Quality of Service in Networking: 
*Industrial Perspectives in Thailand*

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The department of Electrical Engineering consists of four divisions.

Department of Electrical Engineering

- Power
- Control Systems
- Electronics
- Communication

Strategic Research Areas & Departmental Laboratories

www.ee.eng.chula.ac.th
Talk’s Outline

- Network
- Quality of Service (QoS) Bottlenecks
- QoS-Regulatory Activities in Thailand

NETWORK

FIRST TELEPHONES

FIRST SWITCHES
CURRENT VIEW: NETWORKING
(Implementation of End-to-End Communication)

TRANSMISSION NETWORK

Current Drives of Change

- Multimedia, mobile personal computing and WWW dictate the value of networked services
- New access network technologies (xDSL, 2.5/3G/4G, WiFi, WiMAX, FTTH) allow higher level of demands enter core network
- Explosion in available bandwidth due to optical transmission
- Data dominates voice so new network technologies must rather be designed for data hence packet-based backbone
**Talk@SUT: QoS in Network, CAK@NRG-CU**

### Network Evolution

- **Homogeneous Traffic**
  - Single-Service Network
  - Fixed Clients

- **Heterogeneous Traffic**
  - Multiple-Service Network
  - Mobile Clients

### Core Networks in Thailand

<table>
<thead>
<tr>
<th>Past</th>
<th>Current</th>
<th>&lt; 5-10 years</th>
<th>10+ years</th>
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<tr>
<td>IP</td>
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<td>SDH</td>
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<td>Ng-SDH</td>
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### Animated Evolution of Telecommunications

### QoS / Bottlenecks

**WHAT** | **WHEN** | **WHERE** | **WHO** | **HOW**
ITU-T Recommendation E.800

Quality of Service (QoS)

the collective effect of service performance which determines the degree of satisfaction of a user of the service

Network QoS Bottlenecks: When?

- When there is a mismatch between demand & capacity.
  - “Congestion”

Network QoS Bottlenecks: Where?

- Upgrading links between ASs are often too slow that the link speed cannot catch up with growing demands.
- A POI link involves agreement between two different organizations.

What about inside each AS?

- Network operators can upgrade their own link speed to relieve intra-domain congestions.
- So there are usually no QoS bottlenecks at the core network of each AS.
Fixed Access Network Bottlenecks

- NSPs assume that their residential users will rarely send/receive at maximum speed, or at least not at the same time.
- Therefore, they allow the sum of all customers’ maximum access speed to be much higher than the DSLAM uplink’s speed.
- However, peer-to-peer file sharing is causing this assumption to be violated.
- And hence QoS problems.

Fixed Access Network Bottlenecks

- However, last-mile wired links, e.g. the DSL local loops or the enterprise access links, can also become bottlenecked, but usually by the customer’s own choice e.g. to save money.

Wireless Access Network Bottlenecks

- For licensed wireless data operators, due to limited radio spectrum, the QoS bottlenecks can often arise at the radio link.
Wireless Access Network Bottlenecks

- For wireless unlicensed ISM-based WiFi service providers, the bottlenecks can occur at both the radio link (due to contention via multiple accesses) and at the uplink of the access points.

Network QoS Bottlenecks: Who?

- **Fairness**
- **Service Regulator**
- **Capacity Providers**
- **Traffic Users**

Reference Model of QoS Regulation
(Ref: S5561, SagaTel, 1999, proposed for EU)
Data/Internet QoS: Net Neutrality?

- In November 2005, in an interview with Business Week, Edward E. Whitacre, Jr., Chairman and CEO of SBC (now AT&T), stated:

  "Why should they be allowed to use my pipes? The Internet can't be free in that sense, because we and the cable companies have made an investment and for a Google or Yahoo! or Vonage or anybody to expect to use these pipes free is nuts." [Bizweek].

- Internet Content Providers (ICPs) (e.g., Google, Yahoo!, etc.) vs Network Service Providers (NSPs) (e.g., AT & T, Comcast, etc.).

Network QoS Bottlenecks: How?

How to regulate QoS levels?
- QoS differs from one service to another
- Challenge: end-to-end vs edge-to-edge QoS

Regulating QoS Levels by Empowering Consumers

- Customer Information
  - "Who can I choose from?"
  - "What can they give me?"
  - "What do they promise?"
  - "How well do they keep their promises?"
- Regulator carries out independent tests for QoS benchmarking regularly and publish tested results as information to public users
- Applicability: free market with a greater choice of providers for customers to choose

Regulating QoS Levels by Law Enforcement to Operators

- Regulator can direct service providers to report adequate and up-to-date achievable QoS information to the regulator
- Applicability:
  - When there is unfairness in the balance of advantage between providers and customers
  - More likely with large providers and small customers (e.g. residential or small business)
  - High level of complaints from consumers
Regulatory QoS Activities by NRG@CU

