Providing Connection-Oriented Network Services to Mobile Hosts

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Outline

- Motivation
- Environment and Problem
- Connection Rerouting Strategies
- Analysis and Comparison of Strategies
- Conclusions and Future Work

Applications

Multimedia applications

- Video on demand: Movies, news, programming
- Videophone

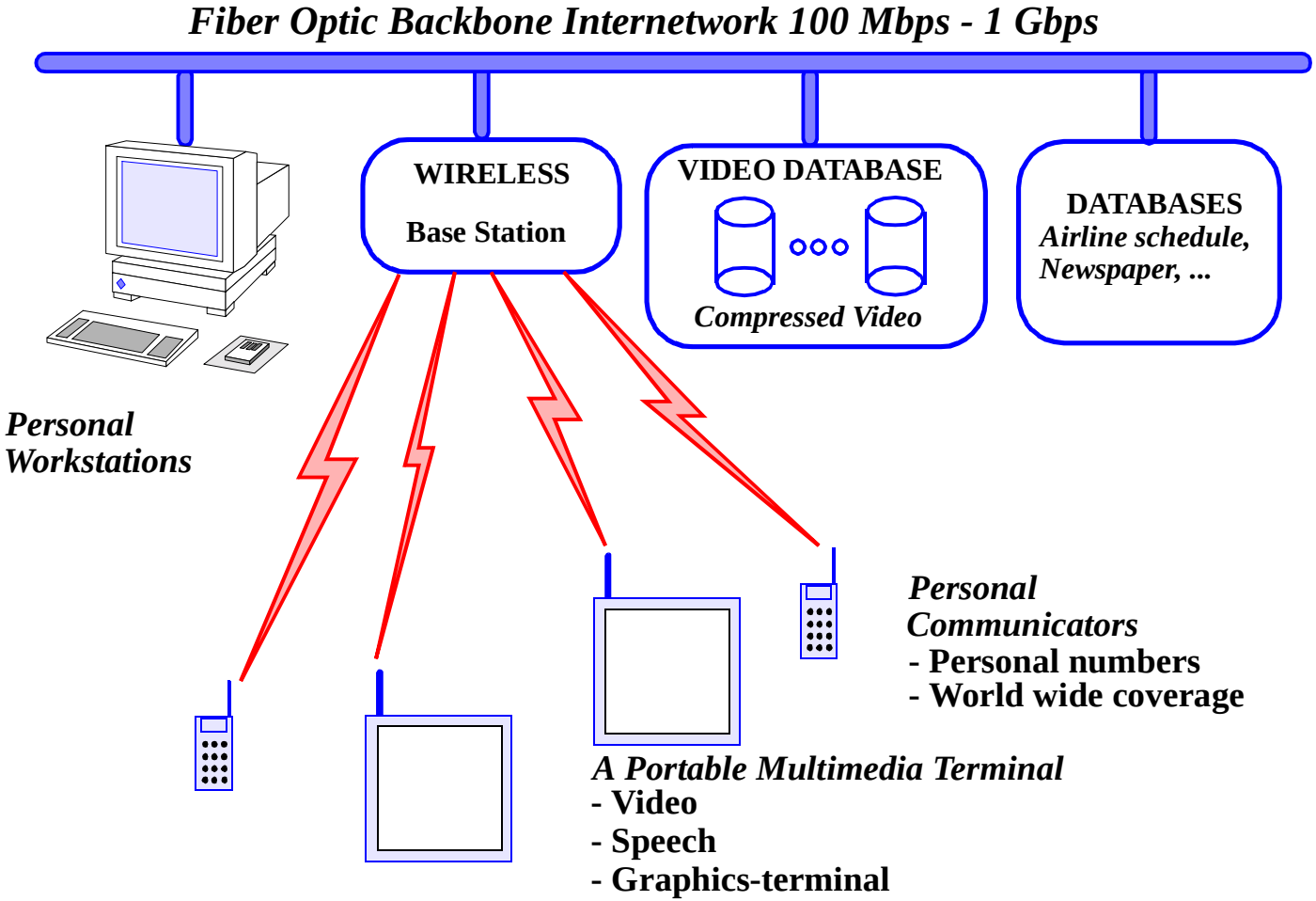
Mobile Applications

- Print media databases: Books, newspapers
- Driver information and safety systems
- Home and office information services

Mobile Multimedia Applications

- Remote sensing and actuation
- Emergency services (instant infrastructure)

A Future Environment



Focus

Topics in network support for mobile multimedia applications

- Multimedia applications need real-time network services
- Mobile computing devices require network support

Handoff problem: redirecting real-time data stream when user moves

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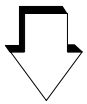
The Real-Time Network Service

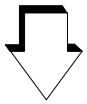
Multimedia applications need predictable performance ⇒ guarantees on:

