Design and Implementation of Sender Initiated Congestion Control

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Content

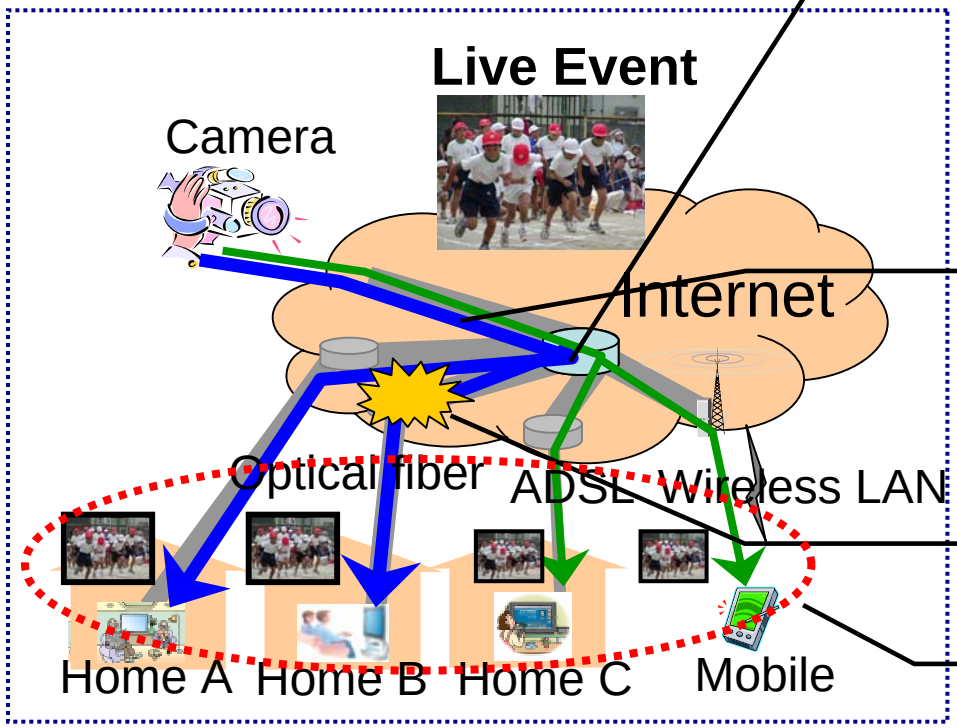
- Three parts
  - SICC protocol overview
  - Design and Implementation
  - Field Implementation

- Related work
- Conclusion
- Future work

Vision and Target

Real-time Group Communication over the Internet

e.g. Personal Broadcasting



Multicasting

→ **XCAST6**

TCP Fairness
(Maintain Fairness with TCP traffic)

Congestion Avoidance

Intra Session Fairness
(Rate Control according to User Network Environment)

SICC (proposed method)

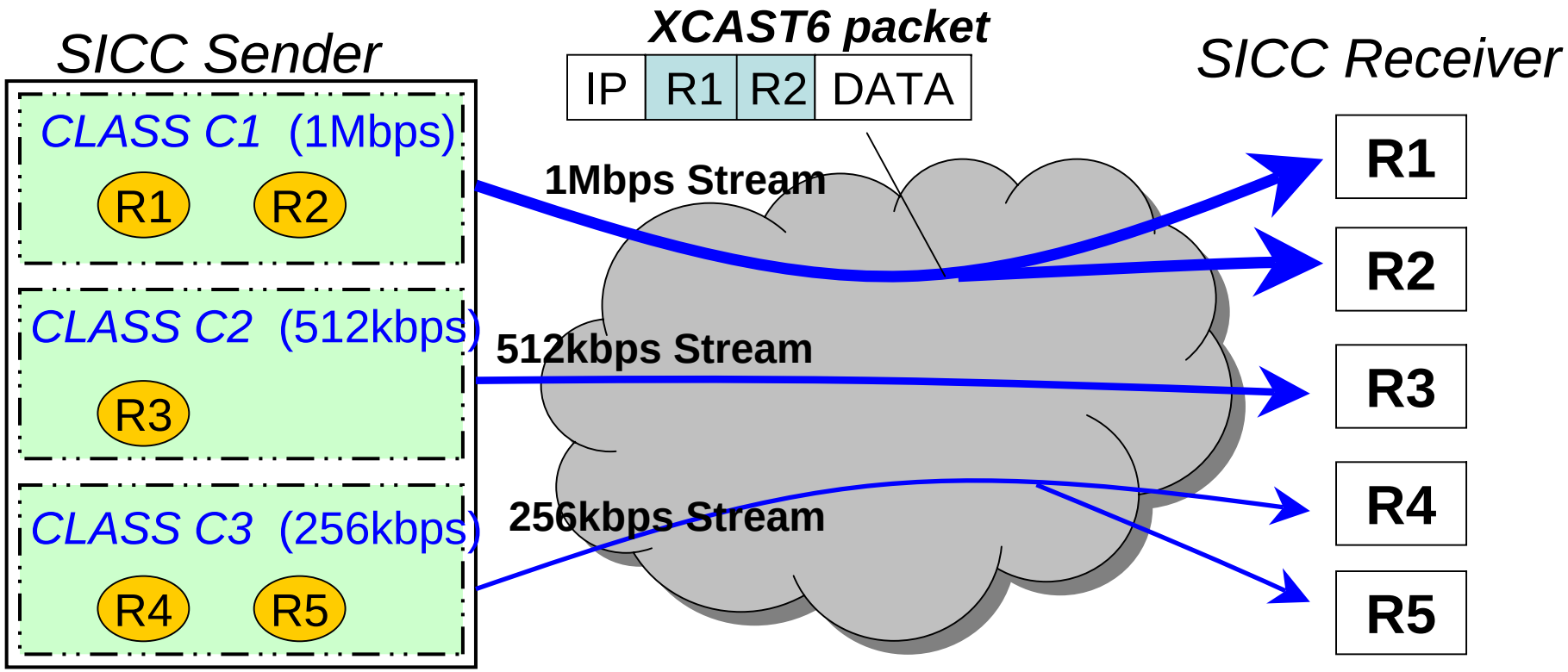
SICC: Sender Initiated Congestion Control

