Sequence Numbers & Time Accuracy

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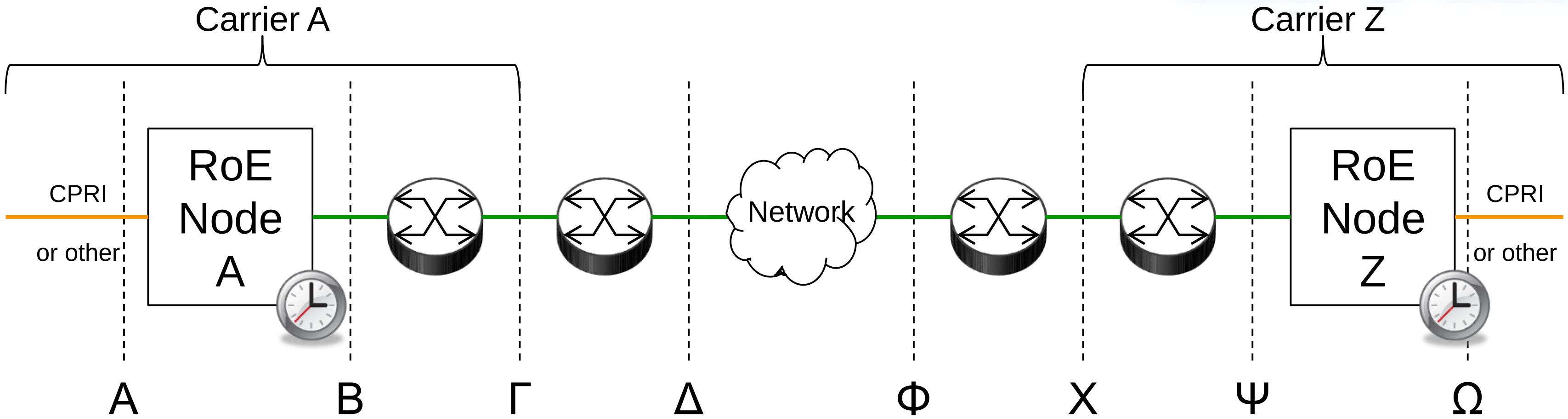
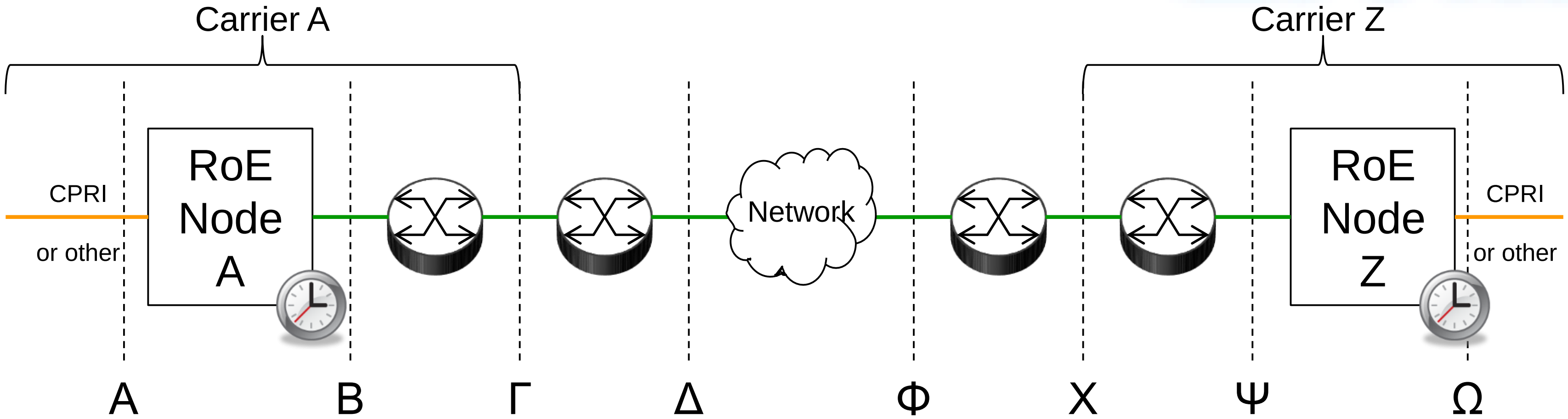
Example RoE Network



