Efficient QoS Support for Voice-over-IP Applications Using Selective Packet Marking

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Overview

- Voice over IP (VoIP)
  - Improved quality for VoIP
- Approach
  - Performance of the G.729 loss concealment
  - Speech Property-Based Selective Packet Marking
- Evaluation
  - Reference packet marking/prioritization schemes
  - Simple network models
  - Objective speech quality measurement
- Conclusions

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Voice over IP

- Main drivers:
  - current economical incentives (Internet flat rate pricing) → *Internet Telephony*
  - service integration, unified packet-switching infrastructure
- One of the main problems:
  - satisfaction of real-time QoS demands in a packet-switched network (fundamental tradeoff: statistical multiplexing vs. reliability → *packet loss*)

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QoS for Voice over IP flows

- low bitrate → high per-flow overhead for reservations (scalability, need for multiplexing)
- high compression (backward adaptive coding: ITU-T G.729, G.723.1)
  - no further sender adaptation / network adaptation (transcoding) possible
  - amplifies high perceptual impact of burst losses (error propagation)
+ tolerance to isolated losses (speech stationarity → extrapolation of coder state → loss concealment)
  → extend the loss resiliency of high-compressing codecs using prioritization (priority enforcement on flow aggregates: Differentiated Services)

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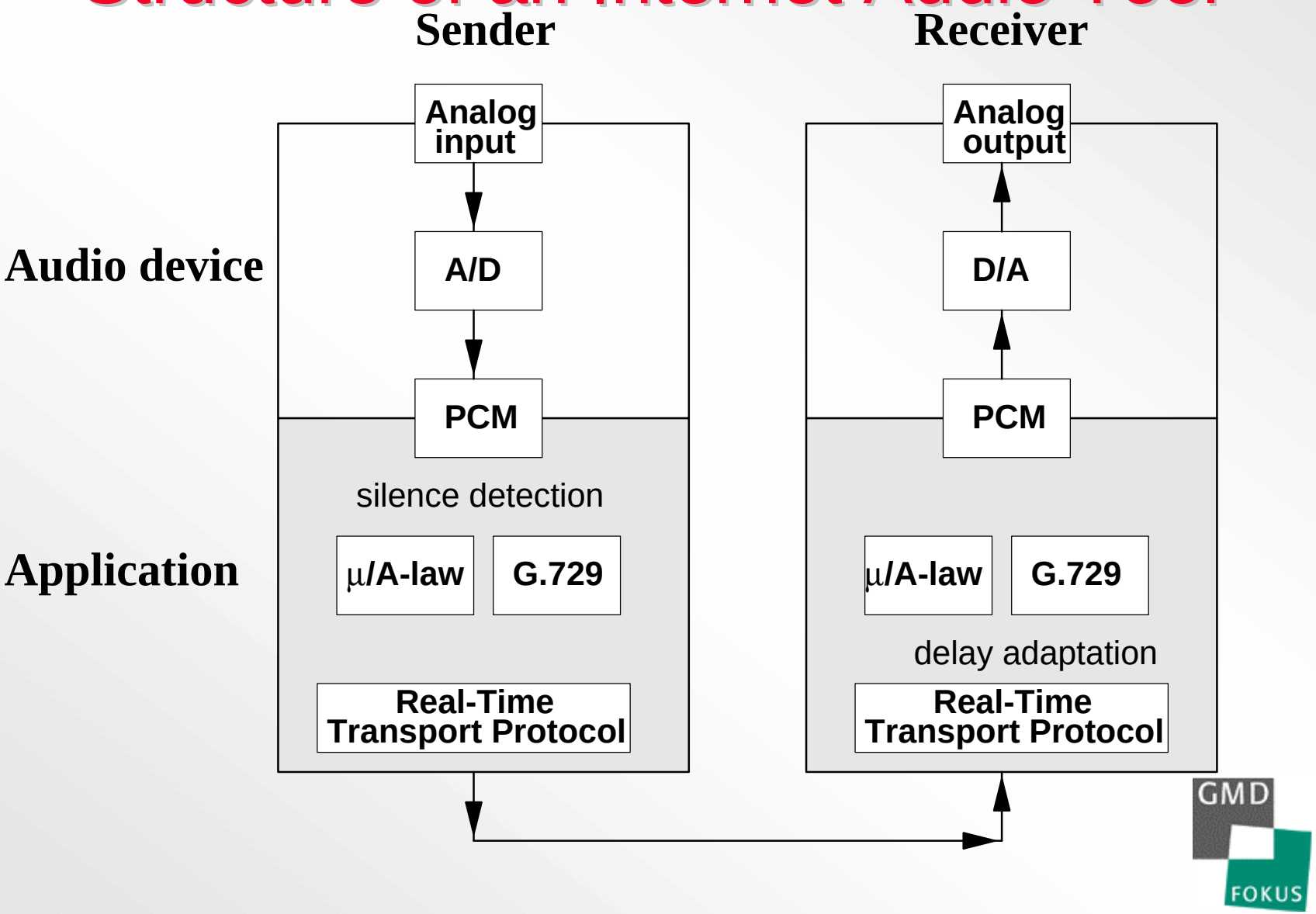
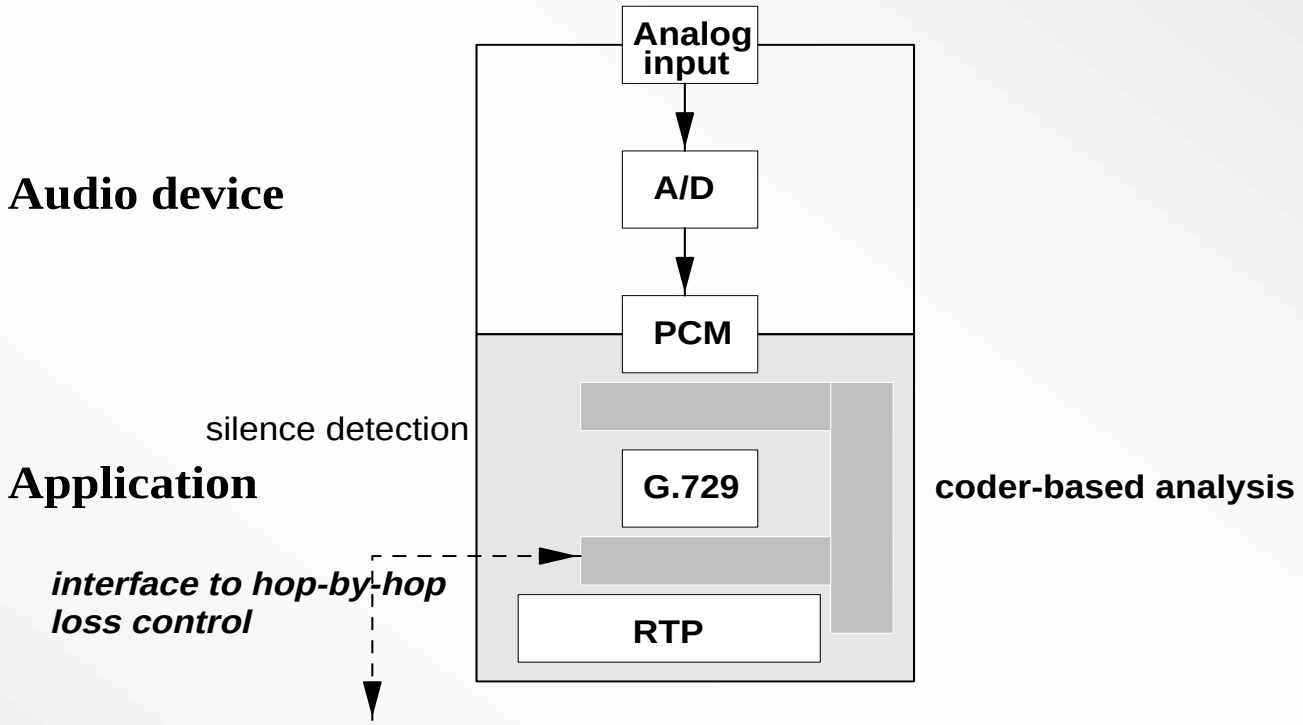
Structure of an Internet Audio Tool



Additional components: Sender



- Side information available at the encoder is used
- Decoder concealment process is taken into account

