Railways, Smart Technologies

The way forward

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Movement Authorities -A systems framework

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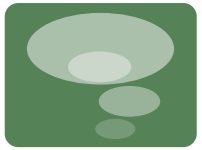
Overview



- Context
  - Generic Systems Framework
- Movement Authorities
  - What are they?
  - When can they be given
  - Process for putting in place and cancelling
- Protection
- Translating from fixed signal to newer technologies

Figure 1 - Generic Systems Framework

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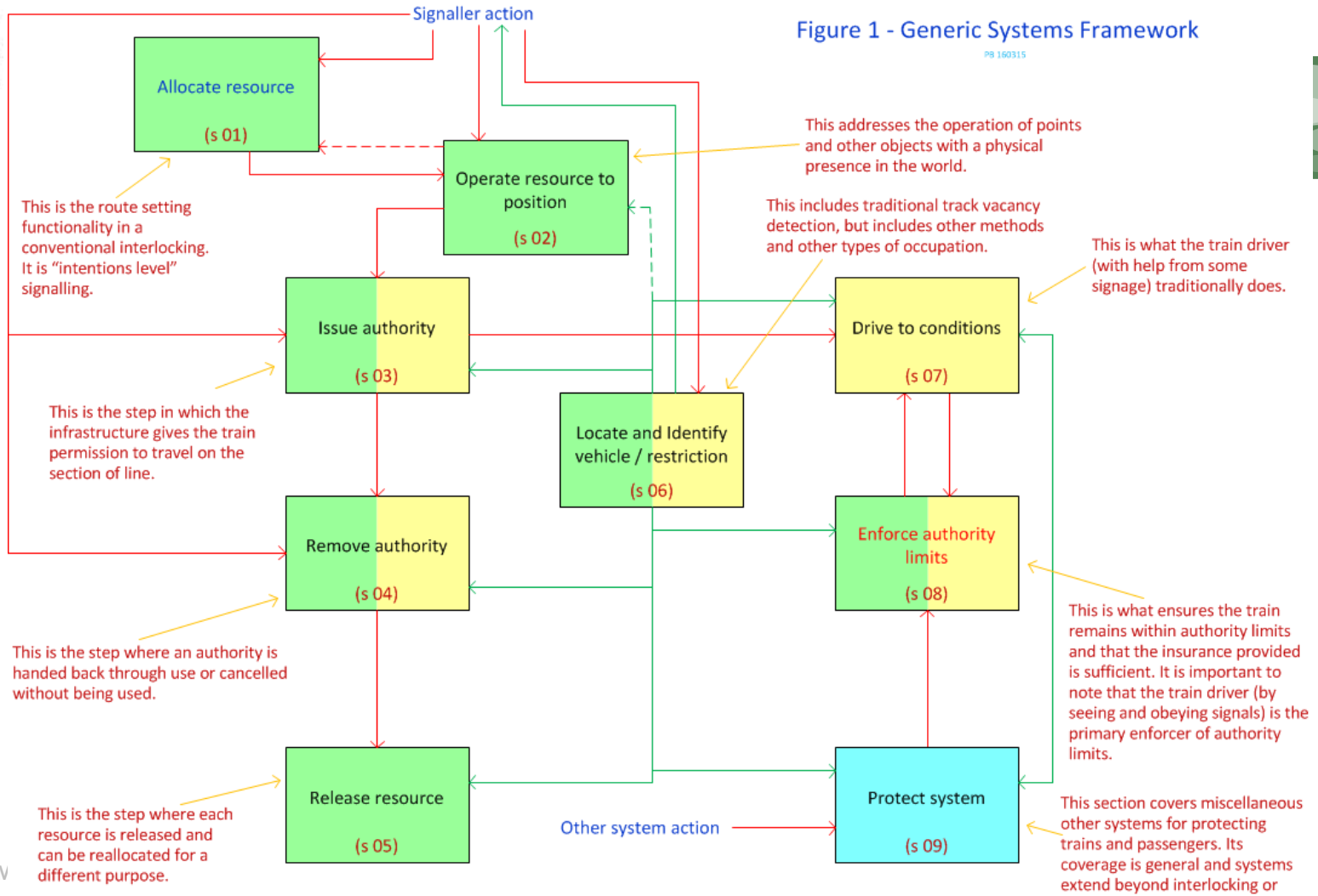
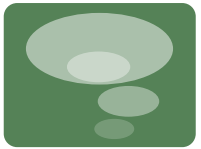


Preconditions



- Before issuing a Movement Authority
  - Route (if any) must be set (satisfying route level tests)
  - Points (or other device) in position (aspect level tests)
    - “Detected” to the extent required by the type of authority
    - “Locked” to the extent required by the type of authority
  - Train understands the “road ahead”
    - “Route knowledge” to the extent required
  - Track ahead clear
    - To the extent required by the type of authority
  - Insurance in place
    - To the extent required by the type of authority

What is an authority?

