I-TCP: Indirect TCP for Mobile Hosts

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Outline

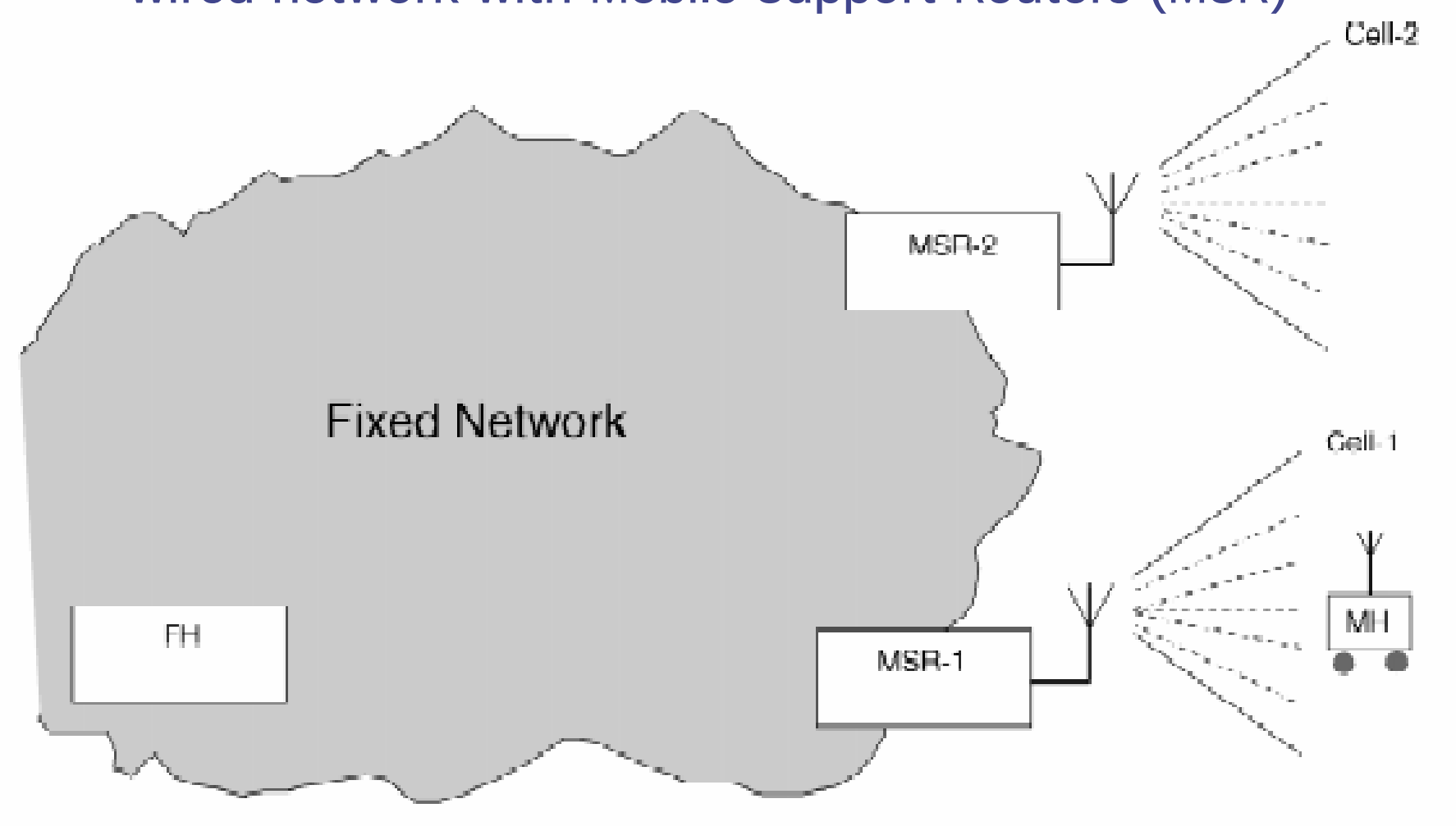
- Brief Review of TCP
- Motivation & Main Idea
- I-TCP protocol
- Performance Evaluation
- Conclusion & Limitation

