Coping with Link Noise at the Transport Level

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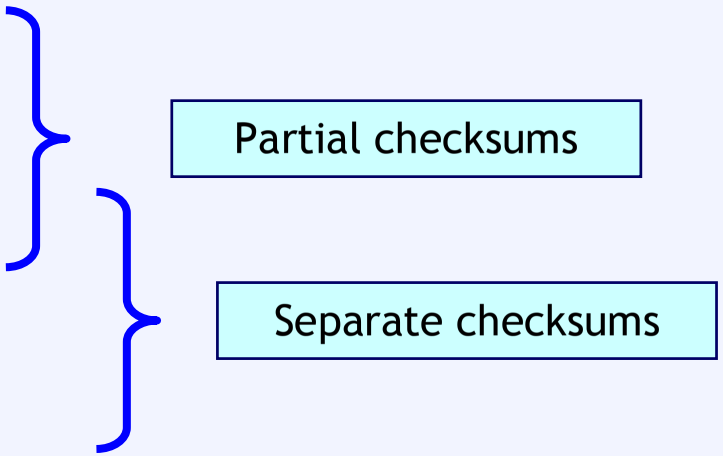
Outline

- Optional 802.16 features related to link noise
  - Link layer ARQ
  - MAC sublayer CRC
- UDP Lite
- DCCP
- TCP
- Conclusion



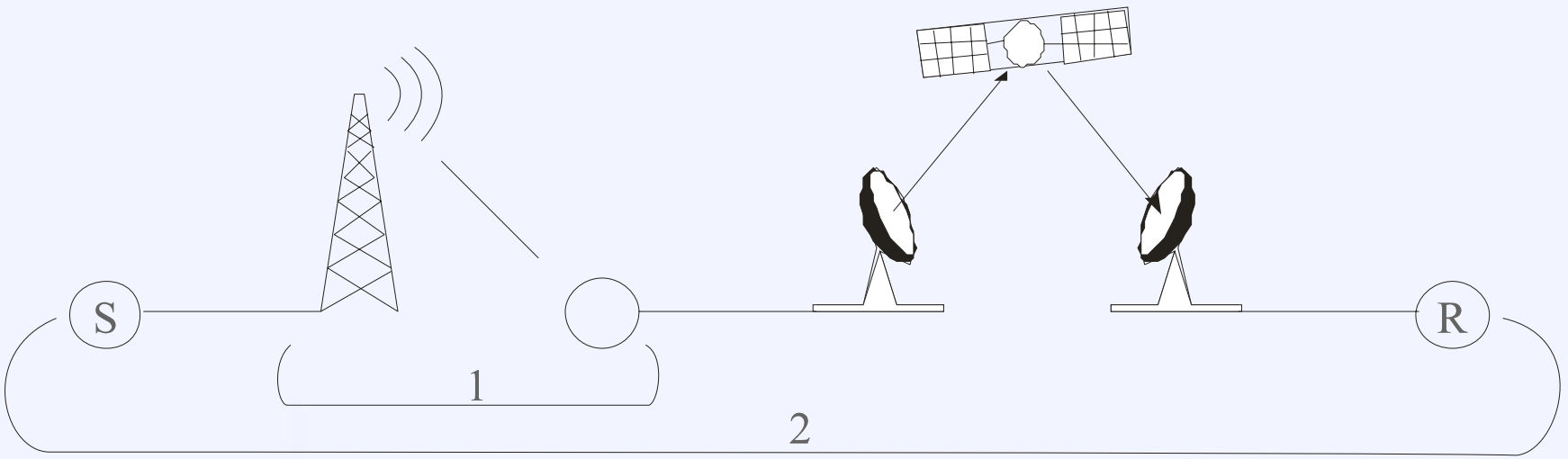
802.16 and link noise

- Large number of options
- We are concerned with two:
  1. Link layer ARQ
  2. MAC sublayer CRC
- Question: why optional?
  (What is the benefit of enabling/disabling these features?)
- Context: TCP/IP over 802.16

Link layer ARQ

- Advantages:
  - potentially faster than end-to-end retransmits
  - operates on frames, not packets
  - could use knowledge that is not available at transport end points