- Delay
- Delay variation
- Bandwidth
- Congestion loss



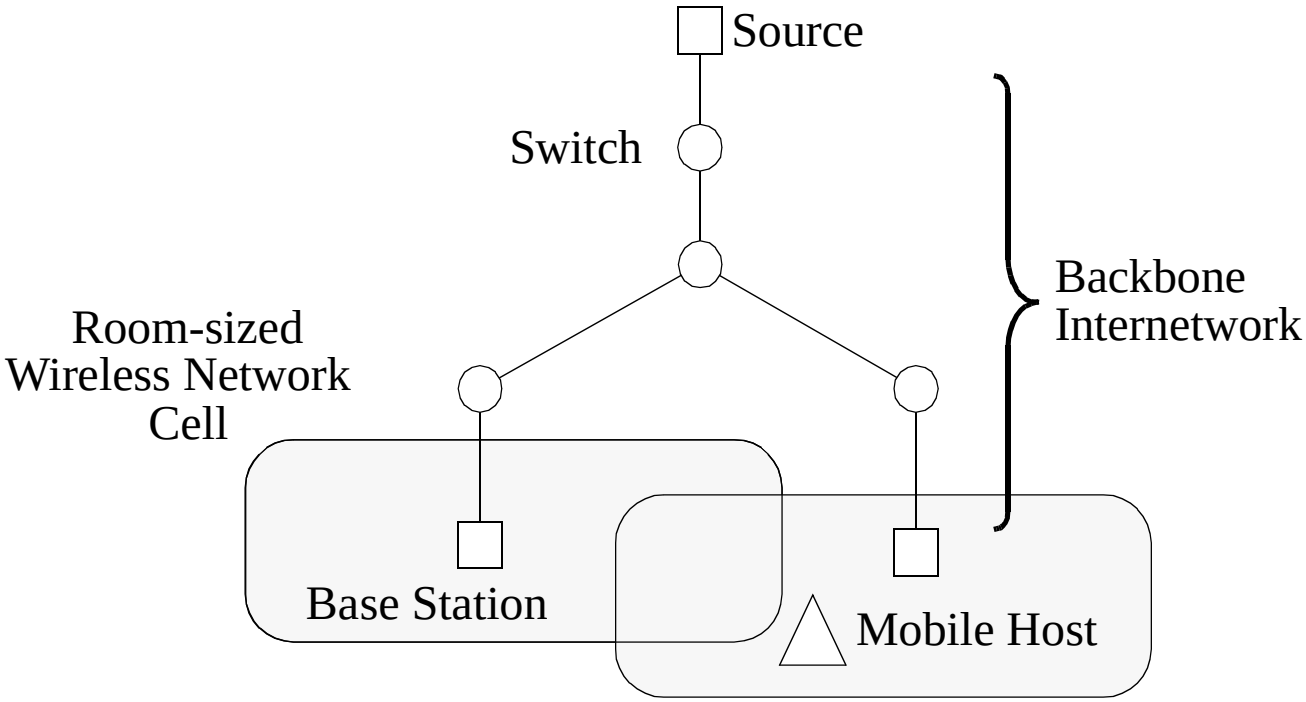
Mechanisms to guarantee performance

- Per-conversation admission control
- Per-conversation network resource allocation



Requires a connection-oriented network layer

Mobile Networks



Mobile hosts communicate with base stations

- Interference may interrupt this communication

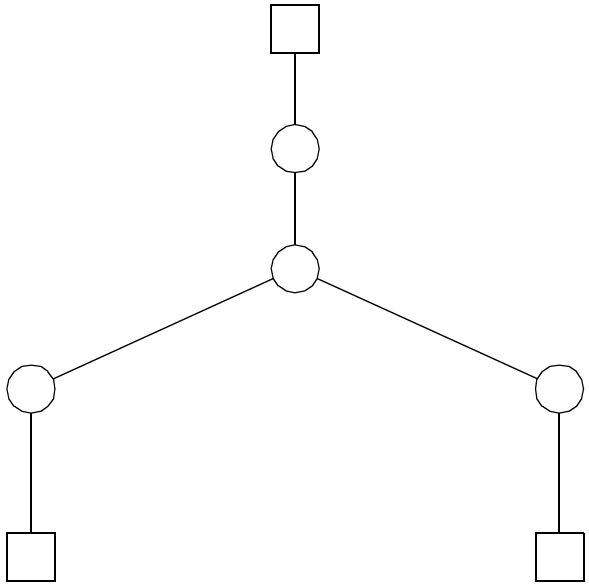
Information available on impending handoff

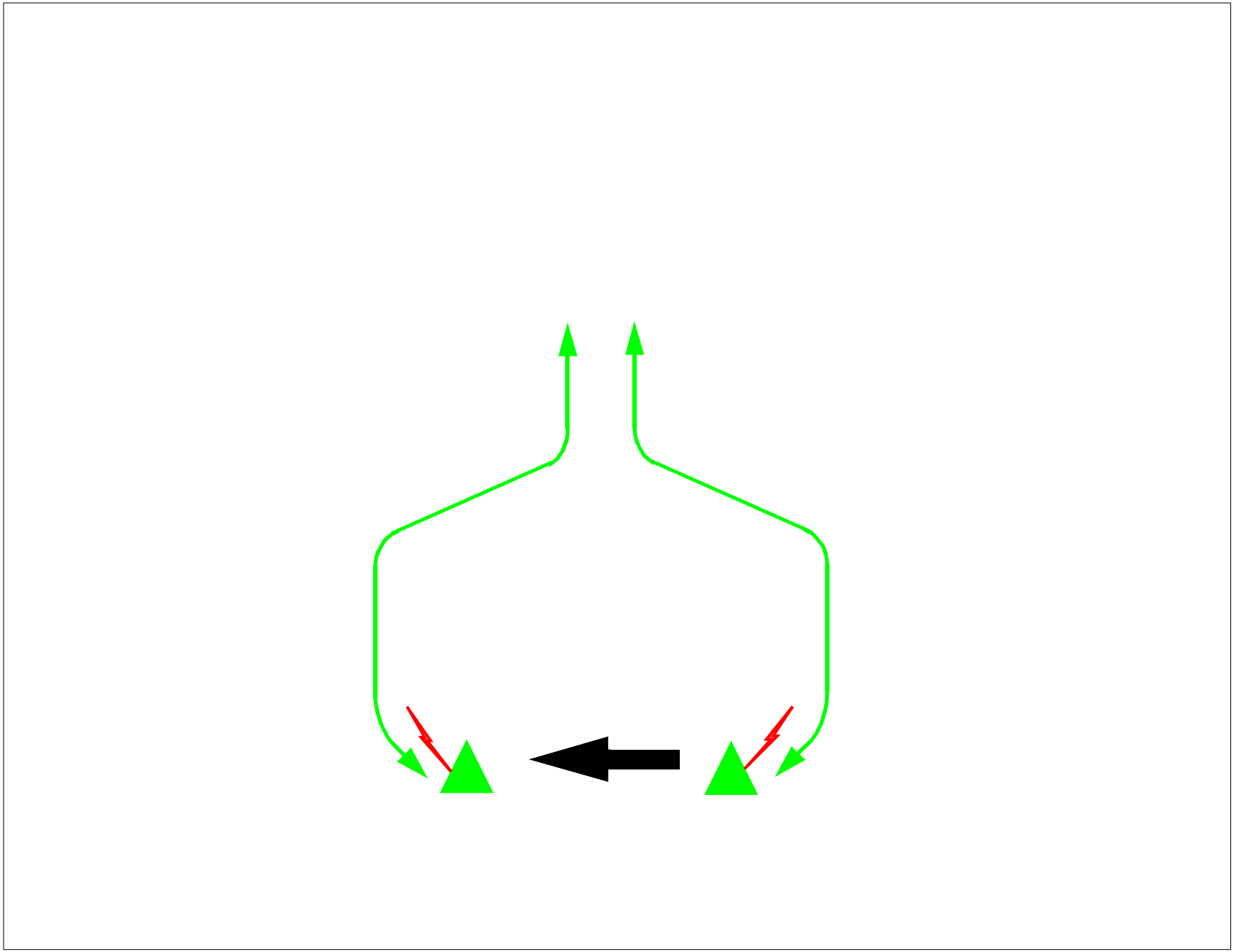
- Not always available
- Used as hints - set up as much of handoff as possible