Motivation & Main Idea

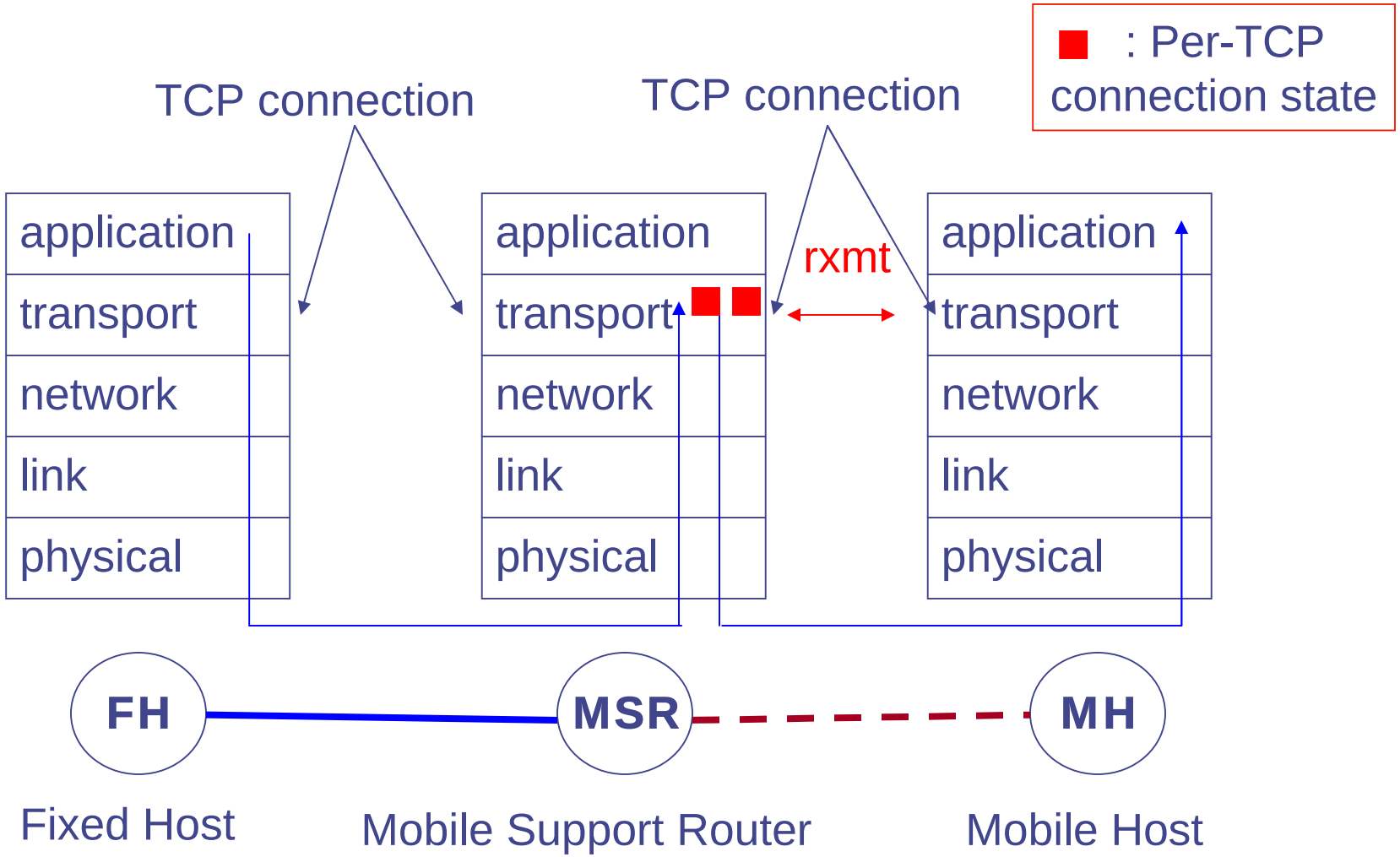
- Wireless link is error-prone
- Mobile node moves around
- Packet loss may be due to transmission error, mobility, not only due to congestion
- TCP cannot distinguish packet loss due to congestion or transmission error
- For TCP over wireless networks, unnecessarily triggers slow start procedure will cause throughput degradation
- Goal: modify regular TCP protocol to improve the performance (throughput)
- Main approach: split the end-to-end connection into two TCP connections
  - Wired part
  - Wireless part
  - Hide wireless link from TCP sender