- Carriers have RoE equipment with Ethernet connections to intermediate network (Β or Γ) to (Ψ or Χ)
  - Could be same carrier's network, competitive carrier's network, cable network, local provider's network, enterprise network, or government/military network
- Carriers A & Z often the same carrier

Α = Alpha
Β = Beta
Γ = Gamma
Δ = Delta
Φ = Phi
Χ = Chi
Ψ = Psi
Ω = Omega

Timing Requirement



- ❑ Each RoE node responsible for its own sense of time via its own local clock
  - – Methodology is not prescribed in 1904.3
    - Can use GPS/GNSS, cesium oscillator, 1588, SyncE, SONET, BITS, or other methods
  - – Timing accuracy not defined in 1904.3
    - 3GPP has 65 ns as tightest timing to date
- ❑ Node time NOT set through RoE

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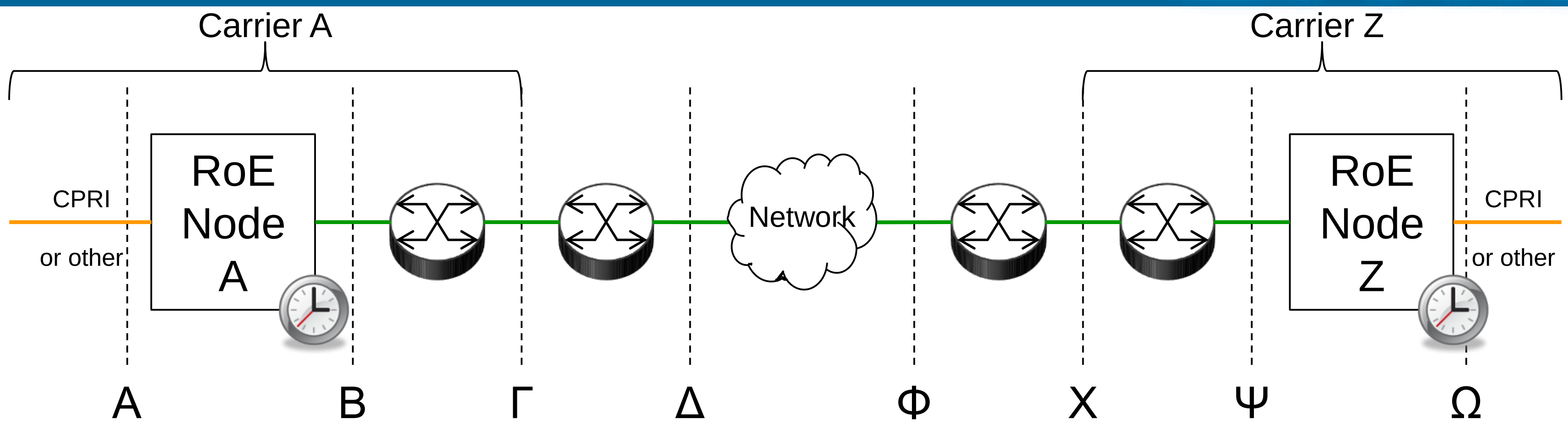
Timing Drift



- Node A and Node Z clocks <u>will</u> drift slightly
  - Each node responsible for correcting time and walking in changes to not cause jitter in radio
  - Example: ITU recommends 1588 systems send time updates ≥ 16 times per second
    - Low-pass filter can adjust clock gradually