SICC Protocol overview

- SICC CLASS
- Estimation of Sending Rate
- Rate Control Mechanism

SICC CLASS

- Prepare several CLASSes which transmit CBR stream using XCAST6



Estimation of Sending Rate

- Sender estimates the rate that each receiver can accept while maintaining TCP Fairness using TFRC[*] approach
- The sender classifies each receiver to Suitable CLASS based on each estimation

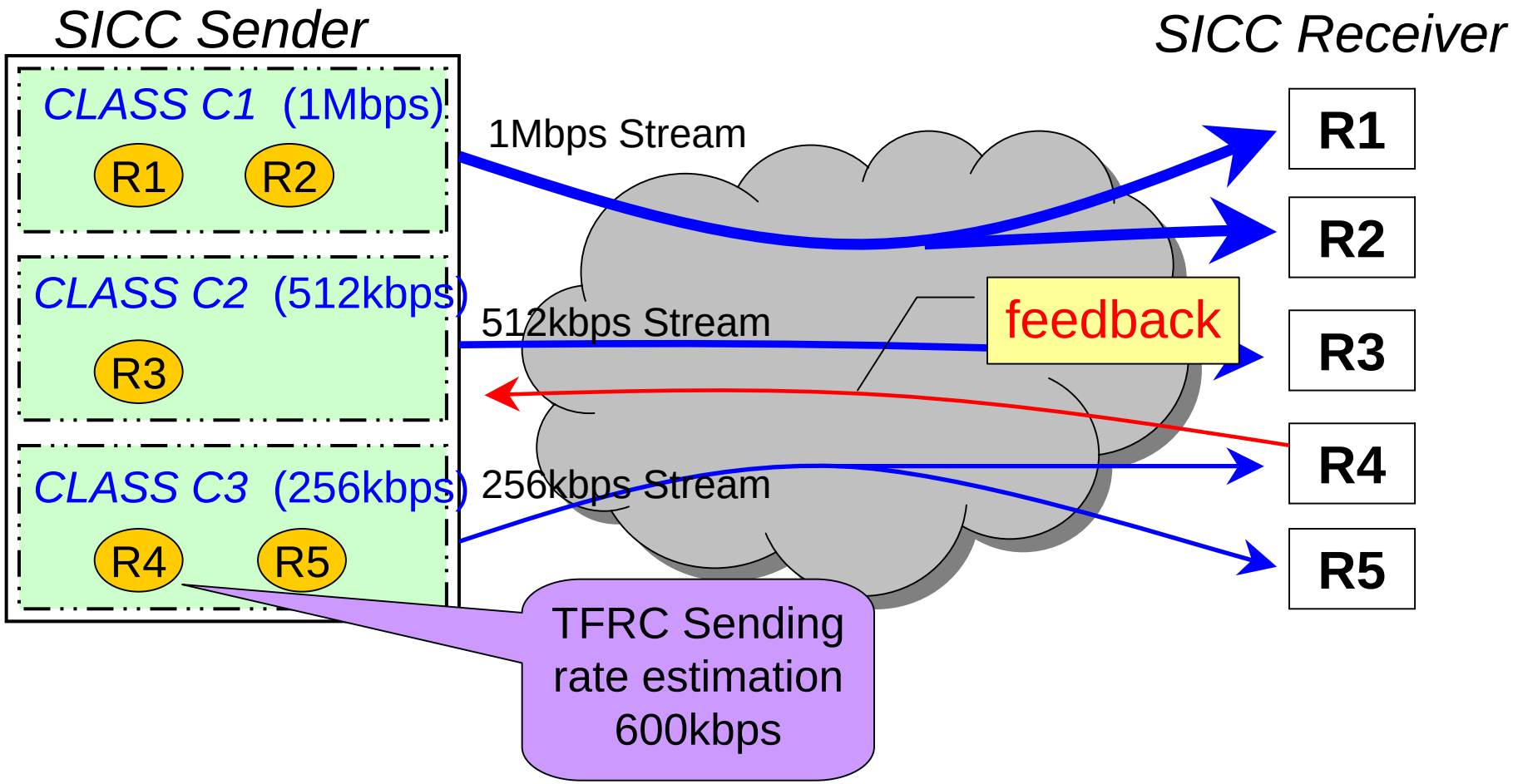
TFRC Equation

$$Xcal = \frac{8s}{R\left(\sqrt{2p/3} + 4R \times \sqrt{3p/8} \times p \times (1 + 32p^2)\right)}$$