System Model

Consider a mobile host communicates with a fixed host in a wired network with Mobile Support Routers (MSR)

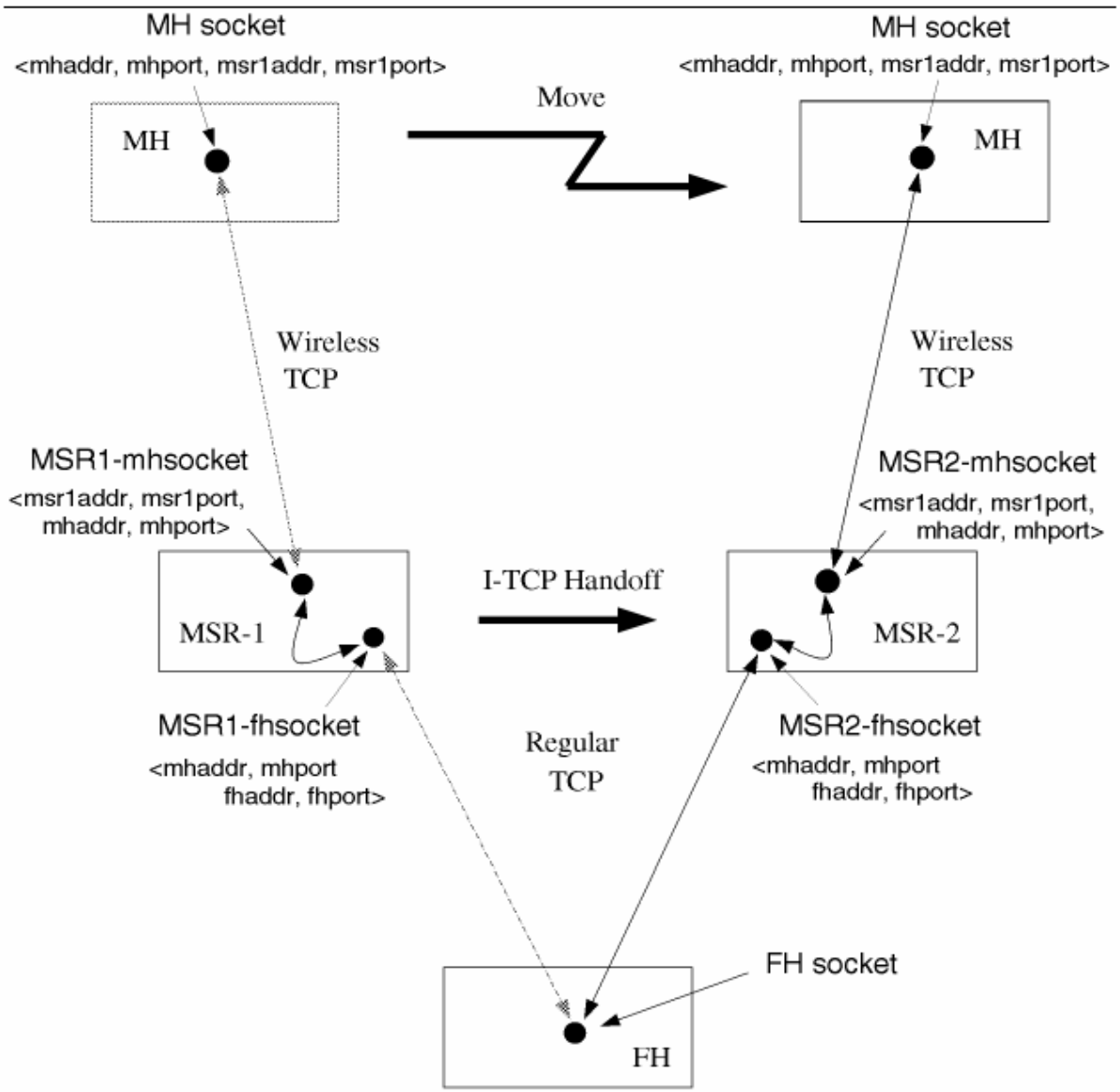


Split Connection Approach



