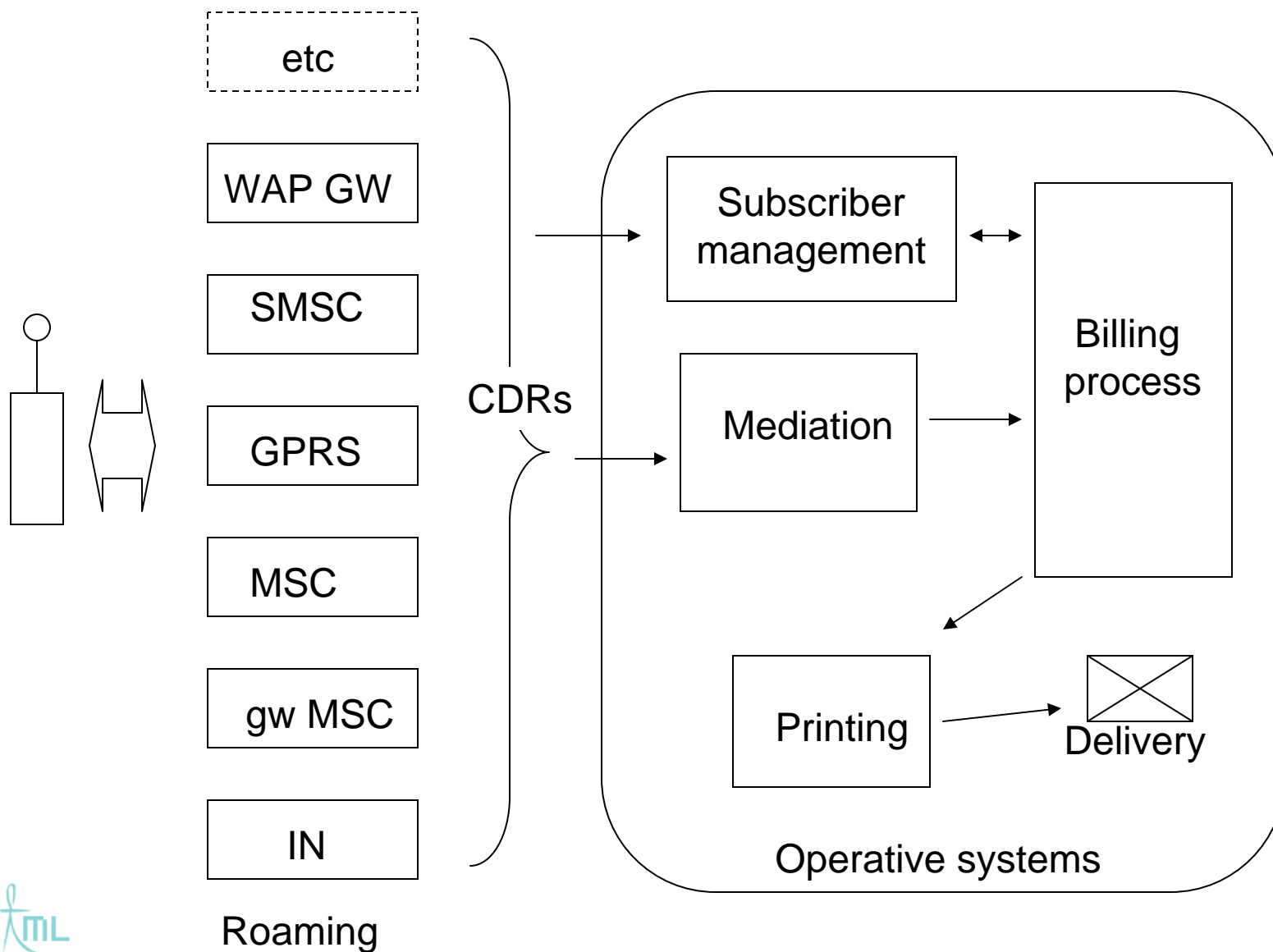
Billing



Billing Basics

- Billing is a very important feature of the modern telecommunications networks
- Initially paper tickets written by operators
 - Low cost work power made this feasible
- Next an electrical counter for each device (telephone line)
 - Active connections received pulses, which increased the counter
 - Value added billing (long distance calls) was generated by increasing the pulse frequency
- Currently billing is entirely computerized
- In modern networks:
 - The user is charged per minute/second or unmetered or prepaid
 - Usage data is collected in Call Detail Records (CDR)
 - Large files or databases containing CDRs are processed to produce a bill

Telecom Billing System Overview



The Billing Process

- Services, switches, SMSCs and other Network Elements produce
 - Session, usage & transaction data: CDRs, tickets, events, other logs
- Mediation functionalities
 - Aggregate, correlate, filter and normalize the tickets, producing
 - Records of who, when, what, (where, why)
- Rating function
 - Prices the records, producing
 - Priced usage records
- Billing function
 - Creates the invoices taking into account:
 - Accounting, payments, collections, tax, discounts
- Presentation
 - Formatting, printing and delivery of the bill