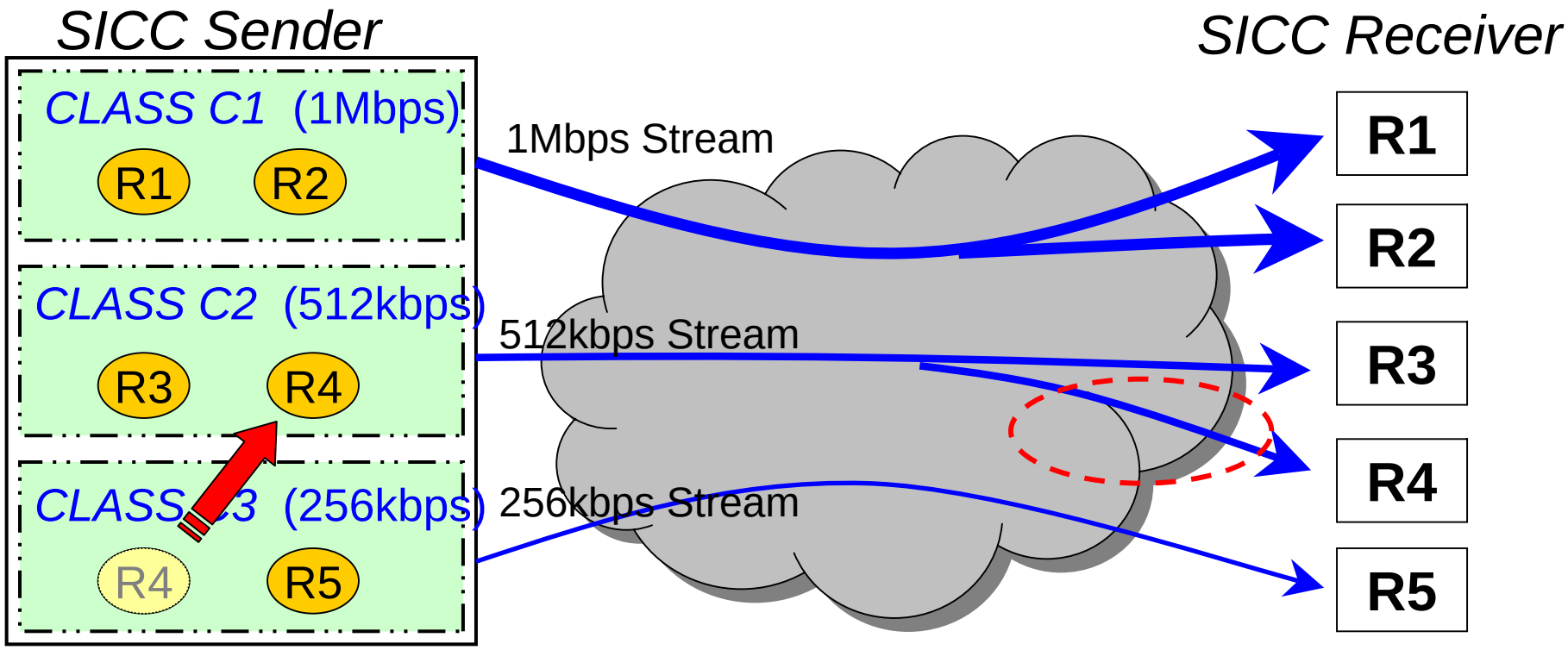
Xcal [bps] is acceptable sending rate
s [byte] is the packet size
R [sec] is the estimated RTT
p is the loss event rate

[*] M. Handley, S. Floyd, J. Padhye, J. Widmer, "*TCP Friendly Rate Control (TFRC): Protocol Specification*", RFC3448, IETF, Jan.2003.