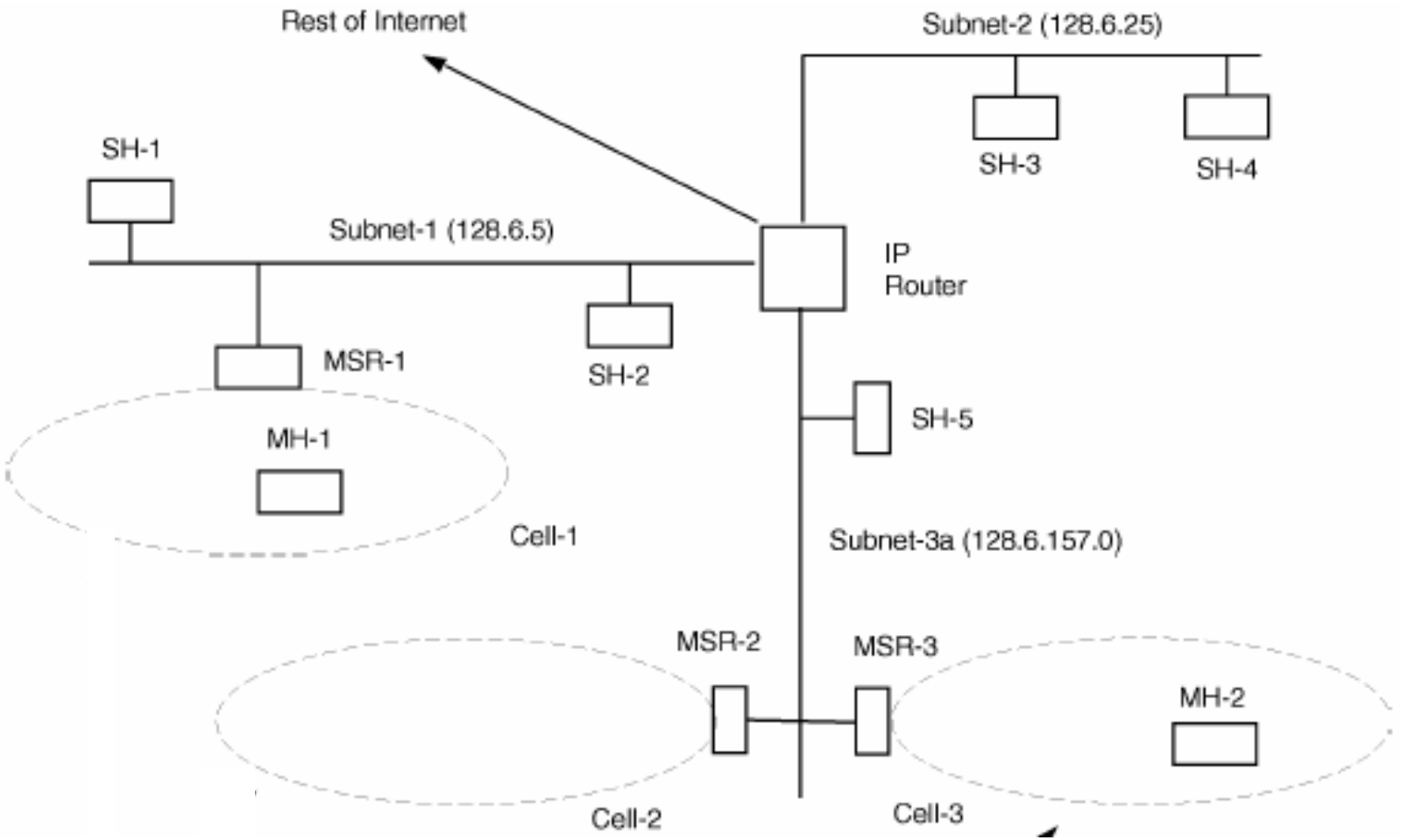
FH-MH = FH-MSR + MSR-MH

Example : I-TCP connection setup



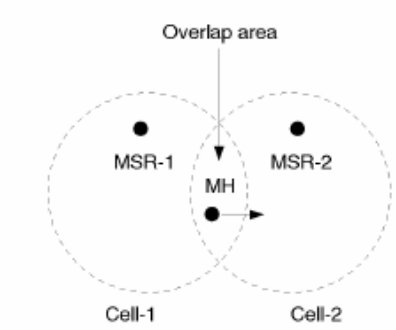
Experimental Mobile Internetworking Testbed

