Limited Team Communication in the RoboCup Standard Platform League

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Reduction of Team Communication in the SPL
- Until 2013: 500 Kbps per team
- 2014: 5 messages per robot per second of 860 bytes (-93%)
- 2015: 5 messages per robot per second of 850 bytes (-1%)
- 2018: 3 messages per robot per second of 508 bytes (-64%)
- 2019: 1 message per robot per second of 508 bytes (-67%)
- 2022: 1200 messages per team per game (at least -80%)

Dynamic Message Sending
- Wait at least 1 s since last message sent by this robot
- Distinguish between priority information and normal information
- Priority information is only sent if message budget still available
- Currently only when the whistle is heard
- Normal information can be sent if ratio between available budget and remaining game time is above a fixed threshold
  \[
  \frac{\text{budget}_{\text{current}} - \text{budget}_{\text{reserve}}}{\text{t}_{\text{remaining}} - \text{t}_{\text{lookahead}}} > \frac{\text{budget}_{\text{game}} - \text{budget}_{\text{reserve}}}{\text{t}_{\text{game}}}
  \]
- Normal information is only sent in state Playing
- Several criteria, whether messages are actually sent

Criteria for Sending Messages
- Behavior information changes (role, tactic, set play, pass target)
- Position information changes (own position, ball position, kick target position)
- Receivers can predict current positions for a while, because speed is sent as well
- Sender checks whether such predictions would still be right
- Significance of position changes is judged both from the perspective of the sender and all receivers corresponding to expected uncertainties in measurements

Number of times a change was a reason for sending a message in the final of the RoboCup German Open Replacement Event 2022

Team Play under Limited Communication
- Team behavior must consider which information has actually reached the teammates
- Coordination in game states without communication (Ready) is entirely based on last shared information

Results
- On average, each message was delayed by 1.91 s during GORE 2022 final
- Better than an expected average delay of 2.5 s, when just sending every 5 s in Playing
- GameController misses messages!

Number of messages sent and how long they were delayed due to budget restrictions in the final of the RoboCup German Open Replacement Event 2022