The Connection Handoff Problem

A handoff occurs when a host moves between adjacent cells

Question: How to re-route network connections during handoffs





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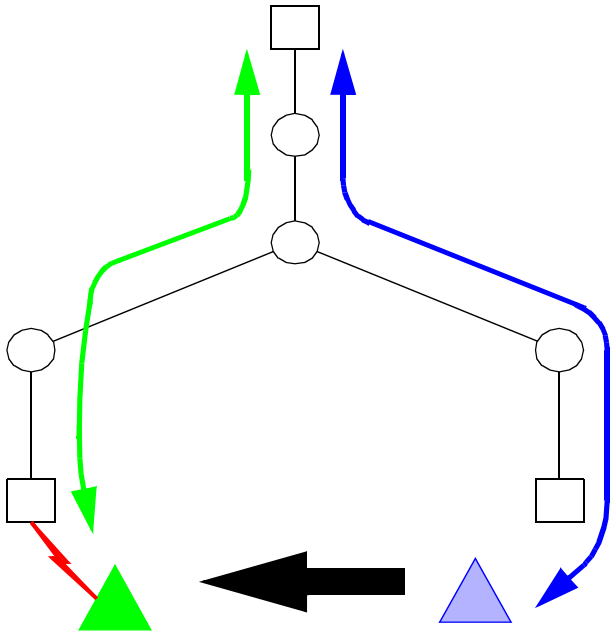
Goals of the Algorithms

- Minimize time during which real-time performance guarantees may be violated
- Minimize time during which data cannot be sent or received by the mobile host
- Minimize data loss during handoff
- Minimize network resources used to perform handoff
- Minimize buffering in the mobile host and base station

Full Re-Establishment

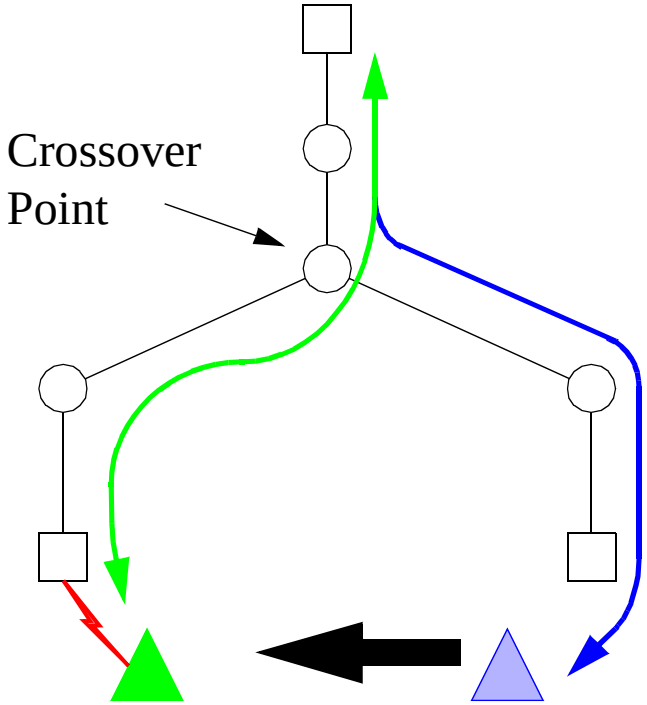
Establish new connection for every existing network connection at handoff



Incremental Re-Establishment

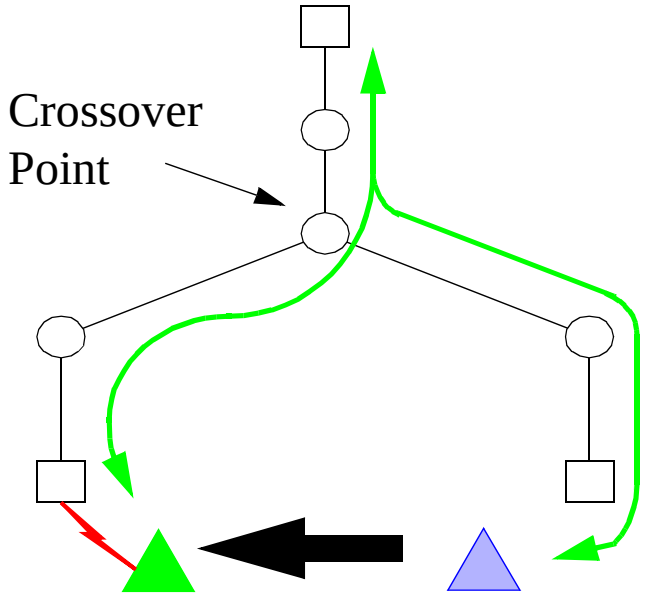
Only create the disjoint part of the connection to the new base station

- Crossover point - the point where the original and new connections diverge



Multicast-Based Re-Establishment

Exploit the existing dynamic multicast facilities of a network to support handoff



Uses existing network primitives ⇒ Easier to build

Expected to utilize considerable network resources

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Algorithm Analysis

Identified messages required to perform handoff

Derived equations for overheads

- Time to completion ⇒ time during which real time performance guarantees may be violated
- Disruption time ⇒ time during which data cannot be sent/received by the mobile host
- Space-Time Product ⇒ Minimize network resources used to perform handoff
- Buffering in the mobile host and base station