3 MSRs (base station); Channel capacity 2Mbps,;
MSRs are connected to 10Mbps Ethernet



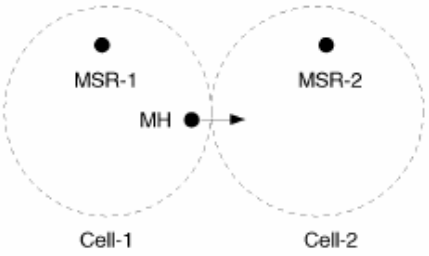
Cell Configurations

1. No moves
2. Moves between overlapped cells
3. Moves between non-overlapped cells with 0 second between cells
4. Moves between non-overlapped cells with one second between cells



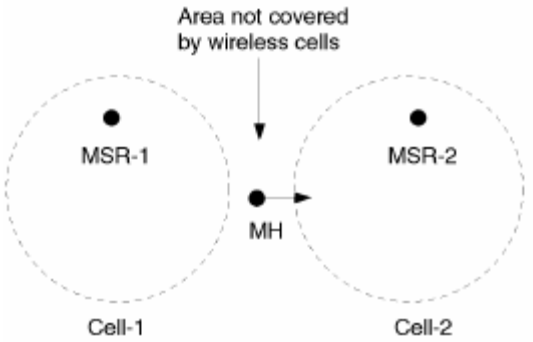
(a) Overlapped cells

A mobile host (MH) switching between overlapped cells stays in contact with both MSRs during handoff.



(b) Non-overlapped adjacent cells

A mobile host (MH) switching between non-overlapped but adjacent cells switches from one MSR to another instantaneously with no loss of link layer connectivity.



(c) Non-overlapped non-adjacent cells

A mobile host (MH) switching between non-overlapped and non-adjacent cells passes through a region of no wireless coverage thus losing link layer connectivity for a short period.