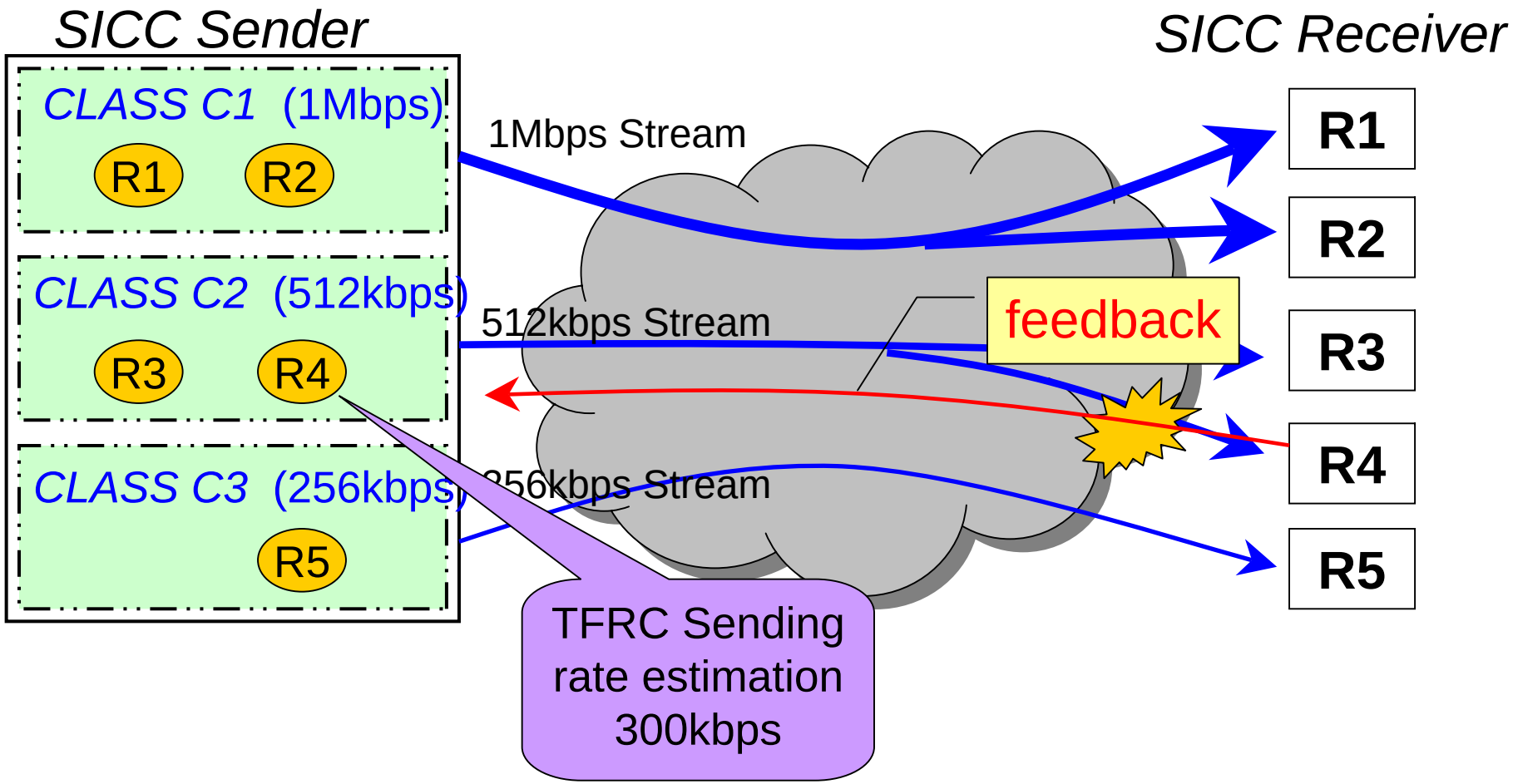
SICC Rate Control Mechanism (1)



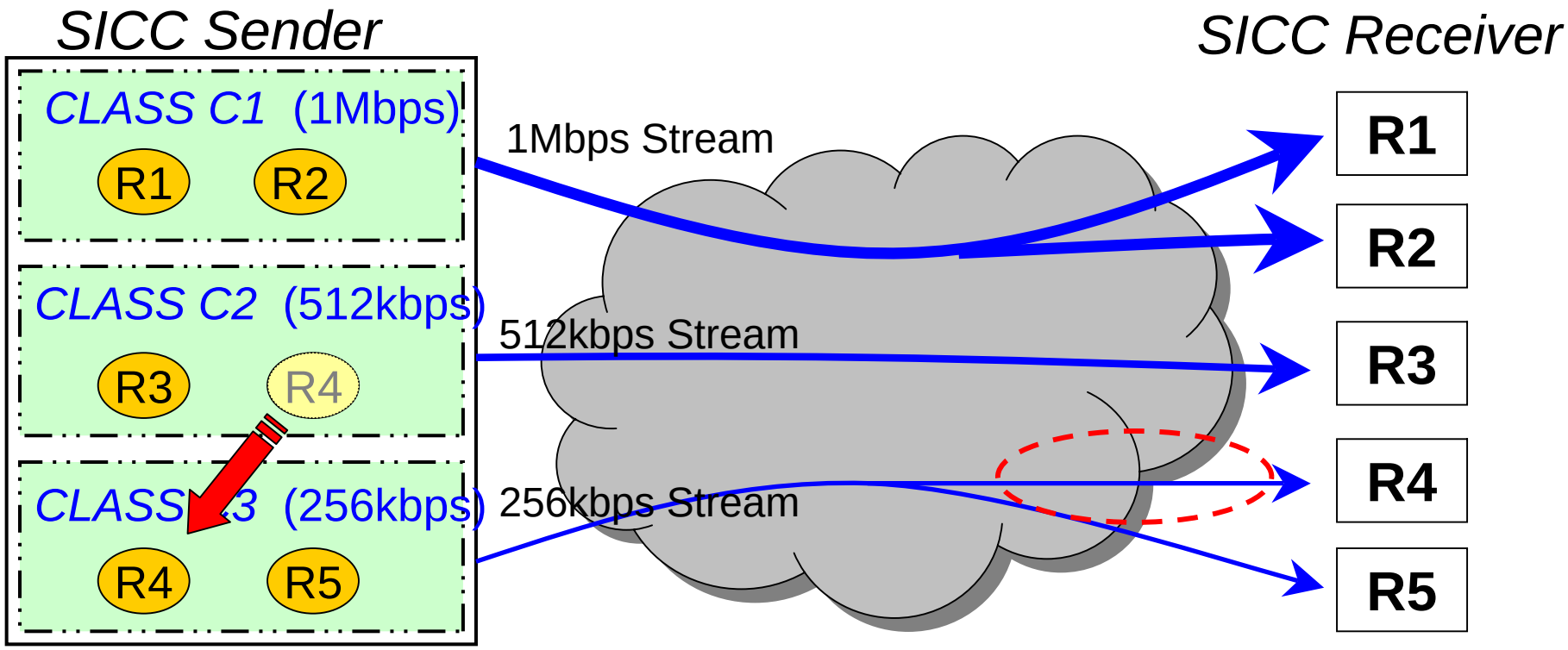
SICC Rate Control Mechanism (2)