- example scenario: control loop 1 much shorter than 2



Link Layer ARQ /2

- Disadvantages:
  - hides information (known corruption) from end points
  - TCP: increased delay ⇒ more conservative behavior
- Link layer ARQ can have varying degrees of persistence
- So what?
- Ideal choice would depend on individual end-to-end flows
- Thus, recommendation:
  - low persistence or disable (leave severe cases up to end points)
  - Give end points means to react properly (detect corruption)

Further details:
RFC 3366

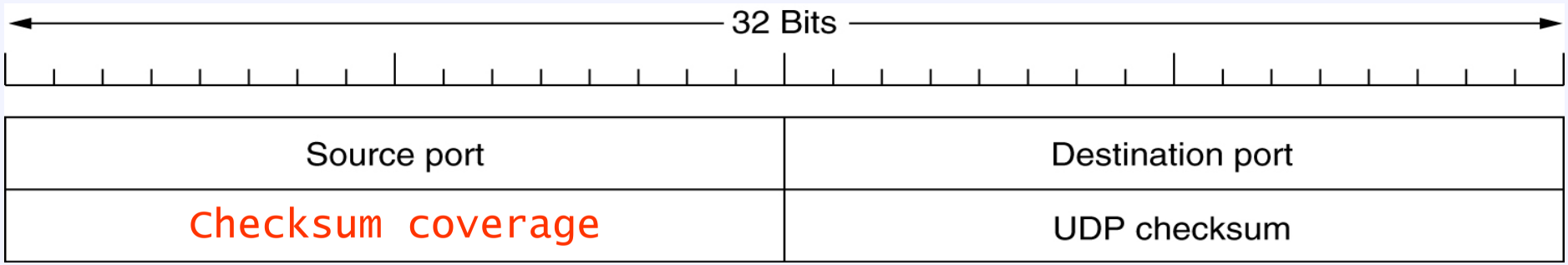
Disable the checksum !

- MAC sublayer CRC optional in 802.16
  - turn it off!
  - just do it :)

- There are ways to use erroneous data in TCP/IP
  - but only if these data are available!
  - handing over erroneous data seems stupid unless they are used by TCP/IP
  - chicken-egg type of problem ... someone has to make a start!
  - the IETF did

- Two basic approaches
  1. partial checksums (give erroneous data to apps) - UDP Lite, DCCP
  2. separate header/payload checksums - DCCP
     (avoid misinterpretation of corruption as congestion)

UDP and UDP Lite



- UDP = IP + 2 features:
  - Ports: identify communicating instances with similar IP address (transport layer)
  - Checksum: Adler-32 covering the whole packet
    - checksum field = 0: no checksum at all - bad idea!
    - ⇒ solution: UDP Lite (length := checksum coverage)
      - advantage: e.g. video codecs can cope with bit errors, but standard UDP throws a whole packet away!
      - acceptable BER up to applications (complies with end-to-end arguments)
      - critical: app's depending on UDP Lite can depend on lower layers
- Usage of UDP: unreliable data transmission
  - DNS, SNMP, real-time streams, ..

Approved by IESG for publication as Proposed Standard RFC

Datagram Congestion Control Protocol (DCCP)

- Unreliable flows (etc.) should perform congestion control
  - up to now, embedded in app (on top of UDP)
    - difficult to realize
    - often not done (properly)
- Many research efforts on CC. for streaming (smoother,..) – e.g. TFRC
- Well-defined framework for (TCP-friendly) congestion control
  - Peers negotiate appropriate mechanism
  - Core OS implementation of congestion control
- Many additional features
  - Partial checksums as in UDP Lite
  - Nonces, ..

Developed in IETF DCCP Working Group;
TFRC: RFC 3448 (Proposed Standard)

Separate header / payload checksums

- Available as feature ("Data Checksum option") in DCCP !
  - Currently discussed in IETF for TCP
  - Note: partial checksums useless in TCP (reliable transmission of erroneous data?)
- Differentiate corruption / congestion
  - Checksum covers all
    - Error could be in header
    - Impossible to notify sender (seqno, ports, ..)
  - Checksum fails in header only
    - Bad luck
  - Checksum fails in payload only, ECN = 0
    - Inform sender of corruption
    - No need to react as if congestion
    - Still react (keeping high rate + high BER = bad idea) ⇒ experimental!
  - Checksum fails in payload only, ECN = 1
    - Clear sign of congestion

Why is that so important?