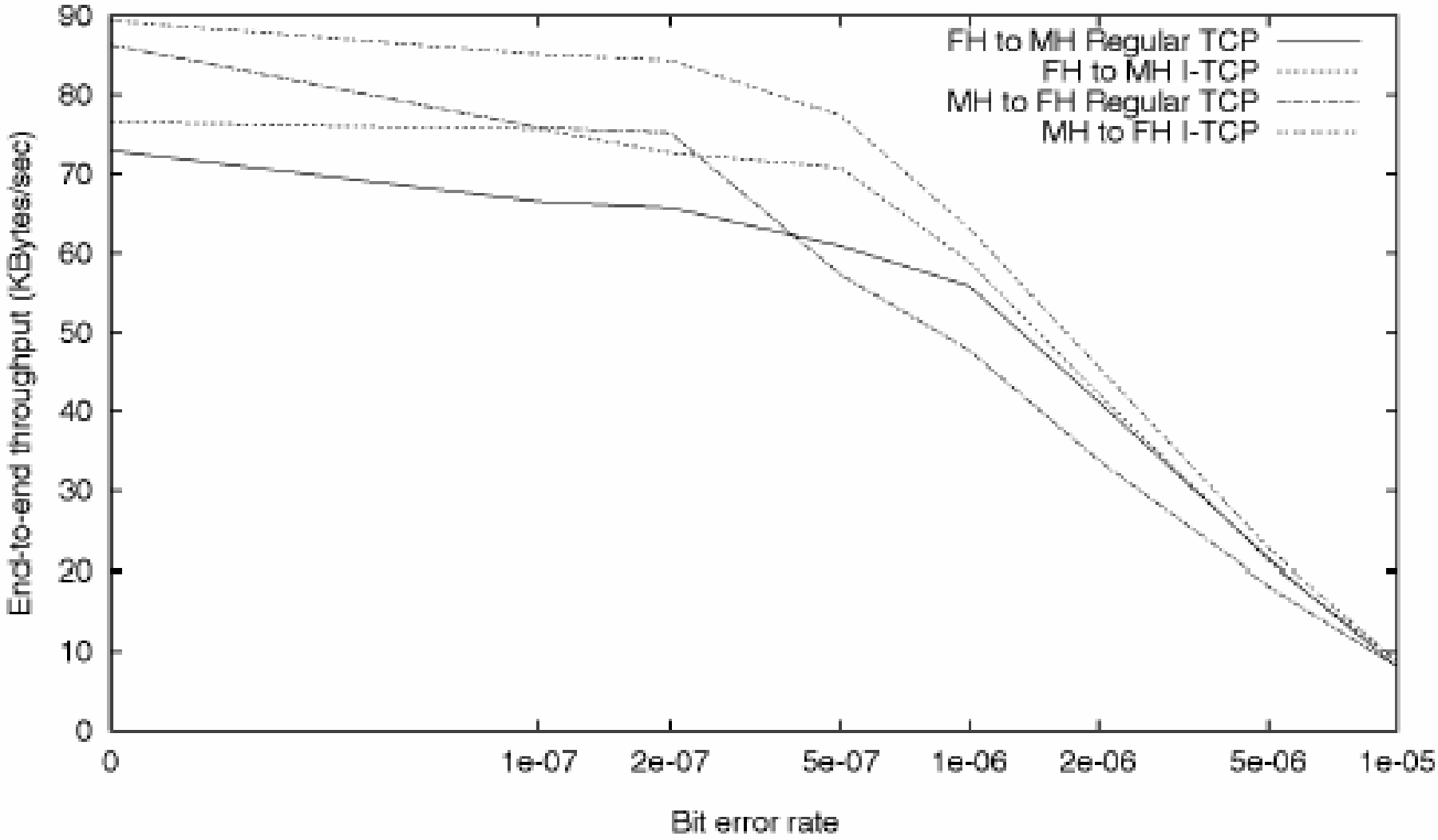
Performance over Local Area

Protocol	No moves	Overlapped cells	Nonoverlapped cells with 0 sec. b/w cells	Nonoverlapped cells with 1 sec. b/w cells
FH to MH throughput in Kbytes/sec.				
Regular TCP	65.5	62.6	38.7	23.7
I-TCP	70.1	65.4	44.8	36.3
MH to FH throughput in Kbytes/sec.				
Regular TCP	76.3	71.5	53.1	35.9
I-TCP	87.6	74.3	67.9	58.0

1. FH and MH communication involves only a few hops within campus

2. 4 MB data are delivered

Effects of Wireless Losses (Local Area)