SICC Rate Control Mechanism (3)



SICC Rate Control Mechanism (4)



Feature of SICC

- SICC achieve
  - TCP Fairness by estimation of sending rate based on TFRC
  - Intra-Session Fairness by using multiple constant sending rate
  - Fast congestion avoidance by changing the CLASS immediately

Design and Implementation

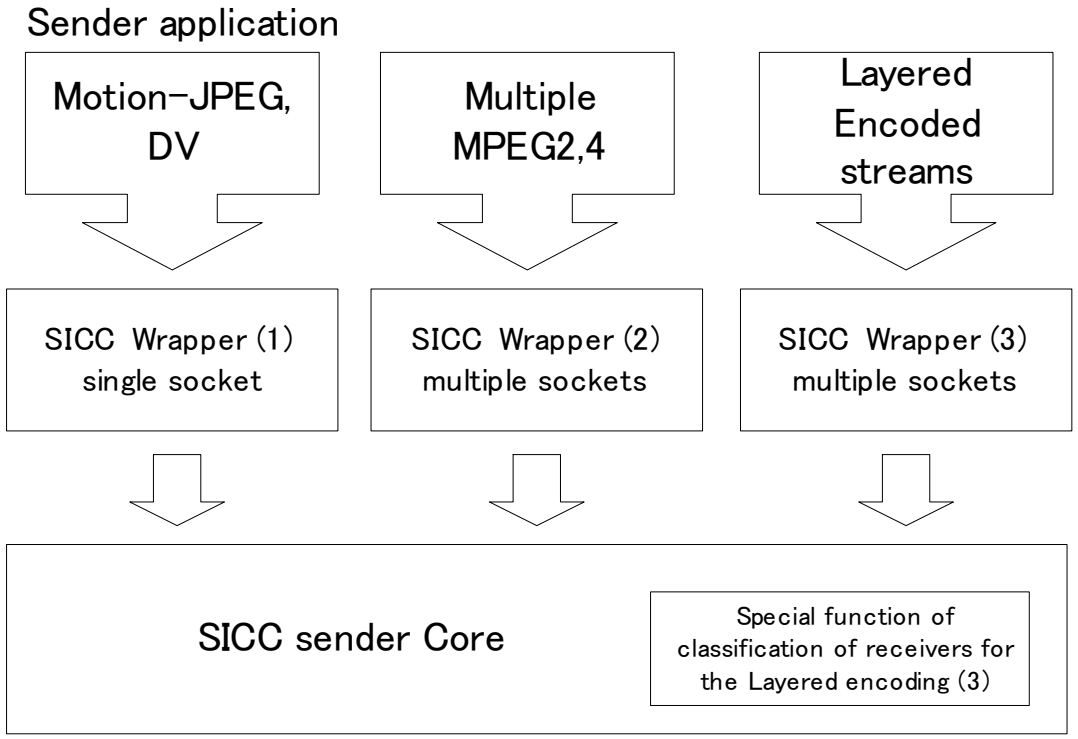
Requirement of SICC protocol stack

- **Application requirement for various encoding**
  - intra frame codec (M-JPEG, DV)
  - multi streams (MPEG-2,4)
  - layered codec (MPEG4-FGS, SVC)

- **Requirement for Real-time streaming**
  - Handling variable length of Application data unit
  - Notification of the availability on time at receiver
  - Synchronous delivery of multiple sub streams (MPEG4-FGS, SVC)

SICC socket design

- Separation of SICC core and wrapper
  - Core provides flow control to satisfy TCP Fairness
  - Wrappers provide adaptation for each encoding



Multiple-implementations

- Purpose & implementation
  - Evaluate the effect of timer accuracy
    - Implement User land NetBSD 1.6.2 with 1ms accuracy (HZ=1000) , it works fine.
  - Proof the concept of the socket design
    - Implement Kernel stack in Linux 2.6.10 and it already works
  - Verify the applicability for small appliance
    - Implement in Micro I-tron which is real time OS for embedding systems
      - Applicable (demonstrated)