- An Authority is a Contract
  - Meeting of Minds
    - Common Understanding: Train v Infrastructure
  - Agreement between parties
    - Identified Train v Identified Infrastructure
    - Formal process
  - A Subject (Scope)
    - Arbitrary (in principle)
  - Terms and Conditions
    - The rules of the Rail Authority
    - Special conditions
  - Consideration

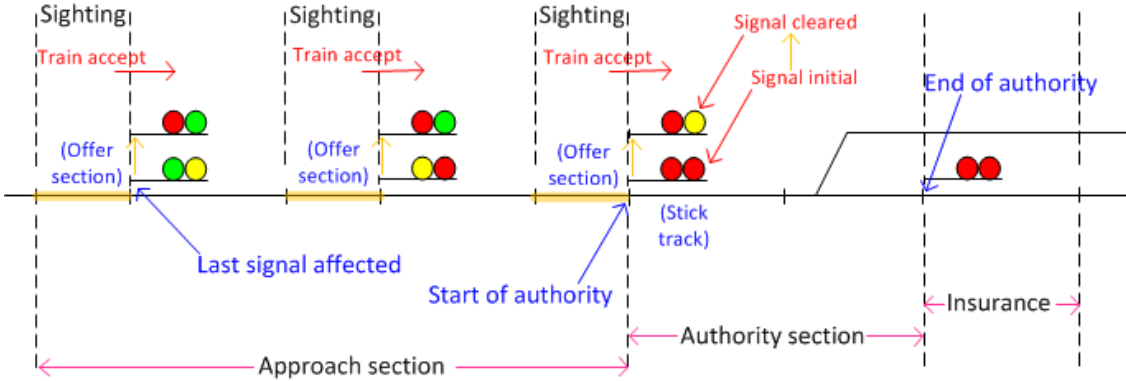
Value of view

- Contract communication is Vital Communications
  - Where agreement between parties is required
- Extensive literature on what can go wrong
  - More flexible than fixed signals

Formal Process - 1

- Preliminary – “Invitation to treat”
  - Train in “sighting of signal” or in execution zone
- An offer (by the infrastructure)
  - Fixed signal displays proceed
  - Train order is read

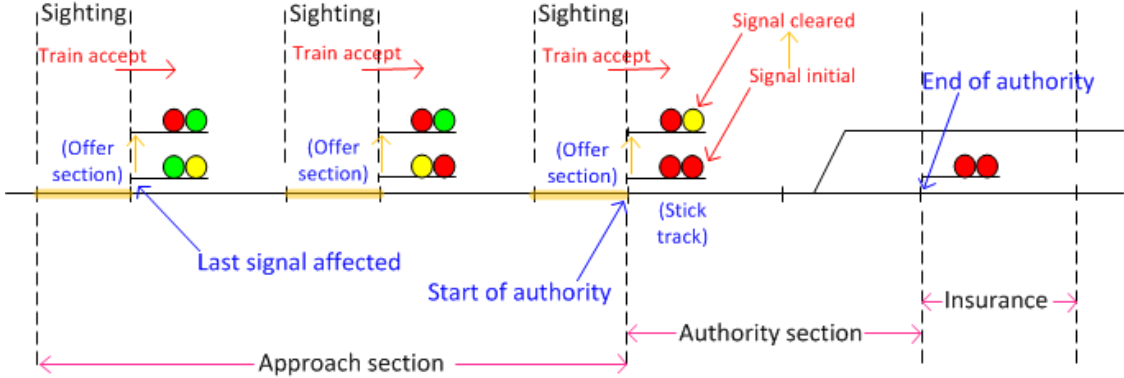
Figure 2: Fixed signal sections



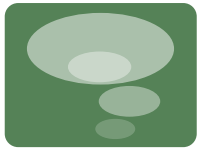
Formal Process - 2

- An acceptance (by the train)
  - Train acts /or reads back authority
- Communication of acceptance
  - Train passes fixed signal
  - Controller hears order read back