→ Selective packet marking

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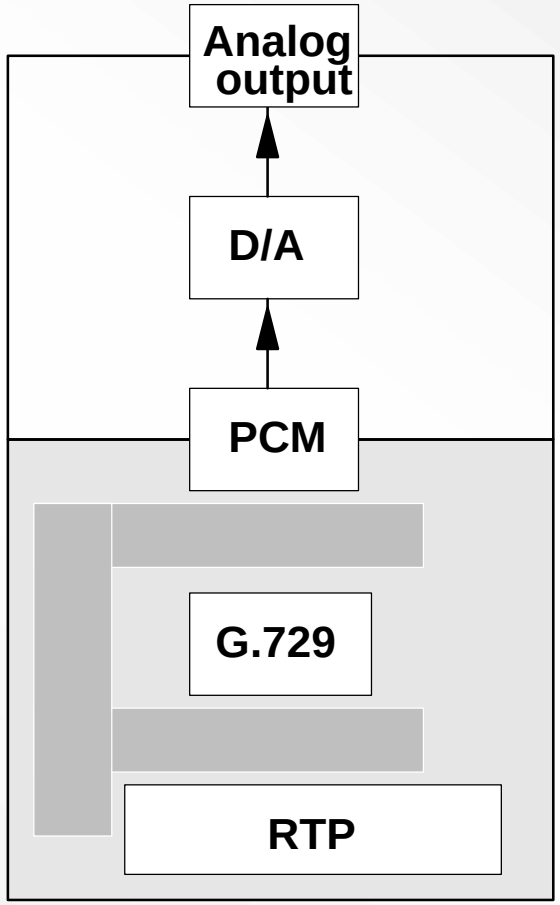
Receiver



decoder-based concealment

loss detection

delay adaptation

- No generic (PCM-level) concealment

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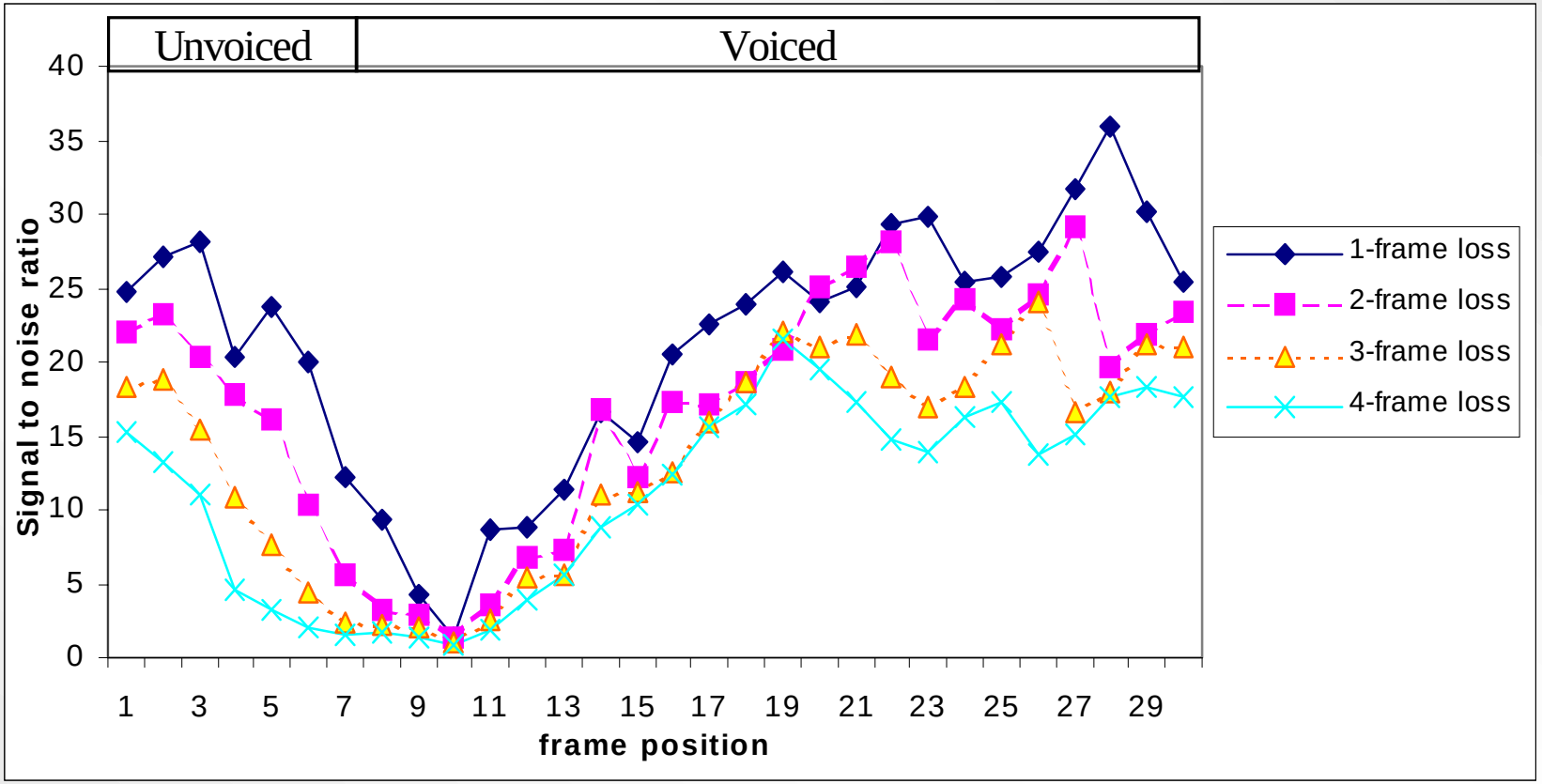
Performance of G.729 loss concealment