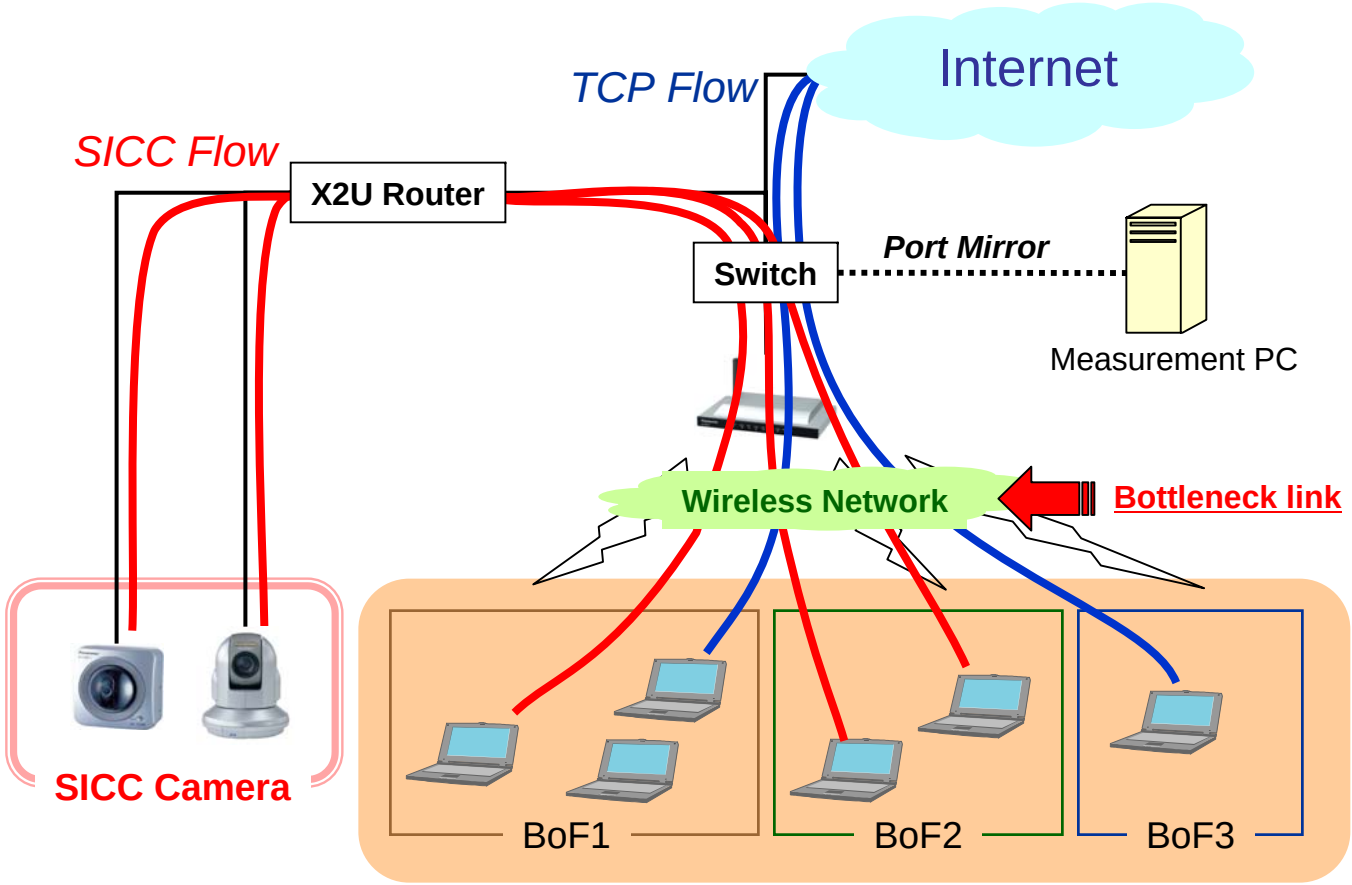
Field Experiment

Purpose of the field experiment

- Confirm the TCP Fairness in the field
  - Experiment network with 231 participant
    - Various TCP session

Field experiment environment

- Traffic (by 231 participants in WIDE CAMP)
  - Many and short lived TCP session with long RTT
  - Multiple SICC session with short RTT