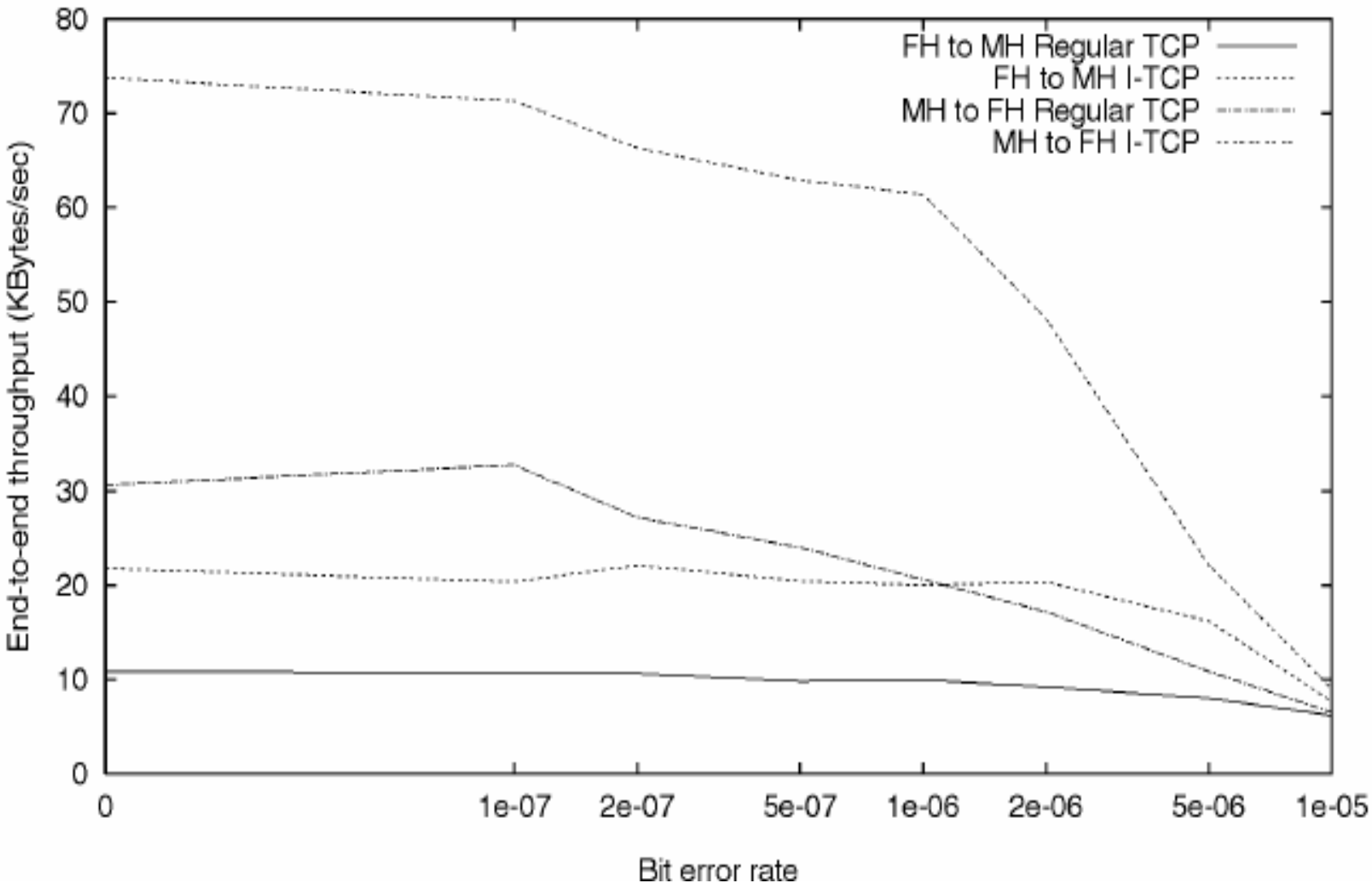
Performance over Wide Area

Protocol	No moves	Overlapped cells	Nonoverlapped cells with 0 sec. b/w cells	Nonoverlapped cells with 1 sec. b/w cells
FH to MH throughput in Kbytes/sec.				
Regular TCP	13.3	13.3	8.9	5.2
I-TCP	26.8	28.0	19.1	16.0
MH to FH throughput in Kbytes/sec.				
Regular TCP	31.0	30.0	16.9	10.6
I-TCP	71.3	61.7	57.4	46.4

1. FH and MH communication involves only a long-haul link over Internet

2. 2 MB data are delivered

Effects of Wireless Losses (Wide Area)



Advantages of I-TCP

1. Simple Implementation
2. Backward compatible to TCP fixed hosts – FH unaware of MSRs
3. Separates flow and congestion control of the wireless and wired link
4. Can optimize FH-MSR connection independently

Disadvantages of I-TCP

1. Violation of end-to-end semantics
2. MSR maintains state. MSR failure can cause connection loss. Hand-off latency increases due to state transfer
3. Unless optimized, extra copying of data at MSR

Conclusions

- I-TCP is one of the early protocols to use the split-connection approach with standard TCP for its connection over wireless link
- I-TCP improves performance for several scenarios

References

1. A.Bakre and B.R.Badrinath, "I-TCP: Indirect TCP for Mobile Hosts",Proc. 15th Int'l Conf. on Distributed Computing Systems, May 1995
2. A.Bakre and B.R.Badrinath, "Implementation and Performance Evaluation of Indirect TCP", IEEE Transactions on Computers, March 1997