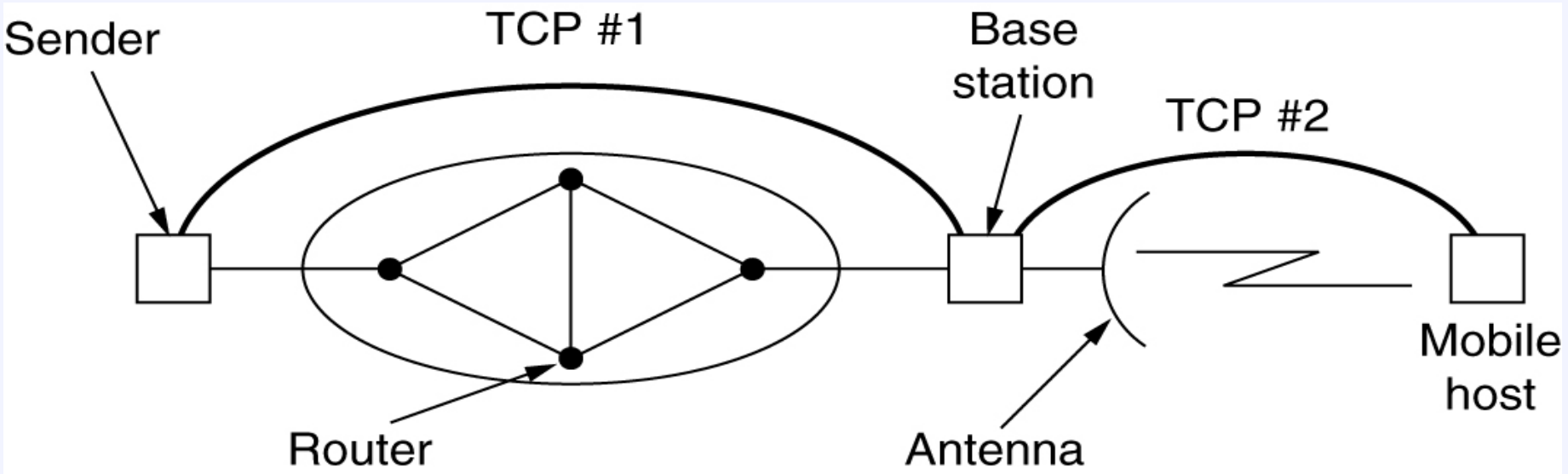
- TCP congestion control:
  - introduced in the 80s, necessary to prevent congestion collapse
- TCP interpretation of network feedback:
  - single packet loss = sign of congestion
    or
    Explicit Congestion Notification (ECN) flag = 1 = sign of congestion
    - sender halves rate (Congestion Avoidance) – exponential backoff!
  - many packets lost in a row = sign of heavy congestion (timeout)
    - sender goes back to Slow Start
  - round-trip time estimate increases / decreases
    - longer RTT = more conservative (e.g., increase by ≈ 1 segment / RTT)

MAC sublayer CRC

Link layer ARQ

Wireless links: misinterpretation of ***packet loss*** and ***RTT estimate*** ⇒ massive throughput degradation!

TCP over wireless: many hacks available



- Various possible enhancements:
  - split connection at base station
    - act like sender towards receiver + act like receiver towards sender
  - monitor connection at base station, buffer + interfere ("Snoop TCP")

Another possibility: change packet size!

- Underlying idea:
  - Frame size: 1000 bits, BER 1/1000 ⇒ each frame erroneous
  - Frame size: 100 bits, BER 1/1000 ⇒ 1 out of 10 frames erroneous
    - Tuned using link layer fragmentation (another 802.16 feature)
  - 1000-bit packet consisting of 10 100-bit frames vs. 100-bit packet consisting 1 100-bit frame: same effect!
    - Tuned at IP layer!

Project idea!

- Simple test:
  - cheap off-the-shelf 802.11b equipment, long distance at our institute
  - 1800 pings (15 minutes, 1 ping every 0.5 seconds), packet size = 100 byte

1000 byte packets	100 byte packets
rtt min/avg/max/mdev = 11.779/**28.271**/315.876/35.121 ms	rtt min/avg/max/mdev = 3.274/**12.410**/1022.437/46.585 ms

NOTE:

802.11b CRC cannot be disabled;

delay = ARQ !

The End ...

- Conclusion: disable 'em ! (unless you know it's a special case)

- **References:**

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