Design and Implementation of a VoIP System for Campus Usage: A Case Study at NPRU

Presented By

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Outline

- Motivation
- Design of NPRU-VoIP
  - Analyzing the Traffic
  - Determining the Bandwidth Requirement
  - Designing the Numbering System
- Performance Evaluation
- Conclusions

Motivation

- Problem: Internal phone line shortage !!!
- Causes:

1. Expansion in the number of the campus's phone users	2. Frequently damage of an analog telephone card
• Have a new PBX system installed → time consuming and costly • Implementing VoIP technology → fast installation and cheaper	• Good grounding & Surge protector → ☹ not working at NPRU • Keep replacing with a new card → never-ended problem

- **Proposed Solution:** Existing PBX + VoIP => NPRU-VoIP

Motivation

- NPRU-VoIP must
  - Minimize the share of the Internet bandwidth
  - Support 45 VoIP users throughout the campus
  - Support basic call functions (call transfer, call waiting, etc.) + add on (conference call, call report, etc.)
  - Work smoothly with the existing PBX
  - Interconnect with PSTN networks to allow outbound calls

Design of NPRU-VoIP

- Analyzing the Traffic
- Determining the Bandwidth Requirement
- Designing the Numbering System

Analyzing the Traffic

- **Goal:** Determine the **number of trunks required** between IP-PBX and PBX
- **How:** Collect statistical data of call traffic (avg no. of call/hour and avg call duration)
  - Internal calls – call log from PBX (one-second increment)
  - External calls – phone bill from ToT (one-minute increment)

ESTIMATED CALL TRAFFIC DERIVED FROM TABLE I FOR THE FUTURE 45 VOIP USERS

Type of Calls	C	T (hour)	A (Erlangs)	No. of trunks[1]
Internal	27.45	0.018	0.494	4
External	10.35	0.055	0.569	4

According to Erlang B table with the probability of blocking of 1%

Bandwidth Requirement

- Bandwidth Requirement

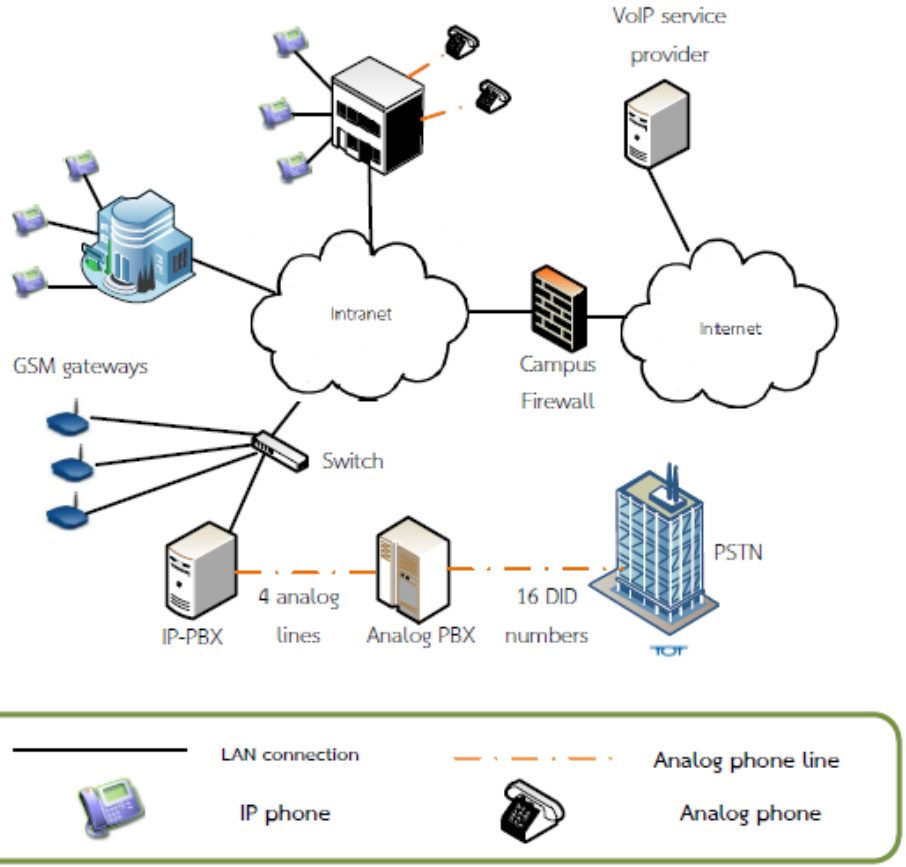
Codec Type	Coding Algorithm	MOS score	Bandwidth (kbps)
G.711	PCM	4.1	80
G.726	ADPCM	3.85	48
G.728	LD-CELP	3.61	32
G.729	CS-ACELP	3.92	24