- Decoder fails to conceal losses at unvoiced/ voiced transition due to lack of state (synthesis filter parameters, excitation)

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Speech Property-Based Selective Packet Marking

```
protect = 0
    foreach (k frames)
        classify = analysis(k frames)
        if (protect > 0)
            if (classify == unvoiced)
                protect = 0
                send(k frames, "0")
            else
                send(k frames, "+1")
                protect = protect-k
            endif
        else
            if (classify == uv_transition)
                send(k frames, "+1")
                protect = N-k
            else
                send(k frames, "0")
            endif
        endif
endfor
```

- Packet marking („0“, „+1“) is application-controlled (adaptive to expected loss concealment performance): *40-50% of packets marked with higher priority („+1“)*

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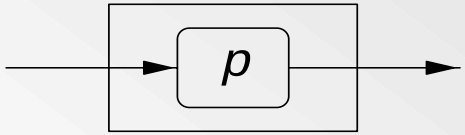
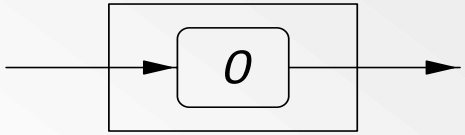
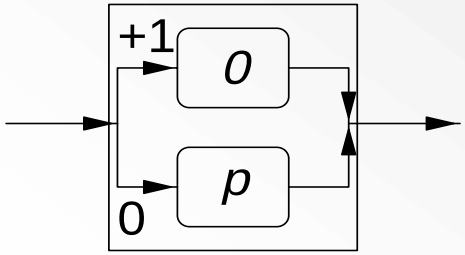
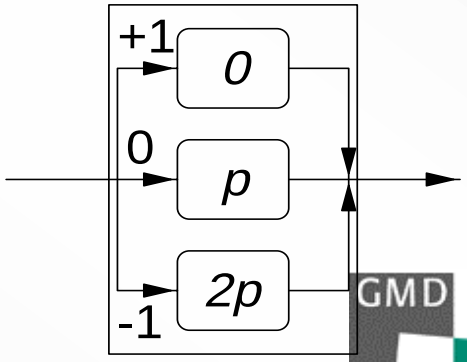
Marking Scheme / Network Model

NO MARK	0 0 0 0 0 0	
FULL MARK	+1 +1 +1 +1 +1 +1	
SPB MARK	0 +1 +1 0 0 0	
ALT MARK	0 +1 0 +1 0 +1	
SPB DIFFMARK	0 +1 +1 -1 -1 0	
ALT DIFFMARK	-1 +1 -1 +1 -1 +1	