Call Detail Records

- The CDR can contain
 - Called / Received / Forwarded
 - Type of basic (GSM) service: speech, data, fax, sms
 - Type of supplementary service
 - IN triggering
 - Event time and date
 - Event duration
 - Charging principle (IMSI, MSISDN)
 - B subscriber, C subscriber
 - Pre-billing information



Mediation

- Collects or receives the information from the various network elements
 - CDRs or raw data
- Aggregates the records
 - For batch processing
- Normalizes the records
 - Information can be lacking, must be collated etc.
- Filters unmeaningful records
 - Operator's own rules
- Produces statistics



Rest Of The Billing Process

- Rating
 - Price tags are put on unified usage records
 - Price is based on tariff tables
 - A function of time, duration, local/long distance etc.
- Billing
 - Discounts (family, volume)
 - Usage matched with customer accounts
 - Connection to Customer Care Software (CRM)
 - Tax
- Invoicing
 - Formatting the actual bill
 - Customers can have several subscriptions
 - Printing and delivery

Hot Billing

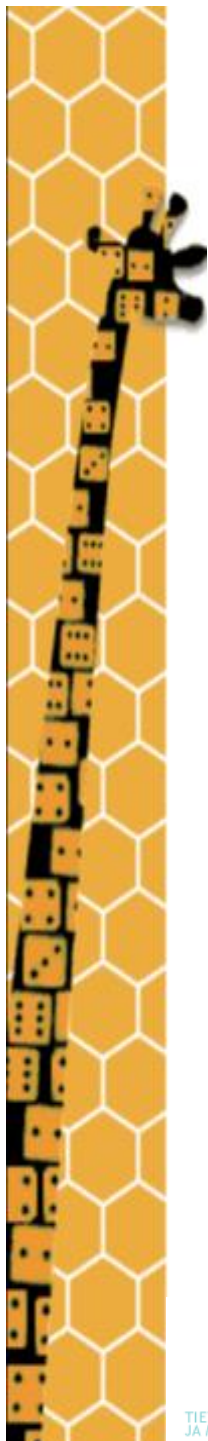
- Also called real time billing
- Needed for spending limits and pre-paid accounts
- In theory customer's account is monitored in real time and the service is shut off when the limit is reached
- In practice this is impossible
 - Real time is expensive (processing requirements)
 - Simultaneous services available (voice, SMS, GPRS)
- Real time billing requires specialized software and tight systems integration across the services

Billing Schemes

- Monthly flat rate fee (ADSL, GPRS, local calls)
- Per minute (speech, circuit data, video conferencing)
- Per megabyte (GPRS, WLAN)
- Per message (SMS, e-mail)
- Per view (video on demand)
- Per transaction (music downloads)
- Per click (click through advertising (billing can be negative, too))
- Per page (fax)
- Per \$ (commission)
- Per bullet (interactive games)
- Or per combinations of the above
- Or modified by daytime, volume etc.

An Estimate On CDR Volumes

- by Jean-Claude Sotro
- GSM
 - 2 CDRs / call
 - 3 calls / subscriber / day
 - ~6 CDRs / subscriber / day
- GPRS
 - 15 CDRs / PDP context (WAP + GGSN + SGSN)
 - 3 contexts / subscriber / day
 - ~45 CDRs / subscriber / day
- UMTS
 - GPRS + Services + QoS -> 15 + 4 + 2 CDRs
 - 6 contexts / subscriber / day
 - ~130 CDRs / subscriber / day



Changing Billing Models

- More actors
 - Network operator
 - Service (virtual network) operator
 - Content service provider
 - Content provider
- New billing models
 - Sponsoring
 - Cost sharing
 - Service provisioning
 - Commission



Payment Brokering

- Who should manage the billing
 - More services and actors
 - The telco billing system is going to be used for purchasing hard goods instead of just services?
 - But the operator does not want to become a financial institution (regulation)
- A broker (small or large financial institution) could manage the billing service
 - post-paid billing
 - prepayment (wallet)
 - customer and service identification
 - micro (average <1 €) or macro (average >10€) payments

Summary Of Billing

- Billing is an important telco process
- It requires heavy duty processing
- Many operators have multiple billing systems for historical reasons
 - Fixed line telephony, mobile telephony, Internet services
 - Also there is a psychological limit to what the customer is willing to accept as a "communications bill"

So Long

*Source and No Money will get you through the
hard times better than Money and No Source.*

Bob Kodner

*Facts without theory are useless
Theory without facts is bullshit*

Unknown

*When in fear, and when in doubt;
Run in circles, scream and shout!*

Unknown