- Project: To Study and Recommend Criteria for QoS of Data Services
  [Commissioned by NTC to ChulaUnisearch for study period from Dec 2010 – August 2011]
- Project: To Run Drive Test for Voice QoS Monitoring of Mobile Phone Service from Consumers’ Persepectives
  [Commissioned by TCI to ChulaUnisearch for study period from Dec 2010 – April 2011]

Study and Recommendation of Regulatory Criteria for Quality of Services (QoS) in Data Telecommunications of Thailand
Dec 2010 – now

Data QoS Project: SCOPE

1) Internet access service via fixed line (xDSL, cable modem, FTTx, etc)
2) Internet access service via mobile terminals (GPRS/Edge, 3G, LTE, etc)
3) Leased line service
4) QoS in telecommunication data applications (SMS, MMS, email, vdo-streaming)

Data QoS Project: APPROACH

1. Study of international standard practices in data QoS
2. Questionnaires and interviews with Thai major operators and stakeholders
3. Focus group meeting and public hearing on list of data QoS parameters and relevant regulatory practices
4. Final recommendation on data QoS best practices for Thai industry
Data QoS Parameters in This Study

• General Data Service Provision
  – Supply time for internet access
  – Response time for services/billing/admin enquiries
  – Percentage of bill correctness complaints
  – Resolution time for customer complaints

• Internet access service via fixed line
  – Supply time for fixed network access
  – Fault repair time for fixed access line
  – Successful log-in ratio
  – Data transmission speed achieved
  – Unsuccessful data transmission ratio
  – Delay in one way transmission

• Internet access service via mobile terminals
  – Radio network unavailability
  – Delay jitter
  – FTP service non-accessibility
  – FTP cut-off ratio
  – FTP mean data rate
  – HTTP service non-accessibility
  – HTTP session failure ratio

• Leased line service
  – Percentage of availability
Data QoS Parameters in This Study

- QoS in telecommunication data application: **SMS**
  - SMS Service Non-Accessibility
  - SMS Access Delay
  - SMS End-to-End Delivery Time
  - SMS Completion Failure Ratio

- QoS in telecommunication data application: **MMS**
  - MMS Send Failure Ratio
  - MMS Retrieval Failure Ratio
  - MMS End-to-End Failure Ratio
  - MMS End-to-End Delivery Time

- QoS in telecommunication data application: **EMAIL**
  - e-mail Login Non-Accessibility
  - e-mail data transfer cut-off ratio

- QoS in telecommunication data application: **VDO Streaming**
  - Streaming Service Non-Accessibility
  - Streaming Reproduction Cut-off Ratio
Data QoS Project: Ongoing Steps @ NBTC

Workgroup/Focus group meetings on Data QoS via Mobile-Phone/Fixed-line Networks

PUBLIC HEARING

Law on Data QoS Standards

Voice-QoS Drive Test Project for Mobile Phone Service in Bangkok

Dec 2010 – March 2011

Voice-QoS Drive Test Project Contributors

NTC THAILAND

Telecommunications Consumer Protection Institute (TCI)

Telecommunications Research and Industrial Development Institute (TRIDI)

Excellence Group in Light-Wave and High-Speed Communications Department of Electrical Engineering Chulalongkorn University

Conventional Drive Testing Practice (Mobile to Fixed Line)
Voice-QoS Drive Test Project
(Equipment by FREEWILL FX)

4 Mobile phones each with SIM from 4 mobile operators are controlled by Notebook with our test software to automatically make periodic calls to corresponding Rx phones

Rx phones are located at Chulalongkorn University (at locations with indifferent received signal level from all operators)

16 mobile phones at Rx station

Voice-QoS Drive Test Project
(Test Configuration)

Inter-call duration: 30 secs
Call duration: 90 secs

Routes for Drive Test

Unsuccessful Call Ratio

Unsuccessful Call Ratio

From AIS To AIS

From DTAC To DTAC

From TrueMove To TrueMove

From Hutch To Hutch

From AIS To DTAC

From AIS To TrueMove

From AIS To Hutch

From DTAC To AIS

From DTAC To DTAC

From DTAC To TrueMove

From DTAC To Hutch

From TrueMove To AIS

From TrueMove To DTAC

From TrueMove To TrueMove

From TrueMove To Hutch

From Hutch To AIS

From Hutch To DTAC

From Hutch To TrueMove

From Hutch To Hutch
Network is Complex
Endless Stairs

Communication Milestones

Optical Fiber

Wireless Electromagnetic Waves

Smoke / Fire Signals Over Air

Electrical Signals in Copper Wire

Knowledge Accumulation of University Students

Final-year Undergraduate

3rd Year

1st Year

2nd Year

Keep on Learning
Thank You … & Questions?

Chaodit Aswakul, Chulalongkorn University
http://pioneer.netserv.chula.ac.th/~achaodit