Parameters

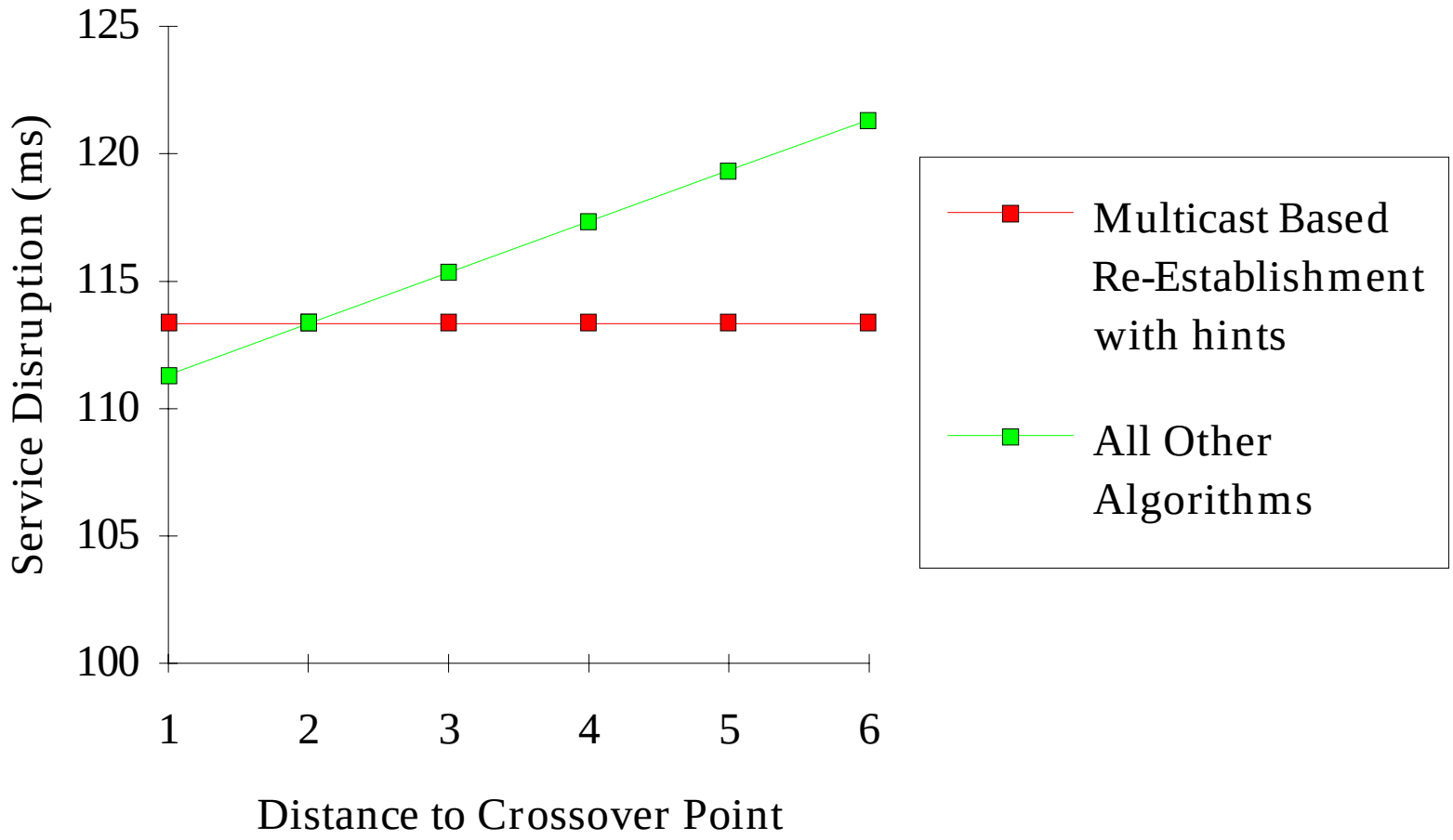
Different connection topologies

- Number of hops to crossover point
- Number of hops between (physically) adjacent base stations
- Distance to server = 6 hops