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Constant Rate Traffic

- Each node needs to know when to start
  - Local clock error may result in slight differences
- Each RoE node sends data at fixed rate
  - Node may adjust its clock rate slightly if its sense of time is different from its clock master
    - With whatever method node uses to get its clock
- Fixed rate data fills circular egress buffer
- Sequence number helps in 2 ways:
  - Any packets received out of order can be re-ordered easily from the Sequence Number
  - Missing Sequence Numbers indicate missing packets

Packet Sizes

- Consistent payload sizes make Sequence Numbers even easier to implement
  - Makes it easy to know how many bits to fill if a packet is lost
  - If a packet is lost with variable packet sizes and you only have a sequence number, how do you know when to send the data from the next good packet?
- Payload size could be established as part of the flow setup procedure

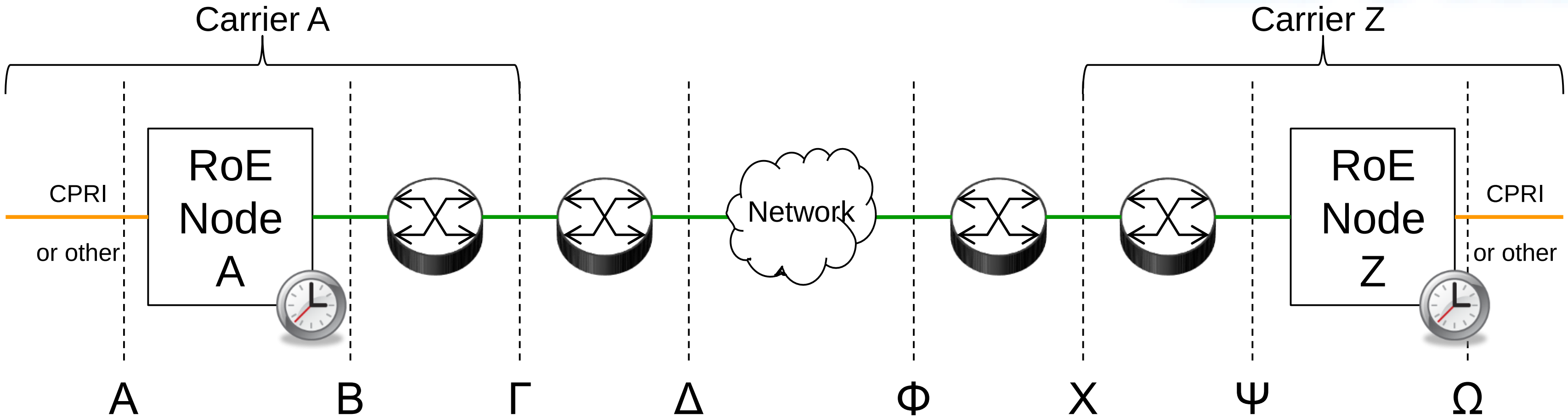
Packet Timing with Sequence #'s

- For constant rate traffic, assume you know the following items:
  - Constant rate negotiated
  - Start time of this flow
  - Consistent payload size
  - Sequence Number for a given packet
  - # of Sequence Number rollovers
- You can then calculate:
  - # of lifetime bits in this flow
  - Theoretical presentation time for that packet
    - There is no need for a presentation time to be sent along with the Sequence Number

Don’t Mix Seq. #’s & Timestamps

- A timestamp will be needed to tell when to start (and end) a flow
- Beyond that, timestamps should NOT be sent with Sequence Numbers
  - Assume both are sent for a given packet
    - If circular buffer is not empty by the presentation time in the timestamp, do you drop bits in the buffer?
    - If circular buffer is empty until the presentation time in the timestamp, do you fill bits in the radio stream?
  - Bottom line: do not mix timestamps and Sequence Numbers for the same RoE packets
    - For a given flow, go one way or the other

Summary



- Each RoE node maintains a sense of time
  - Time synchronization method and intermediate adjustments are outside the scope of 1904.3
- Constant data rate traffic is handled well with Sequence Numbers alone
  - Works best with fixed payload sizes
  - Can calculate theoretical presentation time for any packet sent with Sequence Number

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