The measurement index

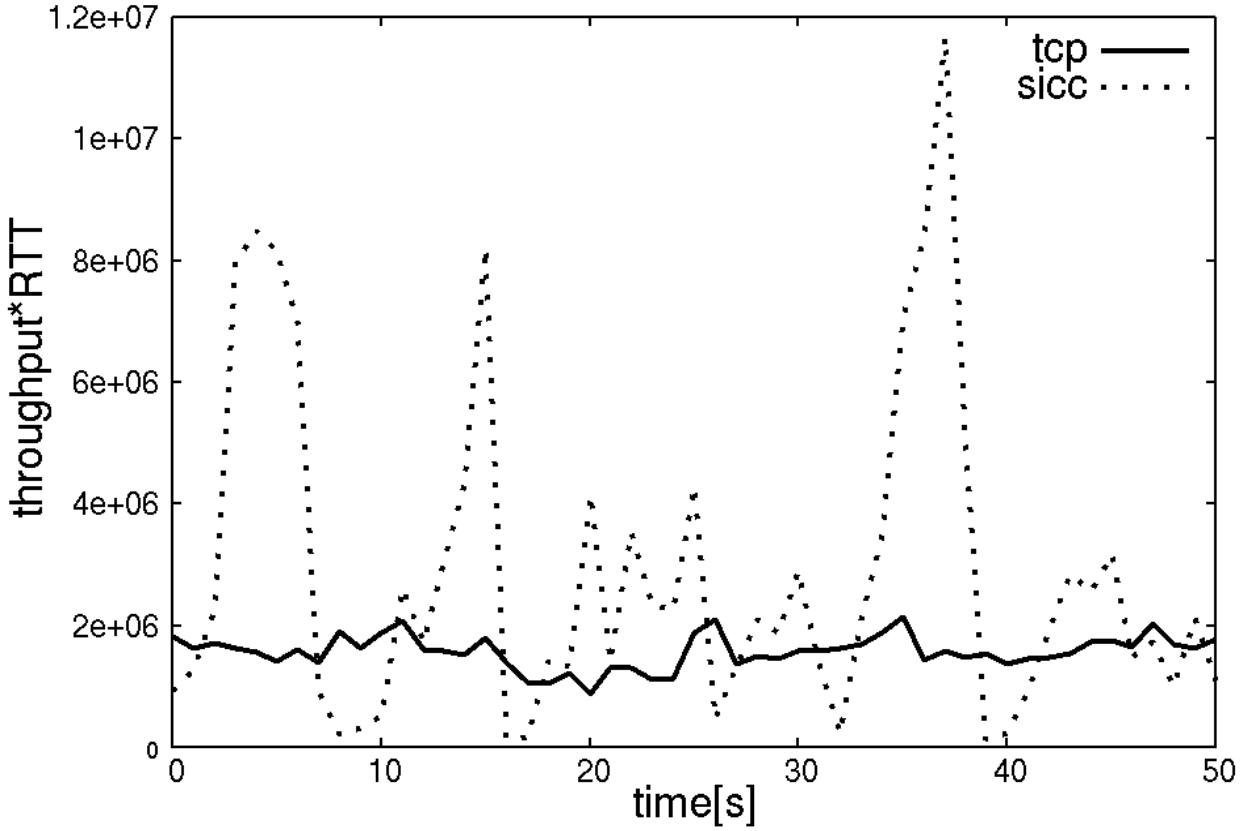
- Mean RTT weighted throughput (T_R) in the field experiment

$$T_R = \sum T_i \times R / s$$

Ti: throughtput for each flow
R:RTT of each flow
S: second

The experiment result

- Mostly fair but fluctuated



The guessing reason of the fluctuation

- fluctuation of RTT value in wireless LAN

Related work

- DCCP implementation by Nishida
  - Applicable to unicast, not for multicast
- TFMCC, PGMCC
  - TCP Fairness : OK
  - Intra-session-fairness: NG
  - No academic report of a field experiment
- NORM
  - Must be combined to achieve TCP Fairness

Conclusion

- SICC achieve TCP Fairness and Intra-session-fairness at the same time
- We have design and implemented SICC to
  - Prove the concept of socket design
  - Confirm the TCP Fairness with restricted timer accuracy with 1ms timer
  - Verify the applicability to small appliance
- We have had the field experiment with the appliance.