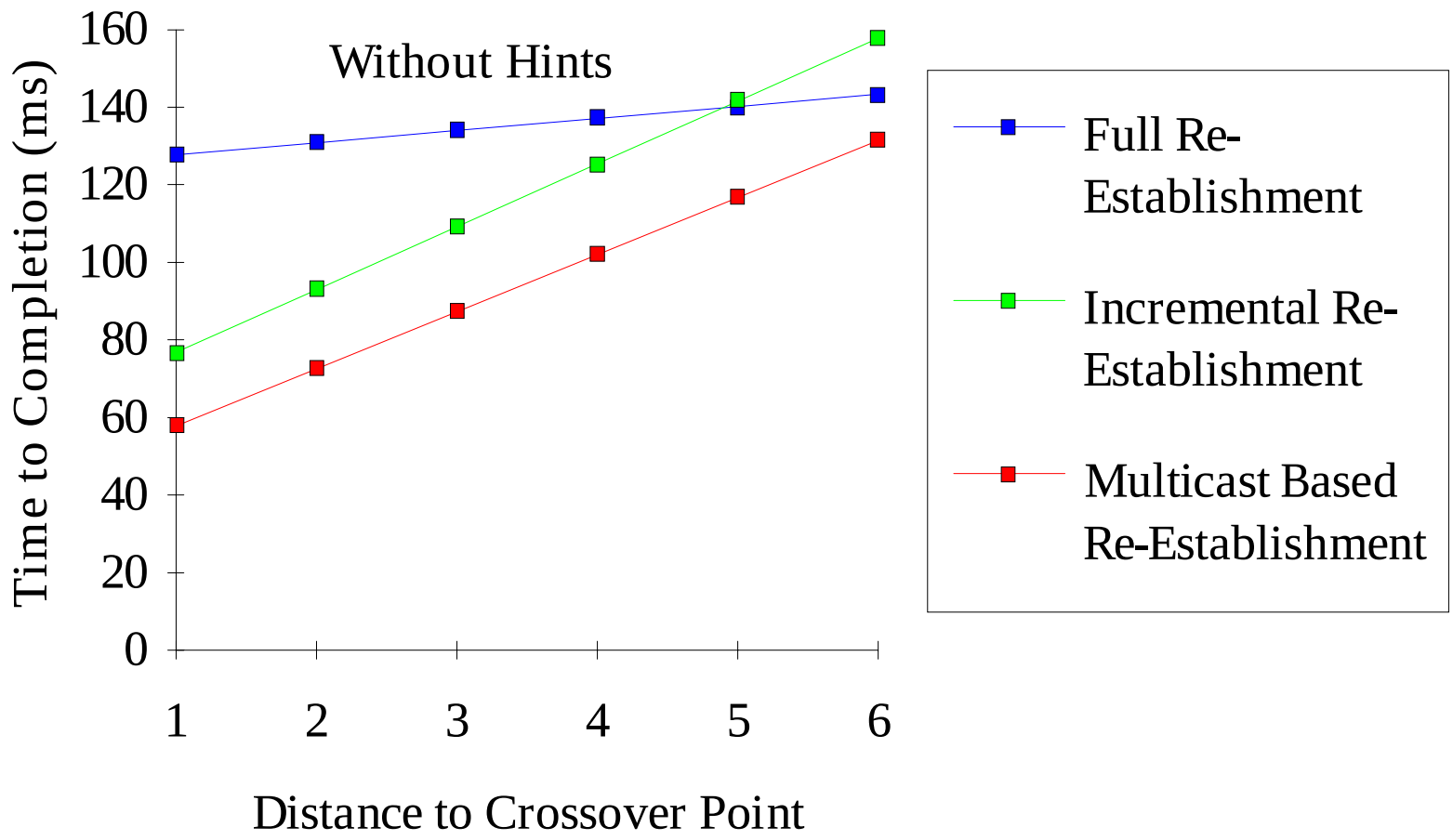
Fixed network technology parameters

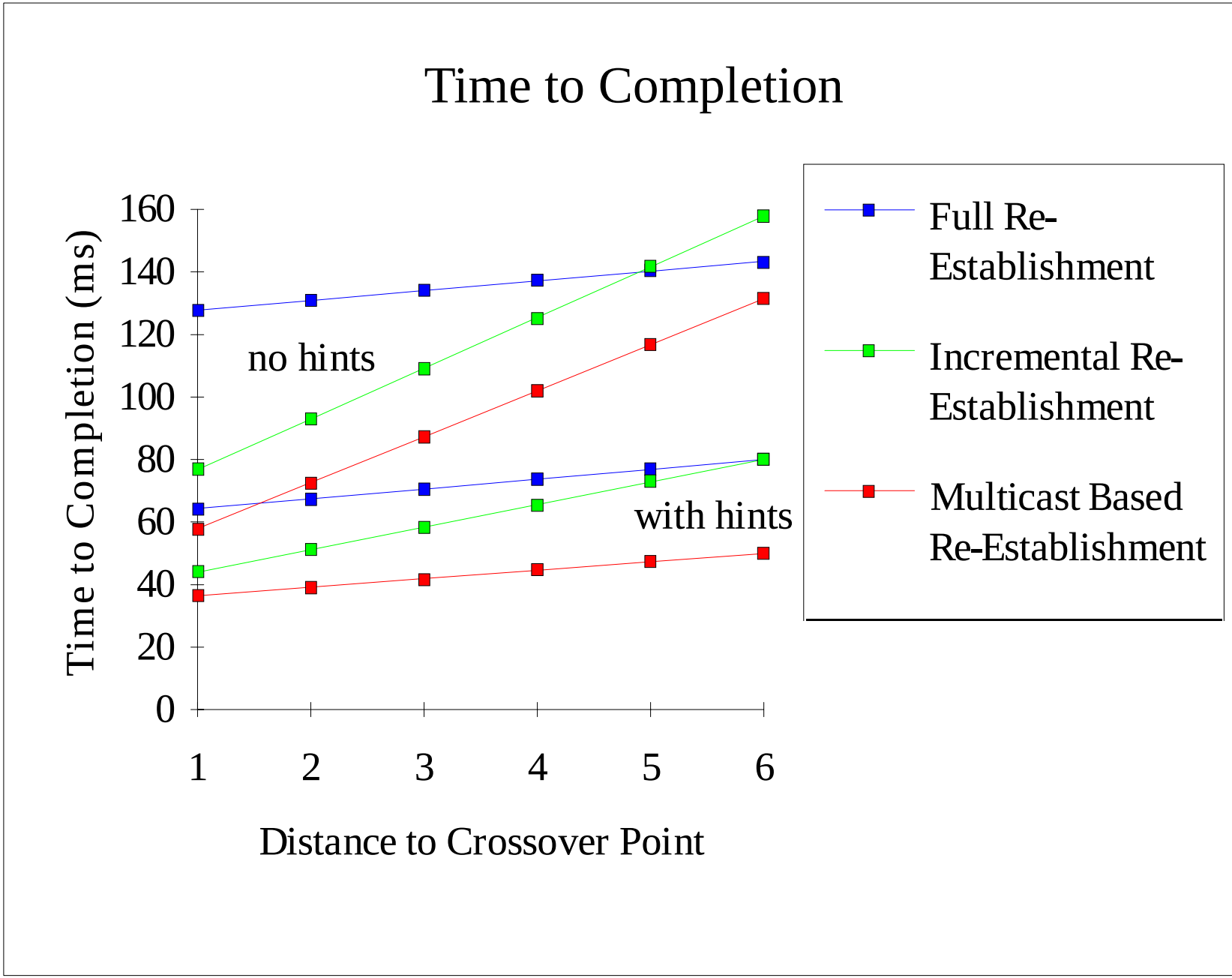
Parameter	Value
Wireless Bandwidth	1Mbs
Wired Backbone Bandwidth	1Gbs
Protocol Processing Times	3ms