Figure 2: Fixed signal sections



Cancelling authority

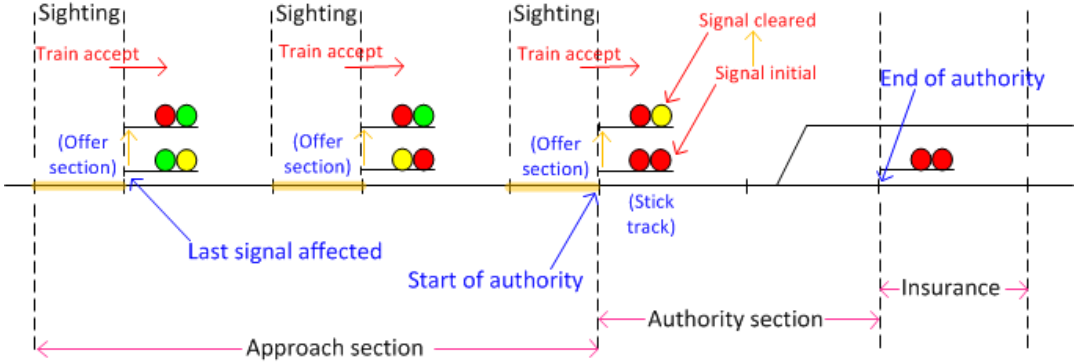


- Most authorities expire with performance
- Cancelling requires Contract Renegotiation
  - Offer = Button Pulled, Signal shows “Red”
  - Acceptance = Train Applies Brakes and stops
  - Communication of acceptance = Train stopped at signal
- Cancellation may be rejected as may any Contract Renegotiation
  - Train passes signal without stopping
    - Assume offer of original authority accepted instead
    - Offer to cancel (signal at stop) may not have been seen
    - Route locked, Authority cannot be withdrawn
- Process is seen in standard Approach Locking, but is more flexible
  - Splits, joins, reverses, stop shorts, speed restrictions are valid variants

Insurance, memory and restart

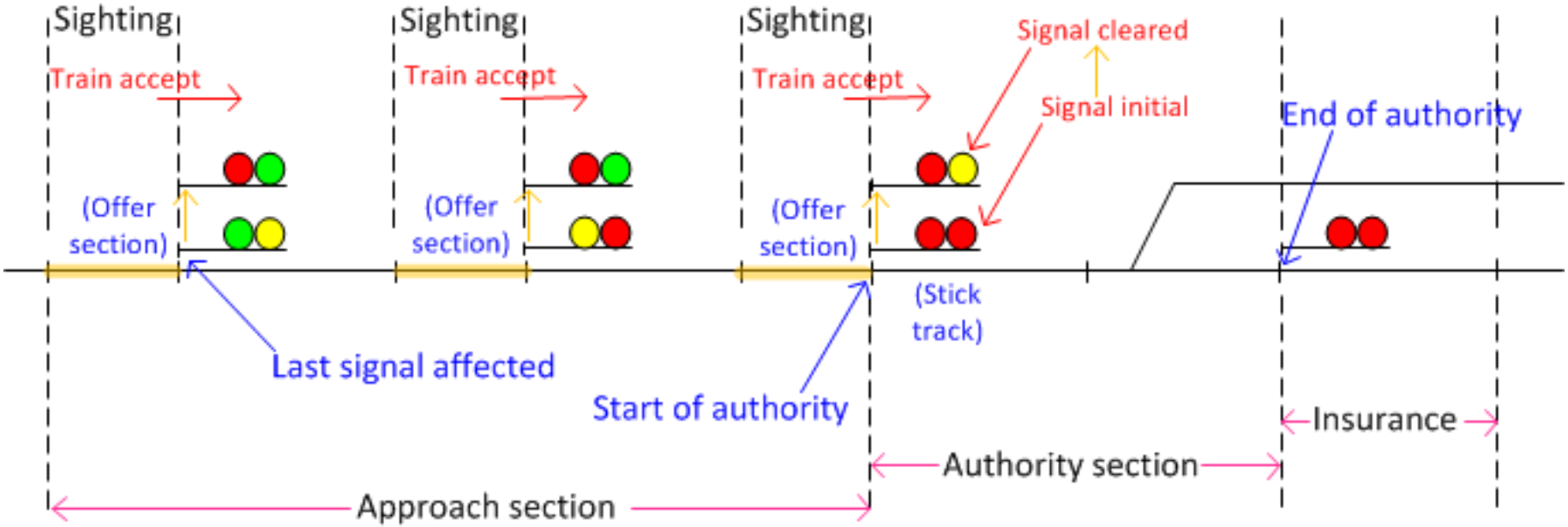
- Insurance provided by the Overlap
  - Can be complex part of interlocking
  - Source of endless debate between Rail Authorities
  - Tends to dominate design effort
- Authority Area and Insurance Area are different
  - Option of “self insurance”
- Memory and Restart
  - Train can request information

Figure 2: Fixed signal sections



Is ERTMS just ATP?