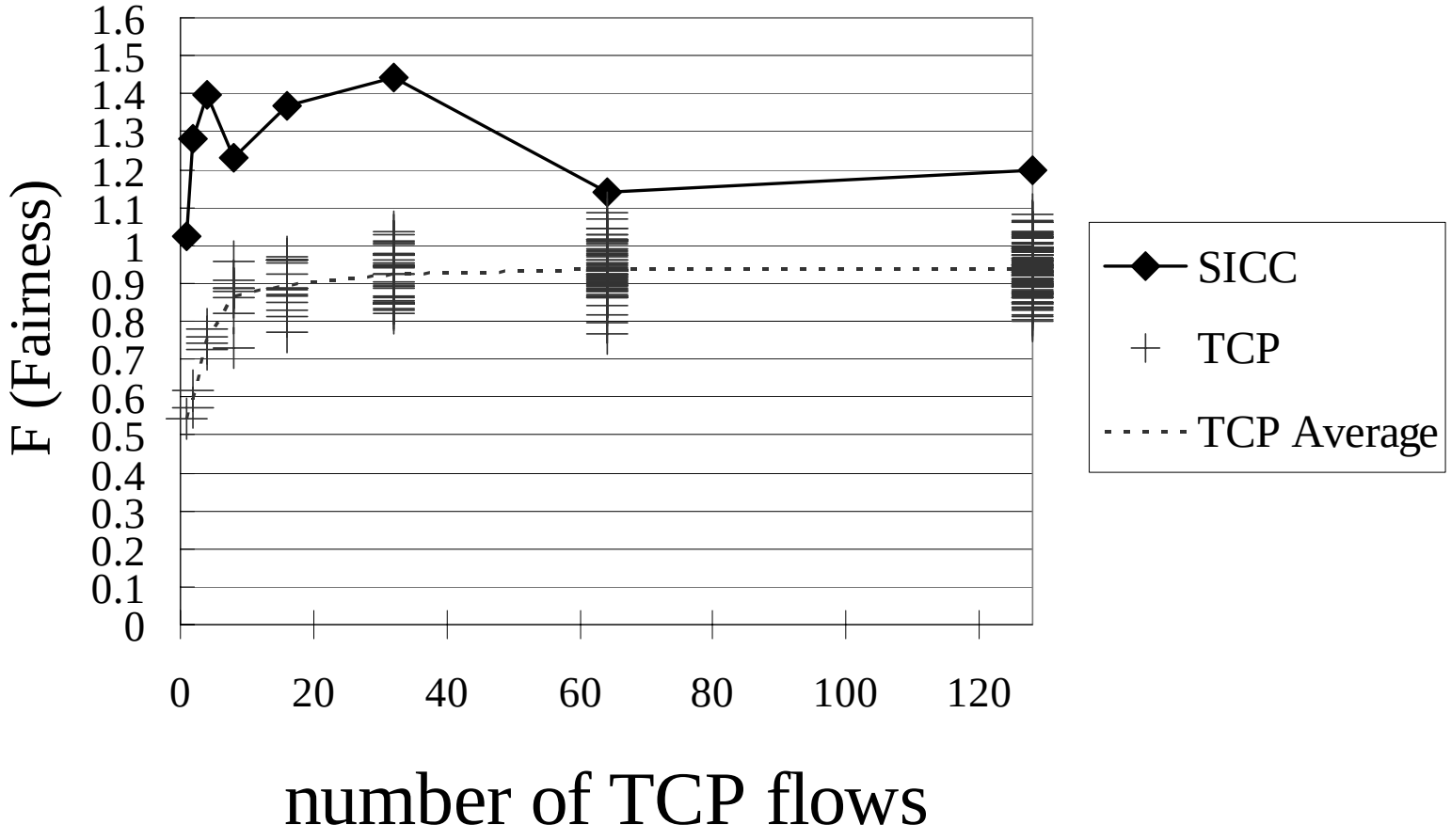
Future Work

- CLASS Change Mechanism
  - We should analyze the oscillation between CLASSes in single SICC session
- Adapting for ALM
  - The calculating time of the ALM sub tree when changing receiver to another CLASS
  - the influence of switching between multiple ALM paths

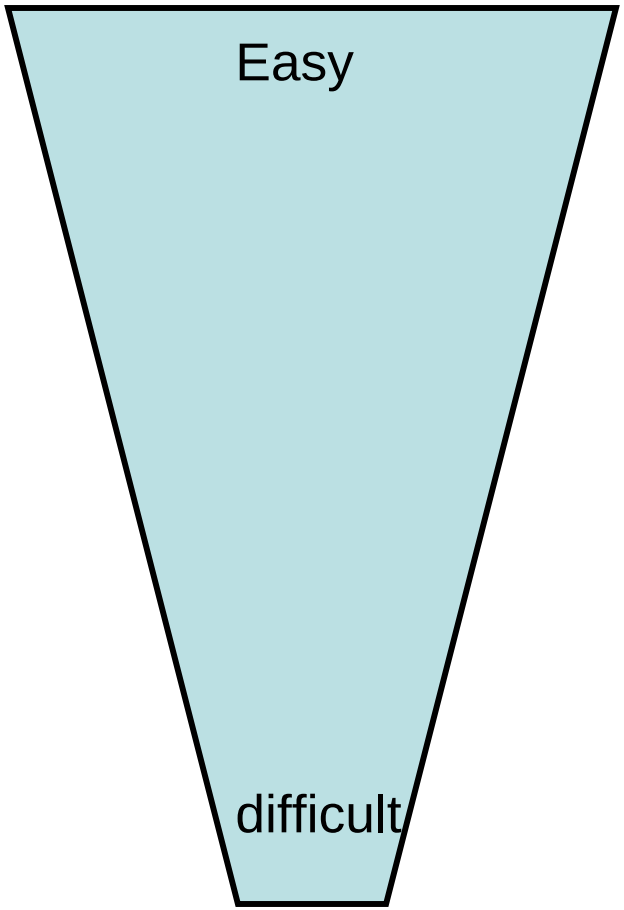
- Thanks

TCP Fairness (the result in dumbbell)

- SICC achieves TCP Fairness



The applicability of SICC on ALM

ALM (representatives)	Type	Applicability of SICC
“Host multicast(HMTP)” B. Zhang,et.al, 2002	Tree first	
“NICE” S. Banerjee,et al, 2002	Hieratical	
“SCRIBE” M. Castro,et. Al,2002	implicit (decentralized)	
“NARADA” Yang hua Chu,et al,2000	Mesh first	