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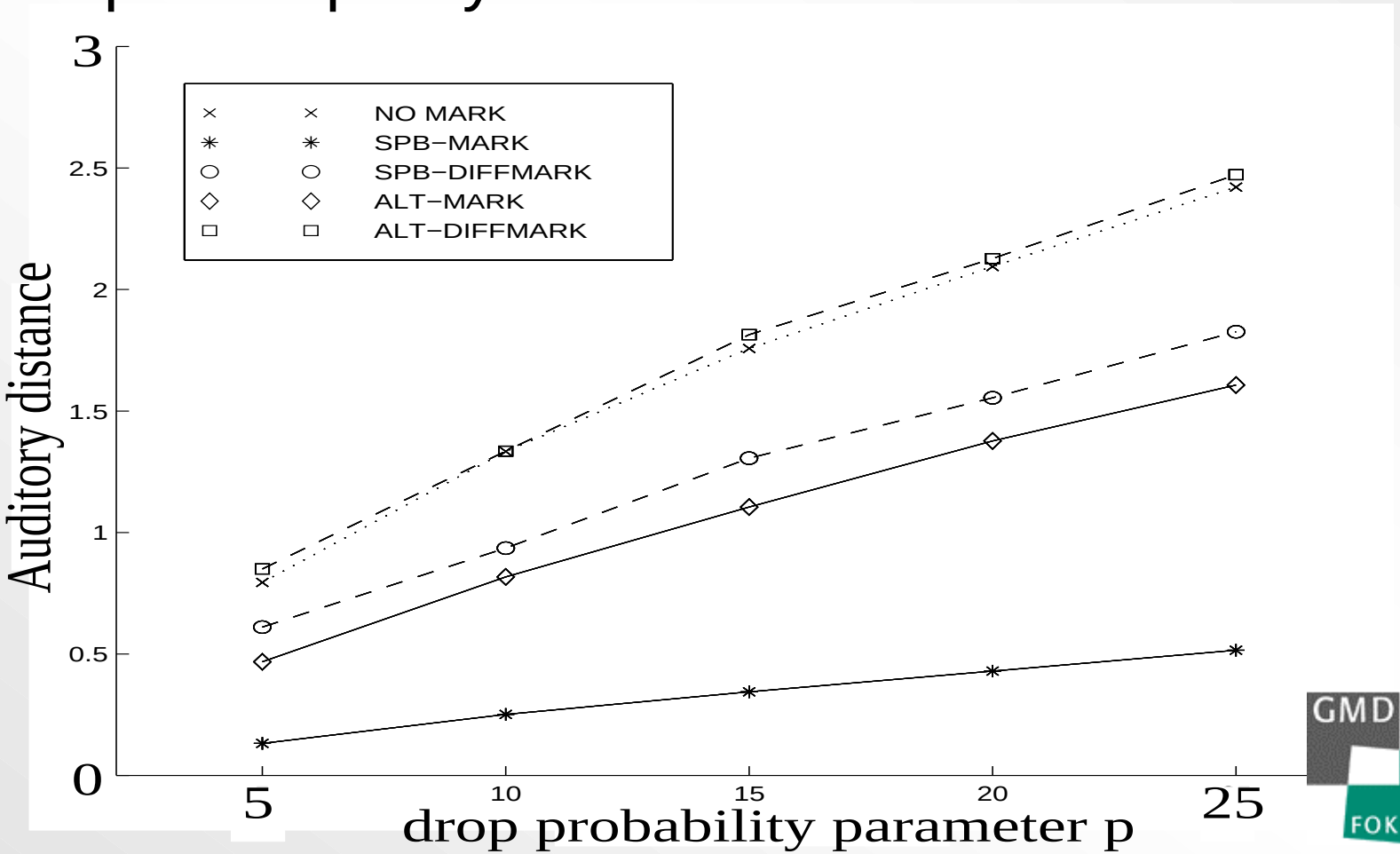
Results: Auditory Distance

- Application of recent advances in objective speech quality measurement: ITU P.861A