Figure 2: Fixed signal sections



Protection

- Protection function separate from Authority function
  - Equipment Fault Detection
    - Fault detected
    - Signal reverts to stop (“failsafe” response)
    - Train Stops (best endeavours if signal seen)
    - Authority remains in place (Route protection remains)
  - Earthquake detection (Shinkansen)
    - Earthquake detected in substation
    - Overhead power switched off
    - Trains understand to brake to stop
    - (Signals not required)

Fixed Signal Functions

- Regulate movement through interlocked areas
  - Traditional interlocking functions
  - Movement Authority process
- Regulate spacing between trains
  - Auto signals
  - ETCS and CBTC
  - Remove points?
- Inform trains of failures
  - “failsafe”

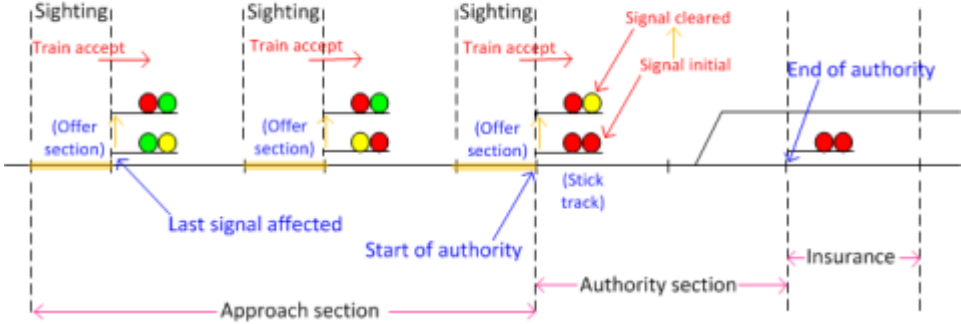
Train separation

- Analogous to vehicles on road
  - Vehicle at rear responsible
    - Vehicle ahead visible
    - Vehicle can see and stop in time
  - Negotiation not required
  - Nothing to cancel
- Rail case
  - Yellow or distant signal provided
  - “Distance to go” concept provides “visibility”
- Protection issue or Authority?

Open & Closed Roads

- Single train authority
  - “Stick” provides train separation
- Multiple train authority
  - Multiple trains permitted between interlocked areas
- Absolute Permissive Block (APB)
  - Authority is for one direction at a time

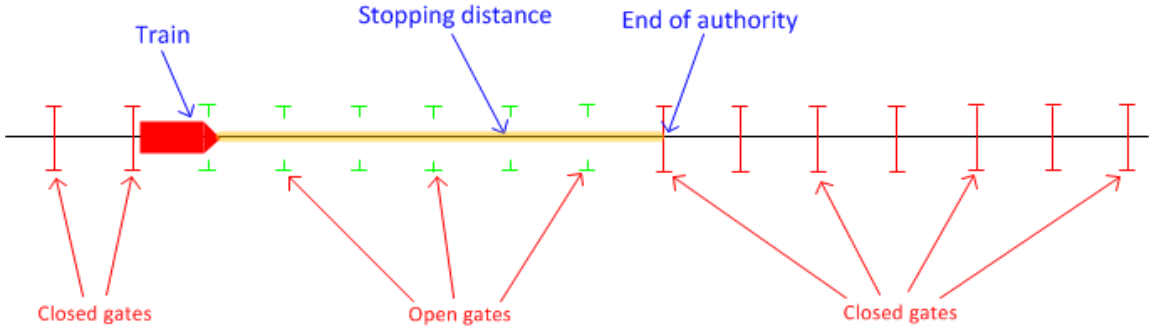
Figure 2: Fixed signal sections



ERTMS

- Train Separation uses Movement Authorities
  - New Authority every few seconds with high capacity
  - Communications constraint
  - Comms fault = Train stops (ERTMS level 2)