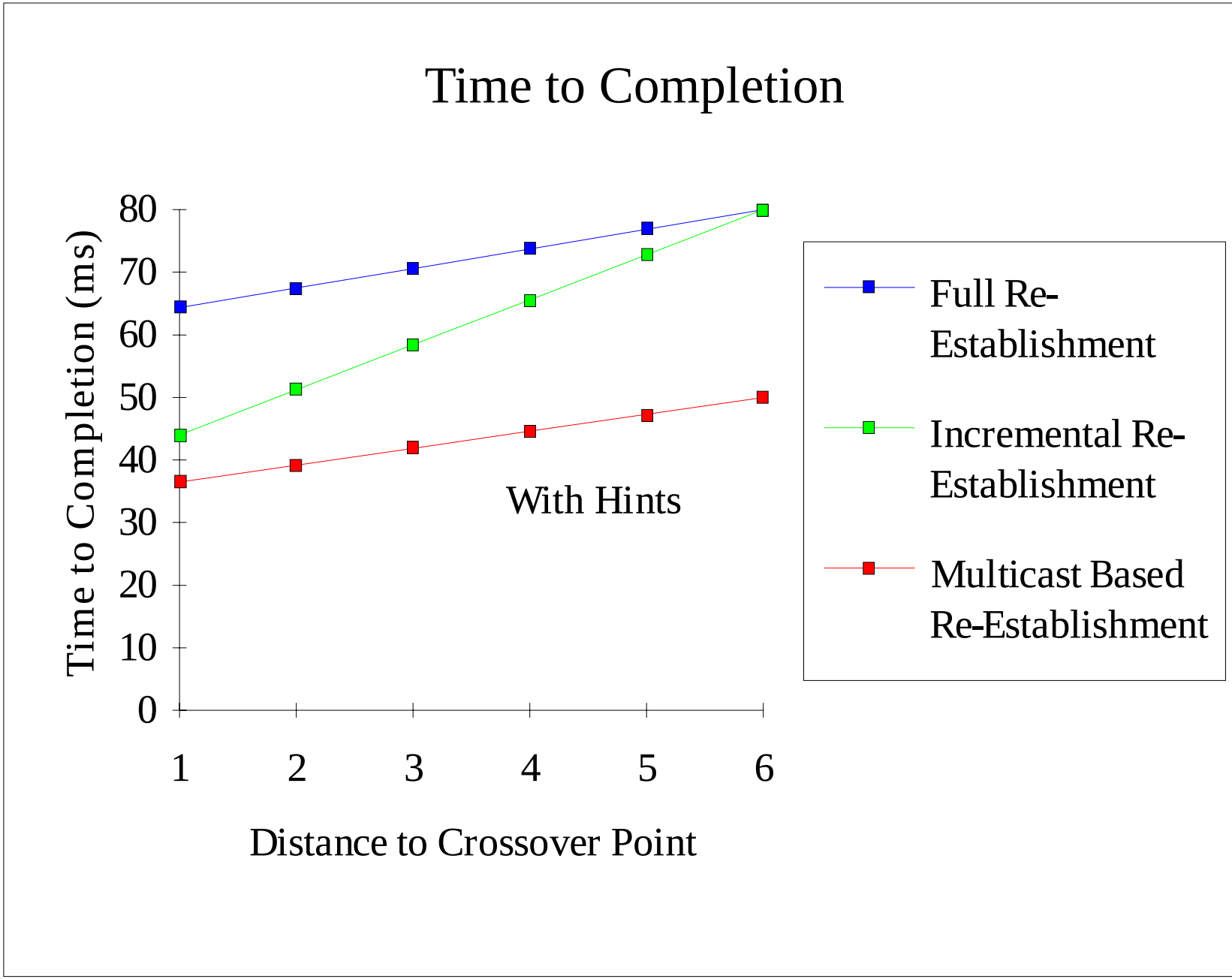
Service Disruption Time



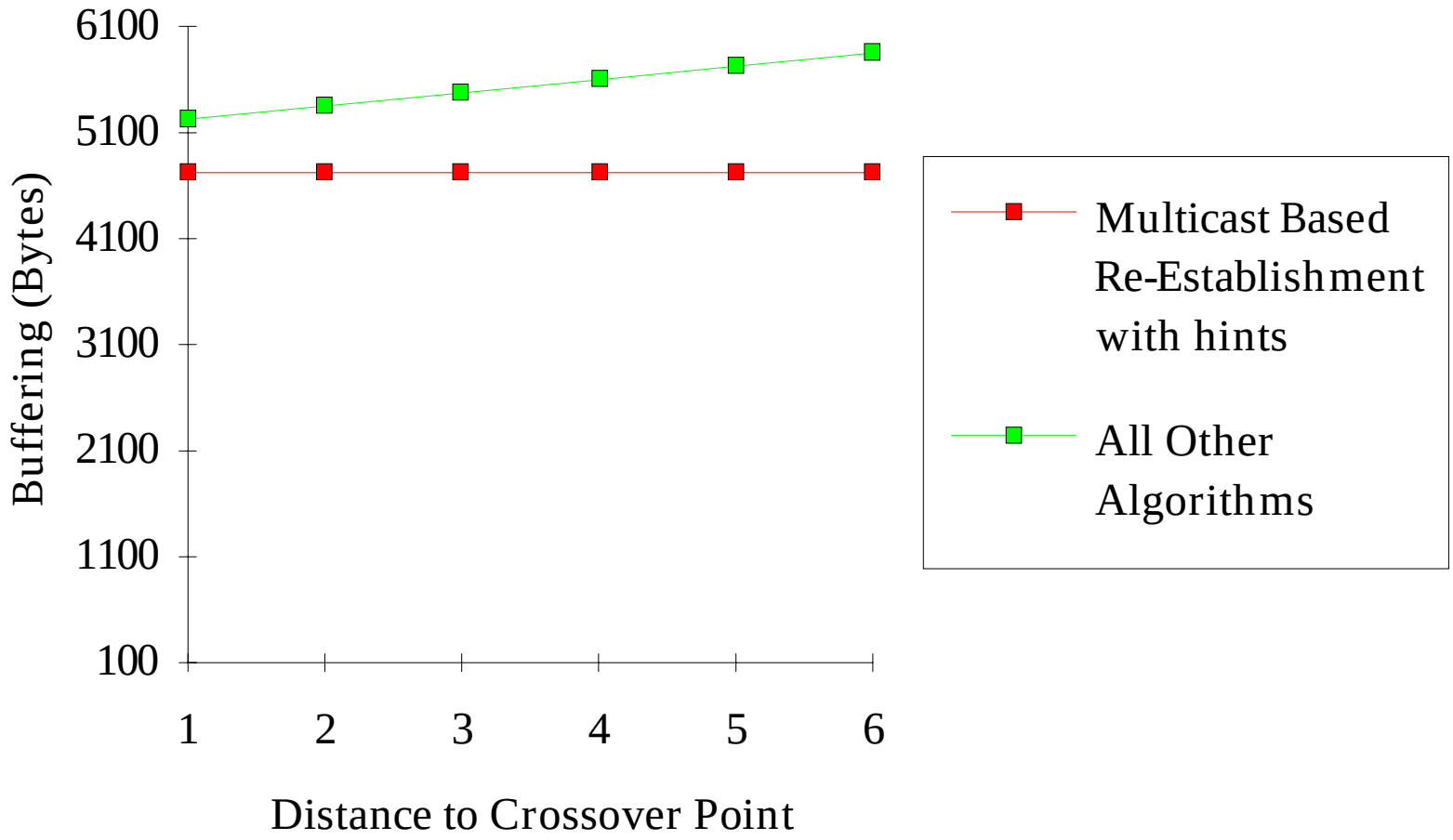
Time to Completion



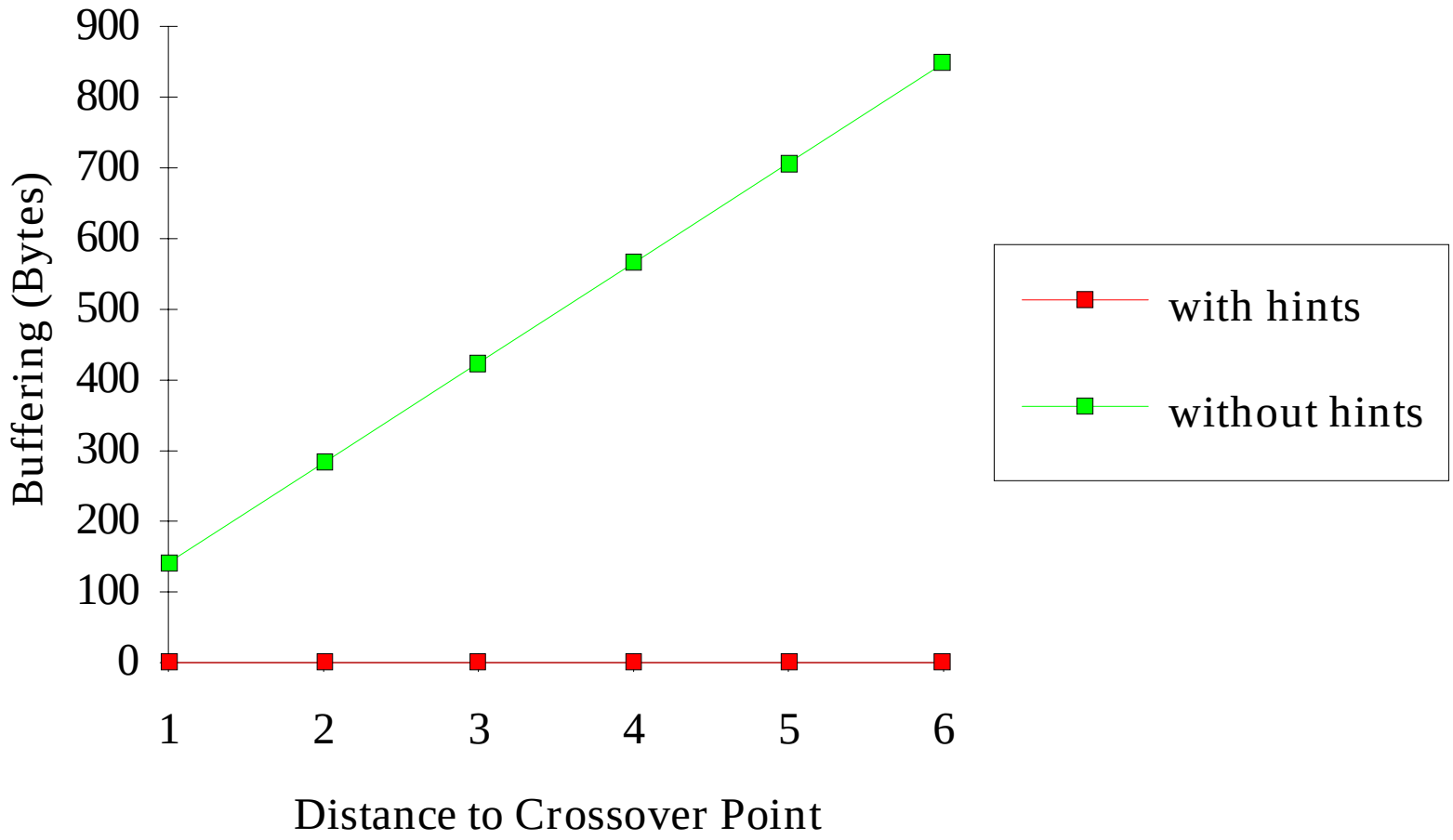

Time to Completion
Time to Completion (ms)
160
140
120
100
80
60
40
20
0
no hints
with hints
1
2
3
4
5
6
Distance to Crossover Point
Full Re-Establishment
Incremental Re-Establishment
Multicast Based Re-Establishment