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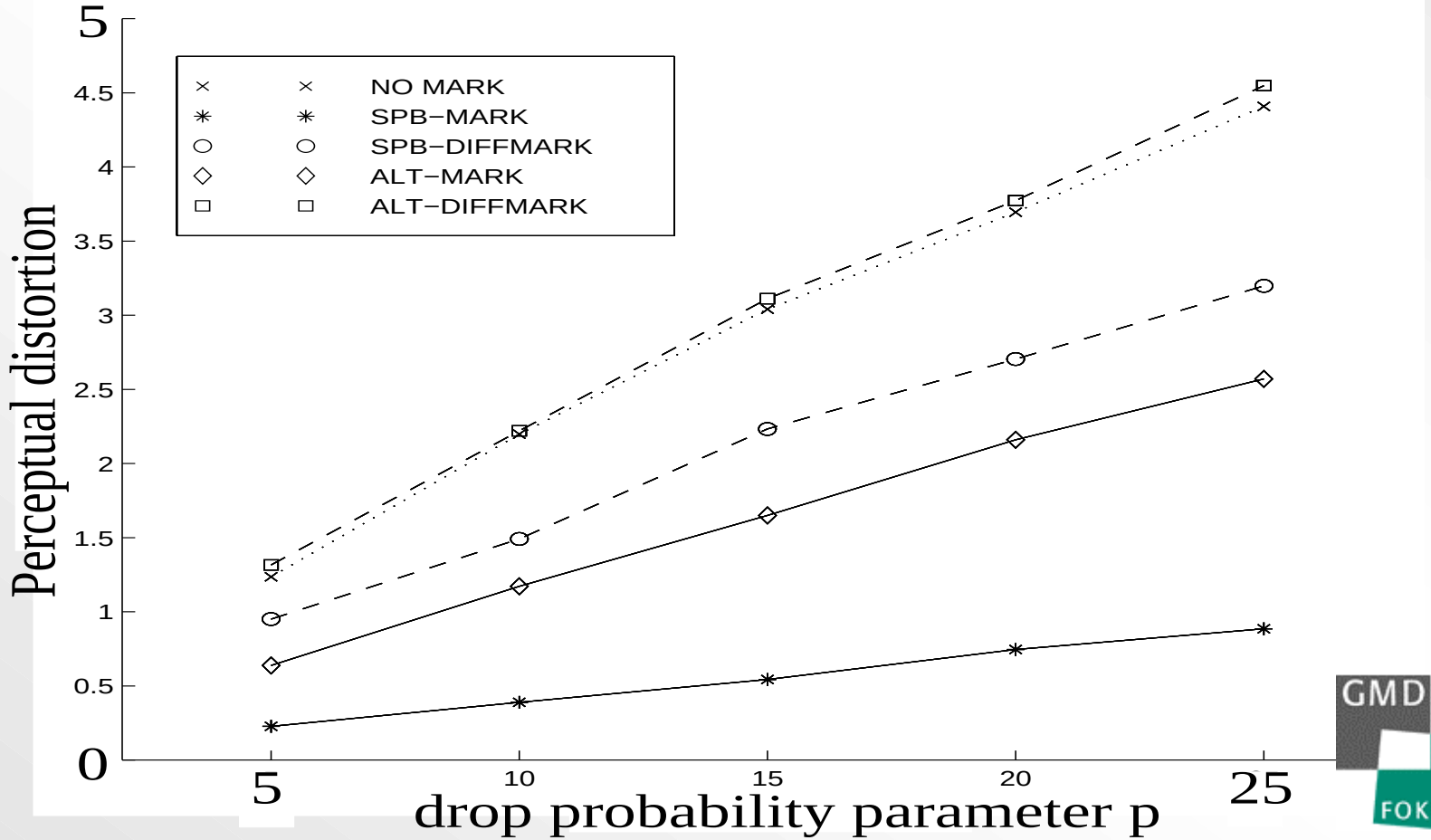
Results: Perceptual Distortion

- Enhanced Modified Bark Spectral Distortion (EMBSD; Temple University)



Conclusions

- SPB-(DIFF)MARK exploits differences in „concealability“ to adjust the amount of needed network prioritization
- simple network models & objective speech quality measures showed the reduction of number of marked packets while maintaining a good output quality
- selective marking requires appropriate socket interface (or application-level gateway)
- future work: employ speech quality measurement for the marking decision
- `http://www.fokus.gmd.de/glone`

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