Figure 3: Closed road ETCS



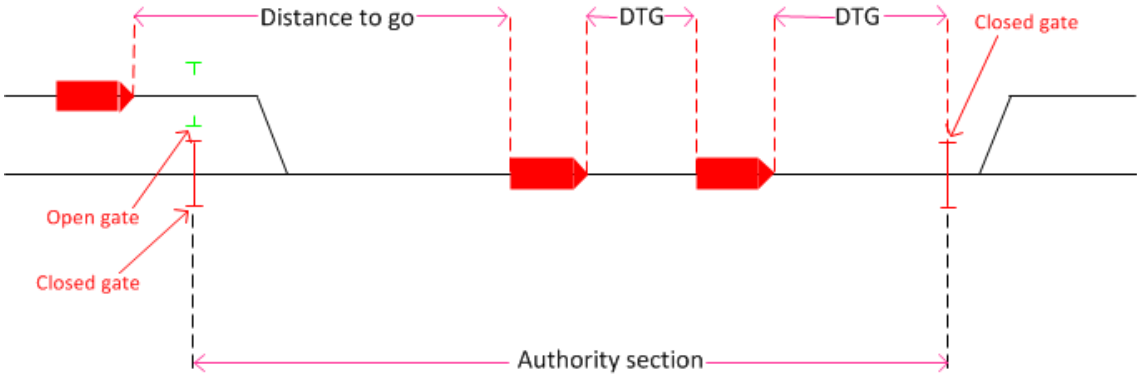
ERTMS & CBTC

- “ERTMS Regional” (level 3)
  - Designed for low density
  - “Distance to go” concept
  - Comms fault = train stops at end of authority
  - Tolerates intermittent communications
- CBTC
  - Designed for higher density
  - “Distance to go” concept
  - Comms fault = train stops at end of authority
  - Tolerates limited intermittency in communications
  - Insurance self management

The Future

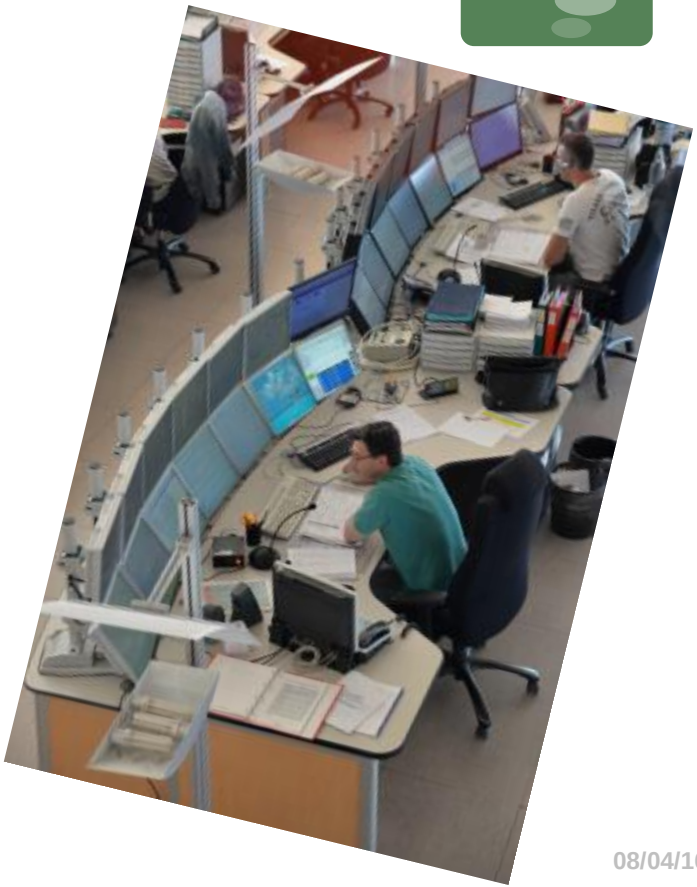
- Separate the three signal functions
  - Train separation as “Protection” function
    - Expand role of “on board” for ATP
  - Interlocking manages interlocked areas
    - Open Road Concepts

Figure 4: Open road concept

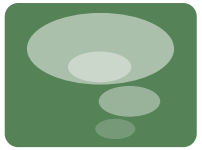


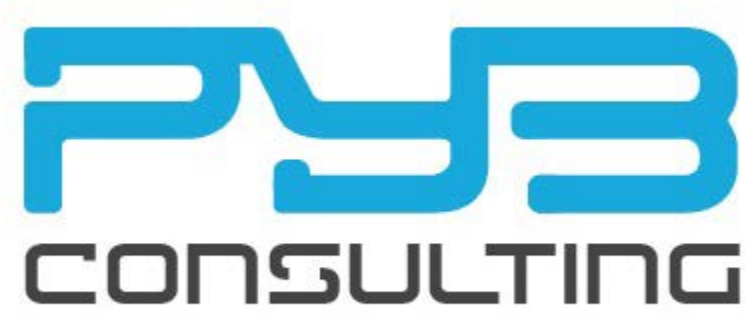
Conclusion

- ERTMS and CBTC are today's technology
  - They excel where train separation is the goal
- Interlocking practice needs to keep up
  - Understanding of fundamentals will help the next generation
  - Good functional integration is possible
- Removing the points is not the only option



Questions?





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