Time to Completion
Time to Completion (ms)
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
Distance to Crossover Point
With Hints
Full Re-Establishment
Incremental Re-Establishment
Multicast Based Re-Establishment

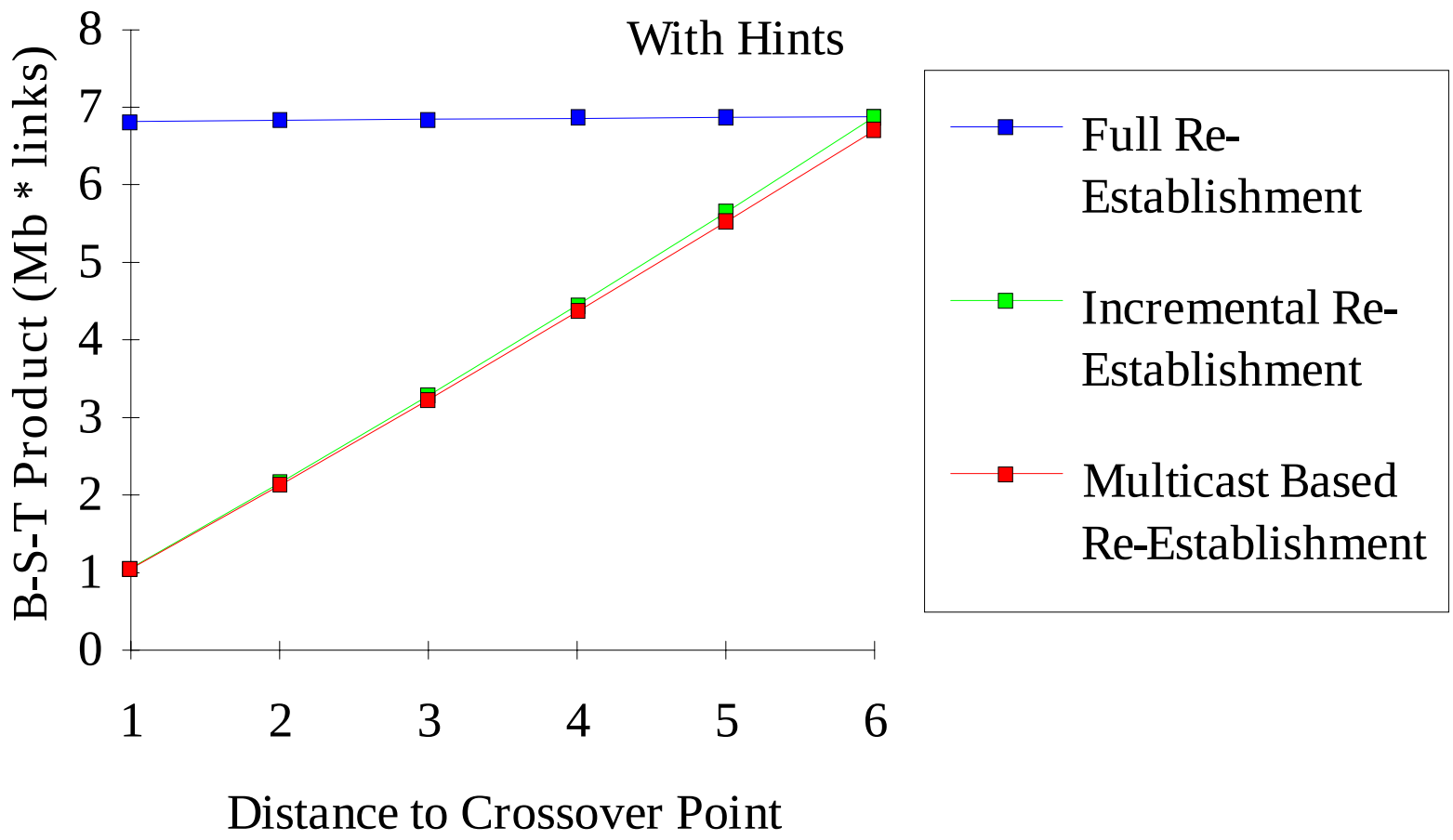
Buffering Downlink Data in Base Station



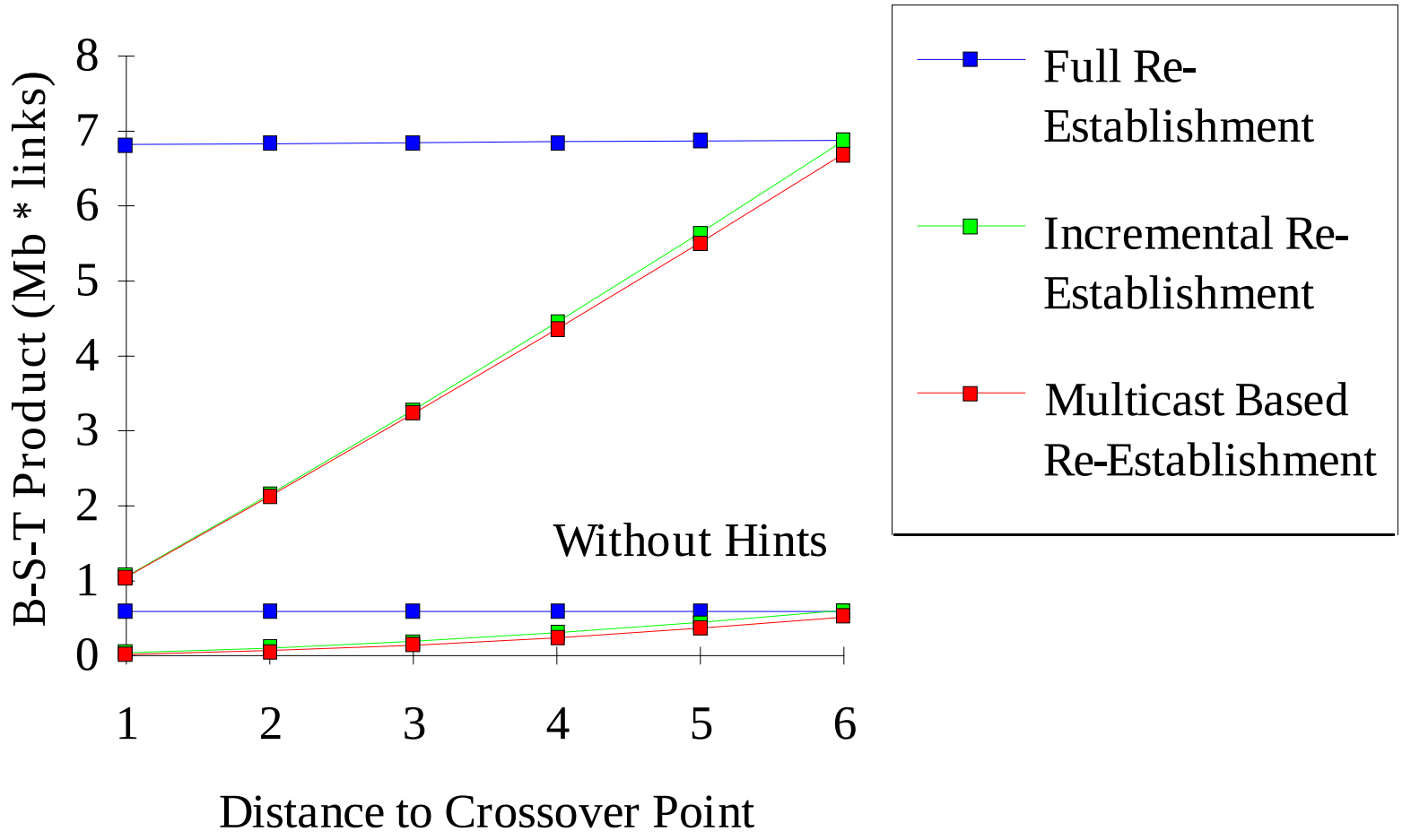
Buffering Uplink Data in Base Station



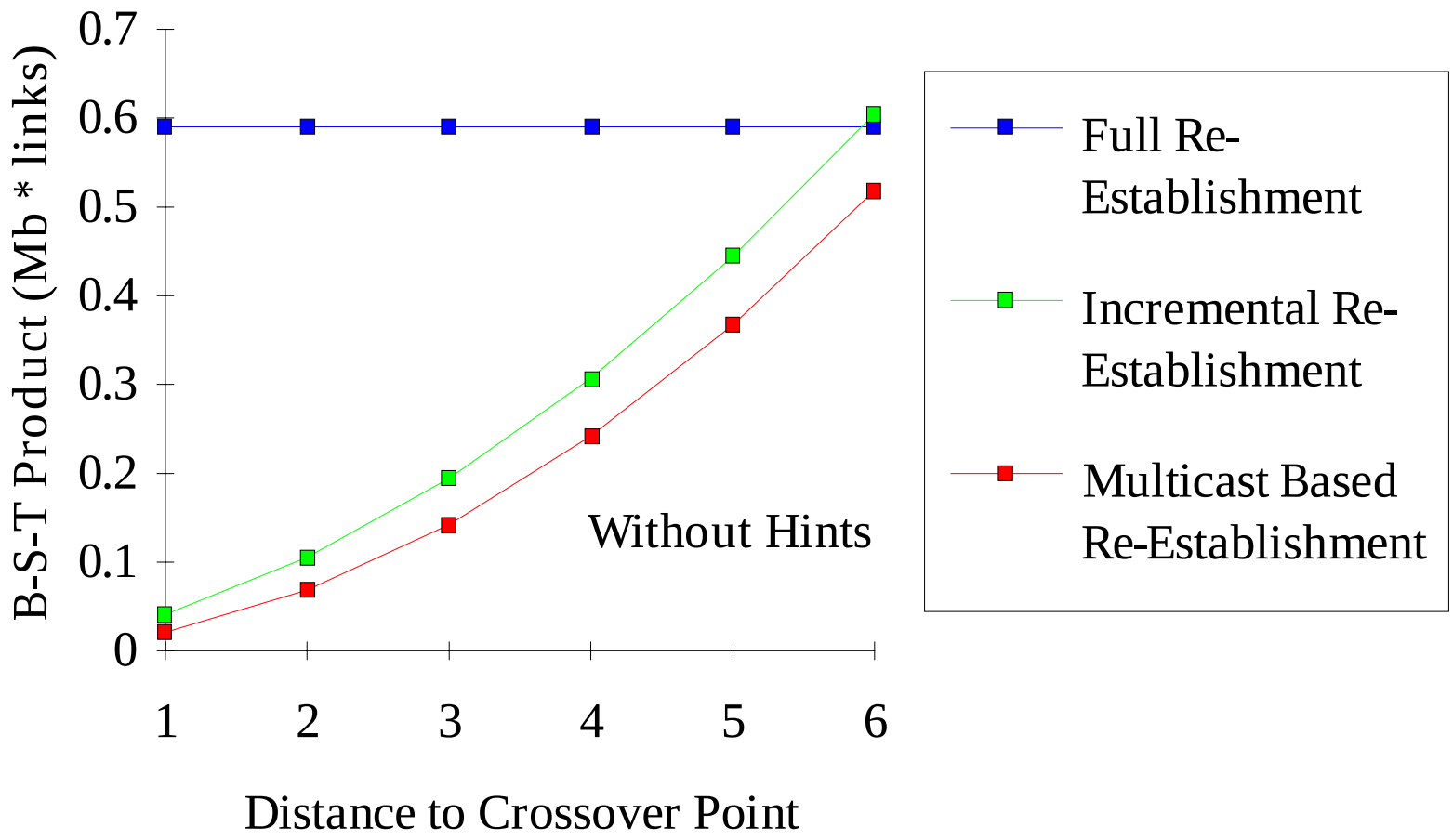
Space-Time Product



Space-Time Product



Bandwidth-Space-Time Utilization



Synopsis

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Conclusions

Combination of multimedia and mobility creates handoff problem

Hints provide a significant aid to handoff

- Handoff latency versus network resources

Multicast-based algorithms are promising

- Reduced latency
- Reduced resource allocation
- Easier to implement

Considerations of network topology are important

- Minimize distance between crossover point and base station

Future Work

Event-driven simulation

- Capture dynamics of the network
- Attempt to measure network capacity

Verification of handoff protocols

- Hint-based protocols
- Unreliable message delivery

Implications of mobility on semantics of real-time guarantees

Implementation

Advantages of Connection-Oriented Network Layers

Deterministic and statistical performance guarantees

- Connections allow resources to be reserved for each conversation
- Real-time guarantees are provided to each connection regardless of congestion due to other connections

Protection from malfunctioning or misbehaving hosts

The Tenet Real-Time Protocol Suite

Tenet Suite I

- Performance-guaranteed, unreliable, connection-oriented, unicast real-time channels

Tenet Suite II: The Sequel

- Performance-guaranteed, unreliable, connection-oriented, *multicast* real-time channels