G.711 – Internal calls

G.729 – External calls

FLOWS OF A VOICE CALL AFTER THE INTEGRATION OF A VOIP SYSTEM WITH THE ANALOG PBX

Call Type	Flow of Traffic
VoIP → VoIP	A → IP-PBX → B
VoIP → analog	A → IP-PBX → PBX → B
VoIP → PSTN	A → IP-PBX → GSM gateway → B
analog → VoIP	A → PBX → IP-PBX → B
analog → analog	A → PBX → B
analog → PSTN	A → PBX → PSTN → B
PSTN → VoIP	A → PSTN → PBX → IP-PBX → B
PSTN → analog	A → PSTN → PBS → B



The Design of NPRU-VoIP

- Numbering System (need to be carefully designed!!!)
  - Reduce call processing delay
  - User location and zoning
- What need to be determined
  - Number of digits:
    - Should be enough to support the system in a near future
    - Should be at least 4 digits (XXXX) to reduce the security vulnerability
  - Leading digit:
    - Should not overlap with the number that already been assigned to the users in another system
    - 3XXX → 1000 available numbers. ☺

Performance Evaluation

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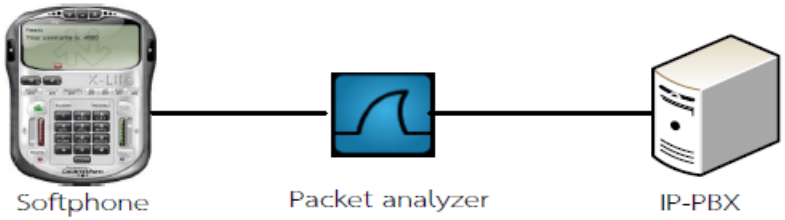
- Voice Quality



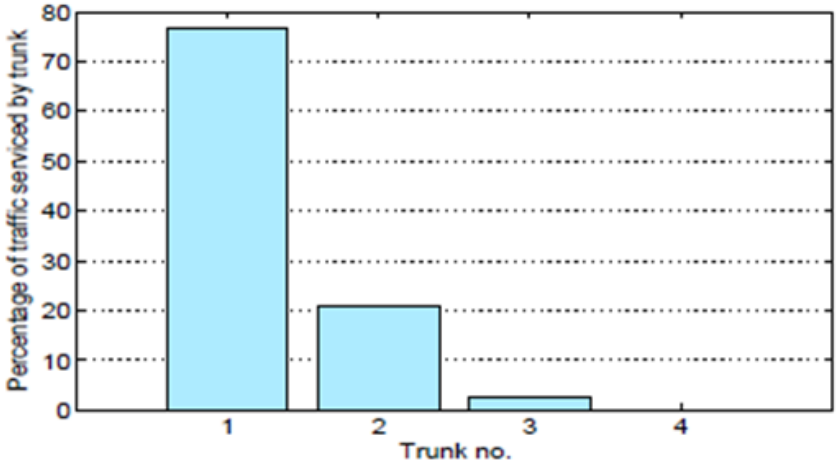
- G.711 (Internal VoIP-to-VoIP)
  - R-factor = 92.477
  - MOS = 4.34 – 4.50

-------- Very satisfied ☺ ----------

- G.729 (VoIP-to-PSTN)
  - R-factor = 80.51
  - MOS = 4.03 – 4.34

---------- Satisfied ☺----------

- Sufficiency of the number of trunks



Conclusions

- The design and implementation of a NPRU-VoIP system is presented
- Design Issues
  - Analyzing the Traffic
  - Determining the Bandwidth Requirement
  - Designing the Numbering System
- System offers superior voice quality and the number of trunks designed can handle the call traffic load very well.